An analysis of the impact of trade liberalization on China's dairy market:

a spatial equilibrium model

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For quality of life

Foreword

This thesis is completed within 7 months under the requirement of course: AEP-80433 MSc Thesis Agricultural Economics and Rural Policy.

The international trade of dairy products has aroused my interest since the Netherlands started to limit the sales of baby milk in supermarkets. The 2008 China's dairy safety scandal caused Chinese consumers lose their faith in the domestic dairy products (mainly infant milk powder). Since then, Chinese people prefer imported dairy products. However, the price of imported milk powder is much higher and the large profits on imported dairy products leads to a huge amount of fake and inferior products. Therefore, the Chinese parents try to obtain the foreign milk powder from western countries directly. The Dutch milk powder has a good reputation of quality in China, so a lot of parents ask their relatives and friends who are in the Netherlands to deliver milk powder to China. However, the panic buying of milk powder caused the shortage in the supermarkets. Noticing this situation, I start to care about the Chinese dairy market, and combining with my economics background, I choose the topic of dairy trade for my master thesis.

The writing of this thesis took much more effort and longer time than I expected. Fortunately, the learning outcome proves it is a meaningful academic training. Here I would like to express my sincere gratitude to my supervisor Jack Peerlings for his instructive suggestions and constructive feedbacks. Besides, I especially appreciate that no matter how many mistakes I made, he was always patient to give me inspiring guidance. Under Jack's supervision, not only did I complete this thesis, but I also learned much from his insights in science which are invaluable and going to stay with in my future career.

I also would like to thank my friends in Lumen, who shared their office. And I feel so grateful to my girlfriend who is in China, but kept encouraging me during the past months. Foremost, I express my greatest gratitude to my parents who offer their unstinting love and sponsor me to study in the Netherlands.

Mengxuan

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Summary

In China, the dairy market has expanded in recent years and it relies heavily on the imports from foreign countries. During the past decades, the Chinese dairy market kept opening, and the fast development of China's dairy trade calls for a research analyzing the effect of trade liberalization on the dairy sector.
In this research, we provide a quantitative assessment of the implications of liberalization of the international trade in dairy products between China and its trading partners using a spatial equilibrium model. The model is developed based on 2011 data from open databases.

The following five questions are answered in this paper: (1) What is the current situation of China's dairy sector and how does China's dairy market develop? (2) What policies are relevant for dairy trade between China and its trade partners now and in the future? (3) How can dairy trade of China be modeled? (4) What data on demand, supply and trade are necessary and available to construct a spatial equilibrium model? (5) What are the effects of trade liberalization on the dairy sector in China?

Three scenarios of different levels of trade liberalization are simulated and the simulation result proves the positive influence of trade liberalization on Chinese dairy sector from a welfare perspective. Based on the results, we come up with some policy recommendations.

Throughout the thesis, chapter 1 provides a general description of the background and problem analysis. Chapter 2 describes the development of China's dairy sector and relevant trade policies. A trade model has been developed in Chapter 3. Next, Chapter 4 focuses on the effects of trade liberalization using a graphical analysis. Chapter 5 details the scenarios and simulation results. Finally, Chapter 6 presents the conclusions, recommendations and discussion.

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1. Introduction

1.1. Background

China's dairy market has experienced rapid expansion in recent years. As a net importer, China doubled its dairy imports from 2005 to 2010, making China the 6th largest world's dairy importer. In another 5 years China is likely to be a Top 3 dairy importer.

In 2012 (January to November), China's dairy import value was 2.43 billion dollars with a yearly growth of more than 20%, accounting for 2.39% of total imports of agricultural products. Besides, the import quantity of dairy products was 103.84 million tons, growing by 26% per year. Furthermore, the dairy products trade deficit was 2.84 billion dollars, accounting for 6.36% of the total agricultural products trade deficit (Chen, 2013).

After China's accession to the WTO, the tariffs on dairy products: whole milk powder, skimmed milk, butter and cheese have dropped from 43%, 43%, 43 % and 42% to 15%, 10%, 10%, 10% and 12%, respectively. This is far below the average world average dairy tariff level (100% in 2004). Along with the reduction of tariffs, imports of dairy products increased rapidly. It is evident that the sharp increase of the import volume impacts domestic dairy manufacturers and dairy consumption. In 2005, New Zealand and Australia brought forward the idea to conclude a free trade agreement with China. In 2008, the New Zealand – China Free Trade Agreement was signed and the free trade agreement between China and Australia is still in negotiation. As large dairy product exporters, New Zealand and Australia account for more than 60% of the total value of Chinese dairy imports. Therefore, dairy trade liberalization will have an impact on New Zealand, Australia and China influencing the dairy industry, but also on agricultural and rural economic development (Liu and Liu, 2007). Moreover, within the WTO there are still multilateral trade negotiations ongoing to reach full trade liberalization.

An extensive literature has emerged focusing on the different aspects of trade liberalization in China. However, earlier studies shed little light on the Chinese dairy market. Fuller and Huang (2006) and Shi and Gao (2007) elaborated on the developments in China's dairy sector and its future prospects, suggesting that there is ample room for future growth in both domestic milk production and dairy demand. Fuller and Huang (2004) analyzed the factors behind the growth in demand and supply of China's dairy sector. Considering the significant status China has in the world dairy market, a paper assessing the influence of trade liberalization on China and dairy exporting countries would significantly contribute to improved policy-making. A spatial equilibrium model seems the most appropriate candidate to perform such an analysis. For example, Kawaguchi and Suzuki (1997) analyzed the imperfectly competitive milk market of Japan by using a generalized spatial equilibrium model. The model relaxes the assumption of a perfect competition market in the standard spatial equilibrium model, allowing for any degree of market structure from perfect competition to monopoly. To analyze the impact of trade liberalization of the USA on the world dairy market, Peng and Cox (2006) presented a world spatial equilibrium dairy model. Both the vertical linkages and spatial characteristics of the dairy sector are integrated in the model. Stennes and Wilson (2003) developed a spatial equilibrium

model that is used to evaluate the impact of changing trade restrictions in the lumber trade for North America, more specifically a decrease in the ad valorem tariff rate quotas and a unit tax increase. Policy measures those are also relevant for the international trade in dairy products. Based on the standard spatial equilibrium model, Florian and Los (1982) presented several extensions including non-constant unit transportation costs, and multiple commodities. These extensions could also be relevant in a model of international trade in dairy products.

1.2. Research Objective and Questions

The objective of the paper is to provide a quantitative assessment of the implications of liberalization of the international trade in dairy products between China and its trading partners using a spatial equilibrium model.

The following five research questions are going to be answered: (1) What is the current situation of China's dairy sector and how does China's dairy market develop? (2) What policies are relevant for dairy trade between China and its trade partners now and in the future? (3) How can dairy trade of China be modeled? (4) What data on demand, supply and trade are necessary and available to construct a spatial equilibrium model? (5) What are the effects of trade liberalization on the dairy sector in China?

The remainder of the thesis first describes the development of China's dairy sector and relevant trade policies. Then, a trade model will be developed in Chapter 3. Next, Chapter 4 will focus on the effects of trade liberalization using a graphical analysis. Chapter 5 details the scenarios and simulation results. Finally, Chapter 6 concludes and provides a general discussion.

2. Development of China's dairy sector and relevant trade policies

This chapter focuses on the development of China's dairy sector and trade policies. Section 2.1 illustrates the history of the Chinese dairy market from the domestic and international perspective. The Section 2.2 introduces the liberalization process of the dairy trade policies.

2.1. Development of Chinese dairy market

During the past 30 years, China's rapid economic growth has brought about remarkable wealth increases, along with which the living conditions of the people have been improved. Accordingly, the diet structure of Chinese has changed a lot with an explicit shift on the dairy products intake. Under such a strong pull of demand, China's dairy sector shows a robust development, which is also attributable to the supportive government policies.

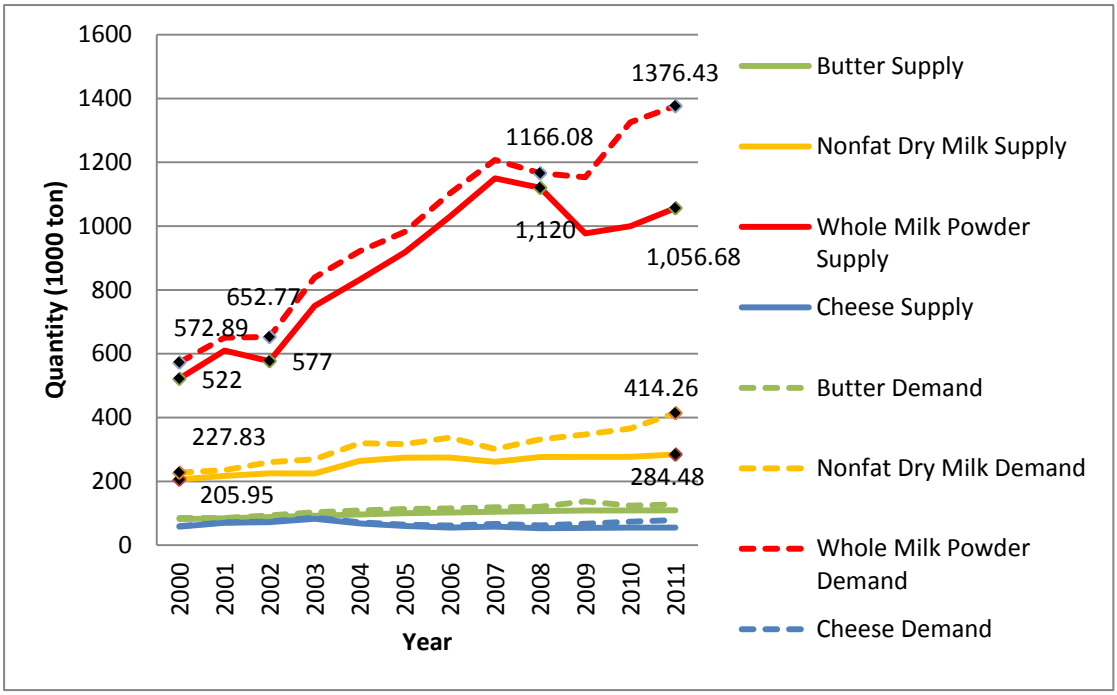


Figure 2.1 Domestic dairy market of China, 2000-2011

Source: FAPRI Commodities Database and FAO Database

Figure 2.1 shows an overall imagine of the development of the domestic dairy market within the first decade of the 21th century (for detail, see Appendix 2 Table A.4). The supply and demand quantities of four main dairy products are presented, including Butter, Nonfat dry milk, Whole milk powder and Cheese. In general, both the supplies and demands of all the products show upward tendencies.

Encouraged by the income growth and the improved marketing channels, the domestic demand of dairy products kept expanding under the promotion of the government and the dairy industry (Fuller and Huang, 2006). From the supply perspective, the amount of cows increased, and by

2011 the milking herd of China comprised of 4.8 million cows (Statistic New Zealand, 2011). Although the increasing herd and more sophisticated technologies have led to a higher production level, it is still insufficient to meet the domestic consumption demand (Fuller and Huang, 2006). In this case, China has to import a large amount of dairy commodities every year.

In Figure 2.1, the demand and supply of Whole milk powder show the largest increase within the given period. The demand and supply almost doubled from 2000 to 2011 with fluctuations. Since the start of the decade, the market of Whole milk powder kept developing and consumption peaked in 2011. However, in 2002 SARS caused a shrink in the market. In spite of the stabile demand volume, the supply amount of Whole milk powder declined by 5.41%. During the following year, the market recovered quickly and exceeded the pre- epidemic level. It is important to note the other turning point in 2008, after which the market kept expanding with a steady growth. During the summer of 2008, a dairy safety scandal broke out. The poisoning accidents happened frequently caused by a failing Chinese food quality and safety system. The 2008 milk scandal stuck as the biggest food crisis in the new century. It was exposed that melamine was added to the milk to boost the protein content artificially (BBC, 2008; Xinhua News, 2008). The dairy quality issue caused a big plunge in the market and it was followed by a one-more-year decrease of both demand and supply. Compared to 2007, the domestic supply of Whole milk powder dropped by 15.04% until 2009, and the consumption volume which reacted more mildly decreased by 4.50%. After 2009, the domestic market started to recover, however, demand held a higher growth rate than supply.

Besides the Whole milk powder, the three products also showed an increasing trend within the given period. In all, despite the fluctuations, China's dairy sector presented a remarkable development in the first decade since 2000.

Additionally, given China's excess demand for dairy products, an analysis of China's import may provide a better insight in the market development. Figure 2.2 illustrates a history of China's dairy imports.

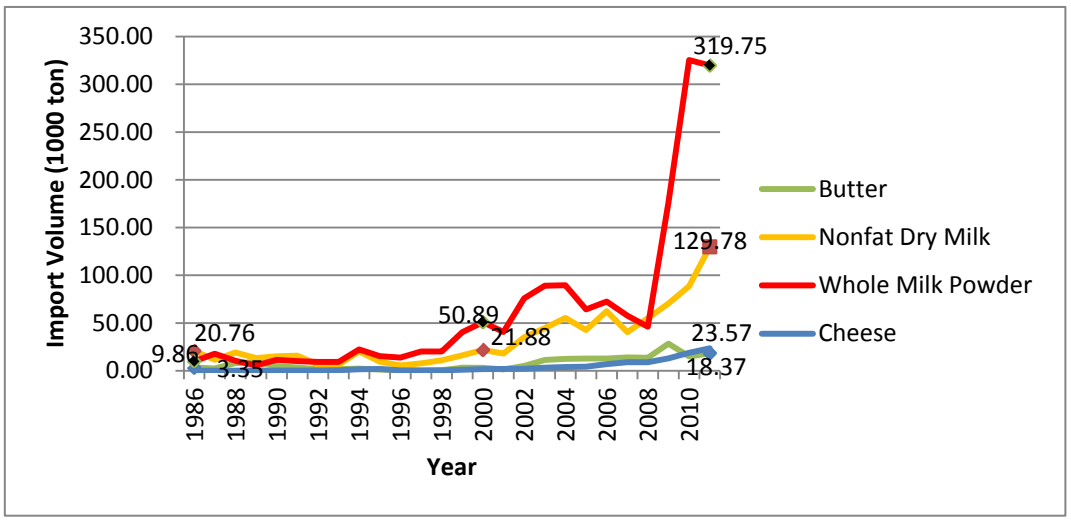


Figure 2.2 Import volume of dairy products (1000 ton), 1986-2011

Source: FAO Database

The above figure summarizes the history of import levels of four dairy products between 1986 and 2011. From the figure, we can conclude that China relied on international dairy trade more and more heavily, especially the Nonfat dry milk and Whole milk powder. Within the 25 years, amazing growth rates were observed for the import volume of four dairy products: Butter 447.58%, Nonfat dry milk 525.14%, Whole milk powder 3141.60%, Cheese 27632.94%. Considering the small base of import volume of Butter and Cheese, in spite of the tremendous growth rates, the absolute values of import are relatively small compared to those of Nonfat dry milk and Whole milk powder. Besides the explosive demand and the relatively slow increasing domestic supply, the milk scandal in 2008 was a significant factor stimulating the import quantity.

After the short period of decrease during the early 1990's, the import of Whole milk powder and Nonfat dry milk began to rise up, reaching the peak in 2000 at 50,890 and 21,880 tons. Experiencing a one-year drop, China the import recovered and kept increasing in the following three years. This could be partly explained by the encouragement of China's accession to the World Trade Organization (WTO) in 2001. From 2004 to 2007, the import volumes fluctuated with a general downward trend. Since 2008 China's dairy product import volume increased fast within the next two years. Compared to 2008, China's import quantities of Butter, Nonfat Dry Milk, Whole Milk Powder and Cheese increased by 35.07%, 136.11%, 593.96% and 162.13% in 2011. Besides the milk scandal, the rapid-growing dairy commodity import might also benefit from the 2008 free trade agreement between China and New Zealand. Section 2.2 provides a picture of the development of the dairy trade policies.

2.2. Dairy trade policies

Before the Reform and Opening in the late 1980's, China was plagued by economic shortages under the system of planned economy. Over the early 30 years (1949-1978), the trade with foreign countries was strictly controlled and embodied in a plan formulated by the government. During that period, under the control of government, the domestic price of imported dairy products was set at lower level than the import price and the price gap was sustained by high tariffs and volume control.

In 1978, China started the Reform and Opening. Since then, China has moved into a market-oriented economy and the dairy market continued to open up. The provisions of accelerating and deepening the reform of the foreign trade system (1988) and the provisions of further reform and improvement of the foreign trade system (1990) removed import restrictions of dairy products. Accordingly, since 1990's, commercial companies have been allowed to internationally trade dairy commodities.

In 2001, China joined the WTO which exerts profound influence on the Chinese dairy market. Since then, China's trade system started to reform based on the rule of WTO under which China has to implement import tariff reductions. Since 2001, most dairy products' import tariff rates for WTO member states have been cut down and the tariff rates for the rest of the world are kept at

a higher level which is more than 80% on average. Table 2.1 shows the adjustment of China's import tariff of four types of dairy products with the entrance to WTO.

Table 2.1 Changes of most favored nation tariff rate of main dairy product with entrance to WTO of China

Tariff Item	Commodity	2000	2001	2002	2003	2004	2005
4051000	Butter	50	43.3	30	23.3	15	10
4022900	Nonfat Dry Milk	50	43.3	30	23.3	15	10
4022100	Whole Milk Powder	50	43.3	30	23.3	15	10
4063000	Cheese	50	42.4	27.2	19.6	12	12

Source: China Customs Import and Export Tariff and Reporting Guidelines (2000-2005)

In 2004, China initiated the free trade agreement negotiation with New Zealand, and in the following year, the negotiation with Australia was launched. Finally, a free trade zone between China and New Zealand was established in 2008. However, the negotiation reached a deadlock, suspended for several times within the 8 years. According to the Free Trade Agreement between the Government of the People's Republic of China and The Government of New Zealand Annex 2: Special Agricultural Safeguard Measures, dairy products are protected temporarily under a special tariff protection policy. China imposes a tariff rate quota for dairy commodities imported from New Zealand. Within the quota level, a lower tariff level is imposed and when the import quantity exceeds the quota, the over-quota tariff rate which is higher is triggered. Before the tariff rate quota is removed, the quota level will be extended each year with a decreasing within-quota tariff rate. According to the agreement, the tariff rate quota will be eliminated in 2019 when the full trade liberalization is realized between China and New Zealand.

3. Data and model

This chapter describes the model and data that have been used to analyses the effects of trade liberalization. Section 3.1 discusses the theoretical model and the data used are presented in section 3.2. In Section 3.3, the empirical model is constructed and Section 3.4 calibrates the coefficients.

3.1. Theoretical model

A spatial equilibrium model for analyzing international dairy trade will be used in the paper. The model will be based on the spatial equilibrium model that was developed by Samuelson (1952) and further developed by Takayama and Judge (1964). The model includes linear supply and demand functions, ad valorem transportation cost and tariffs and it can be used to calculate welfare changes of trade liberalization. However, the structure of world dairy markets is more complicated. The extension of the model proposed in this paper is to include multiple commodities as dairy is not a homogeneous product. However, we treat the commodities separate. In addition, according to the literature, China has a tariff rate quota (TRQ) for imports from New Zealand. However, the quota level is far less than the import amount (e.g., the quota was filled within 2 months in 2013). Besides, according to the free trade agreement between China and New Zealand, the quota amount will increase and the in-quota tariff will decrease year by year. Since 2018, the tariff rate quotas will be eliminated and all the tariffs on dairy products will be zero. Therefore, given its relevance the TRQ should be included in the model.

3.2. Data

The model is calibrated with the 2011 trade data for China, Australia, New Zealand and the rest of the world (ROW). All the relevant data are collected from open databases. The data on demand of supply price elasticities and income price elasticities are collected from the Food and Agricultural Policy Research Institute (FAPRI) Elasticity Database. In addition, the demand and supply functions are calibrated with the demand and supply volumes of each product in 2011, which are also from the FAPRI Elasticity Database. The income data come from the Knoema Database. Besides, to derive the initial domestic prices, we are using data of trade volumes and values which are obtained from the Food and Agriculture Organization of the United Nations Database. Moreover, the data from other literature sources such as China Customs Import and Export Tariff and Reporting Guidelines (2011) are also used in the model. Appendix I reports the data and gives more detailed information on the data sources.

3.3. Empirical model

The spatial equilibrium model is constructed featuring the trade of dairy products among three countries and one region (China, Australia, New Zealand and the rest of the world: ROW) with an explicit focus on four dairy products: Butter, Nonfat dry milk, Whole milk powder and Cheese. In the model, Australia and New Zealand are net exporters and China is a net importer. ROW is assumed to be a net importer who imports the excess supply from

Australia and New Zealand. In addition, the model includes linear supply, demand and import functions, ad valorem transportation cost and tariffs. Furthermore, China imposes tariff rate quotas on the dairy products imported from New Zealand. Because the quota level is far less than the import amount, the quota is non-binding and the domestic price is not influenced by the tariff rate quota. The model aims to quantify the welfare changes of consumers, producers and governments under various trade liberalization scenarios.

To simplify the model, the model employs several assumptions. All the commodities are exchanged internationally through the world market at an identical world market price, which is equal to domestic price of New Zealand and affected by the policy-setting countries under the large country assumption. In addition, the supply and demand amount is assumed to be the linear the functions of the domestic prices. Moreover, the ad valorem tariffs and tariff rate quotas are incorporated as the market distorting policies in the model. The quota levels are far less than the excess demand in China. So the tariff rate quota is non-binding at the domestic price. Furthermore, transportation costs are incorporated into the model. Besides, to derive the import function of the ROW, it is assumed that the import price elasticity and import income elasticity of the ROW is equal to the elasticities of China and the domestic price of the ROW equals that of Saudi Arabia.

Under the above assumptions, we model the dairy products trade from a spatial equilibrium perspective. The parameters of the demand and supply functions are calibrated using the data discussed. The calibration is such that the outcomes of the model mimic the real world situation. The constructed model will generate the equilibrium prices, quantities and welfare changes of stakeholders.

Suppose there are i (i=1…4: China, Australia, New Zealand and ROW) players and j (j=1…4: butter, nonfat dry milk, whole milk powder and cheese) dairy products. We assume completely independent markets for each product. We present here the model for one product, and therefore, for ease of exposition, we omit here the subscript j.

Additionally, for each product, there are in total six linear supply (1) and demand functions (2) which represent the demand and supply of China, Australia and New Zealand.

$$Q_i^d = a_i + b_i P_i + c_i I_i \qquad i=1..3 \quad \text{Demand function of country i} \qquad (1)$$

$$Q_i^s = \alpha_i + \beta_i P_i \qquad i=1..3 \quad \text{Supply function of country i} \qquad (2)$$

Where: a_i The intercept of the demand function of country i, b_i The price slope of the demand function of country i, c_i The income slope of the demand function of country i, Q_i^d Demand in country i, α_i The intercept of the supply function of country i, β_i The price slope of the supply function of country i, P_i Price in country i, I_i Income in country i.

The import and export quantities (3) are derived from the excess demand and supply of each

country.

$x_i = Q_i^d - Q_i^s$ i=1..3 Trade amount of country i (3)

Where: x_i: Trade amount of country i; if positive i is an importer, otherwise, i is an exporter.

Besides, the model includes an import function (4) denoting the import of the ROW.

$IM = \eta + \theta Pr + \lambda Ir$ Import function of the ROW (4)

Where: IM Import amount of the ROW, η The intercept of import function of the ROW, θ The price slope of import functions of the ROW, λ The income slope of import function of the ROW, Pr Price in the ROW, Ir Income in the ROW.

When the market reaches equilibrium, the total import amount equals the sum of the export amount (5).

$\sum_{i=1}^{3} x_i + IM = 0$ The total demands of importers is equal to the total supplies of exporters (5)

The domestic market prices are linked by ad valorem tariff rates and transportation costs (6), (7), to the world market prices of the products.

$P_i = P^w(1 + tc_i + r_i)$ i=1..3 Price in country i (6)

$Pr = P^w(1 + cr)$ Price in the ROW (7)

Where: tc_i Percentage transportation cost for country i, r_i The import tariff rate of country i, cr rate representing both tariff and transportation cost of the ROW.

The within-quota price of China (8) is derived from the ad valorem within-quota tariff rate and percentage transportation cost.

$P_1' = P^w(1 + tc_1 + wr_1)$ Within-quota price in i=1 (8)

Where: P_1' Within-quota price in country i=1, wr_1: Within-quota tariff rate for country i=1.

Until now, the equations of the model have been introduced. In all, there are 16 equations and 28 variables. Since the imbalance between the number of variables and functions, we are supposed to explicitly define the exogenous variables. The tariff rate of country i (r_i), income of country i (I_i), within-quota tariff rate (wr_1) are fixed at the baseline level. Moreover, the transportation cost of country i (tc_i), sum of tariff and transportation cost rate of the ROW (cr),

and import amount of row (Ir) are set to be equal to their calibrated baseline values. According to the assumption, the world market price is equal to the domestic price of New Zealand (9). So,

tc_3=0 and r_3=0 (9)

Totally, the model employs 12 exogenous variables and 16 variables are defined endogenously, including: Q_i^s, Q_i^d, P_i, Pr, P^W, x_i, IM and P_1'.

Next, we will calibrate the coefficients of the functions.

3.4. Calibration

Based on the initial data obtained from the databases, the empirical model is calibrated using the General Algebraic Modeling System (GAMS). Taken as the baseline data, the initial data are used to derive the parameters of the supply and demand equations. First, we derive the domestic prices (10) in each country.

$P_i = \frac{vtrade_i}{qtrade_i}$ The domestic price of country i is equal to trade value divided by trade volume (10)

Where: $vtrade_i$ The initial trade value of country i, $qtrade_i$ The initial trade volume of country i.

Then, based on the demand and supply functions, it is clear that:

$e_i^d = \frac{P_i}{Q_i^d}\frac{\partial Q_i^d}{\partial P_i} = \frac{P_i}{Q_i^d}$ b_i i=1…3 Demand elasticity of country i (11)

$e_i^I = \frac{I_i}{Q_i^d}\frac{\partial Q_i^d}{\partial I_i} = \frac{I_i}{Q_i^d}$ c_i i=1…3 Income elasticity of country i (12)

$e_i^S = \frac{P_i}{Q_i^s}\frac{\partial Q_i^s}{\partial P_i} = \frac{P_i}{Q_i^s}$ β_i i=1…3 Supply elasticity of country i (13)

Where: e_i^s Price elasticity of supply in country i, e_i^d Price elasticity of demand in country i, e_i^I Income elasticity of demand in country i.

Based on equations (11), (12) and (13) and the known values of the elasticities, quantities, prices and income, the coefficients of the demand and supply functions can be obtained as follows:

$b_i = \frac{Q_i^d e_i^d}{P_i^d}$, $c_i = \frac{Q_i^d e_i^I}{I_i}$, $a_i = (1 - e_i^d - e_i^I)\, Q_i^d$ i=1..3 Coefficients of demand

function of country i (14)

$\beta_i=\frac{Q_i^S e_i^S}{P_i}$, $\alpha_i= (1-e_i^S)\, Q_i^S$ i=1…3 Coefficients of the supply function of country i (15)

Next, we calibrate the import function of the ROW. It is assumed that the ROW imports equal the excess supply from China, Australia and New Zealand. Therefore, the initial import volume of ROW (16) is the difference between initial total demands and supplies of China, Australia and New Zealand. However, the parameters for calibrating the import functions are unknown. So, we have to assume the values of import price elasticity, import income elasticity and income of the ROW. Considering the significant role China plays in the world dairy market and data availability, we assume the import price elasticity, import income elasticity and income of the ROW equal to those of China. Besides, because Saudi Arabia is a big player when compared with other Asian countries, it is assumed the domestic price of ROW comes from Saudi Arabia. Thus, the import function of ROW can be derived as follows:

First, we construct the import function of China based on the equations (1) and (2):

$x_1 = Q_1^d - Q_1^s = (a_1 - \alpha_1) + (\mathrm{b}_1-\beta_1)P_1 + c_1 I_1$ Excess demand of country i=1 (16)

Then, the import price elasticity (17) and import income elasticity (18) can be derived from equation (16):

$e_1^{xp} = \frac{P_1}{x_1}(b_1 - \beta_1)$ Import price elasticity of country i=1 (17)

$e_1^{xI} = \frac{I_1}{x_1}\, \mathrm{c}_1$ Import income elasticity of country i=1 (18)

According to the assumption made, the import volume of the ROW (19) equals the excess supply from China, Australia and New Zealand:

$IM = \sum_{i=1}^{3}(Q_i^s - Q_i^d)$ Initial import quantity of ROW (19)

Based on the ROW's import function (4), we know:

$e_{im}^p = \theta \frac{P_r}{IM}$ Import price elasticity of the ROW (20)

$e_{im}^I = \lambda \frac{P_r}{IM}$ Import income elasticity of the ROW (21)

According to the assumption made, the values of the elasticities of the ROW are as follows:

$e_{im}^{p} = e_{1}^{xp}$ Import price elasticity of the ROW is equal to that of country i=1 (22)

$e_{im}^{I} = e_{1}^{xI}$ Import income elasticity of the ROW is equal to that of country i=1 (23)

Based on the equations (22) and (23) and the assumed value of the import price elasticity and import income elasticity, income and import amount, we can derive the coefficients (23)…(25) of the ROW's import function:

$\theta = e_{im}^{p} \frac{\mathrm{IM}}{P_r}$ The price slope of the import function of the ROW (24)

$\eta = (1 - e_{im}^{p} - e_{im}^{I})\ \mathrm{IM}$ The intercept of the import function of the ROW (25)

$\lambda = e_{im}^{I} \frac{IM}{Ir}$ The income slope of the import function of the ROW (26)

Finally, we come to the transportation cost of countries i=1… 3 and transportation cost plus tariff rate in ROW based on equations (6) and (7). Considering the domestic price of country i ($\mathrm{P_i}$) equaling the world market price plus tariff and transportation cost, we can derive:

$Pr = \mathrm{P}^{w}(1 + \mathrm{cr})$ Price in the ROW

$\mathrm{tc}_i = \frac{P_i}{\mathrm{P}^{w}} - 1 - \mathrm{r}_i$ i=1…3 transportation cost in country i (27)

$\mathrm{cr} = \frac{Pr_i}{\mathrm{P}^{w}} - 1$ sum of transportation cost and tariff rate in ROW (28)

The above equations have shown the calibration part of the model. Next, we will present the welfare changes of all the stakeholders in each country in case of various trade liberalization scenarios.

4. Graphic analysis

In this chapter, a graphic analysis of impacts of different levels of trade liberalization is presented. Section 4.1 shows the baseline equilibrium which is based on the 2011 dairy market. Section 4.2 clarifies the welfare changes in various trade liberalization scenarios. Subsection 4.2.1-4.2.3 indicate the effects on stakeholders' welfares of an import tariff cut, removal of the TRQ and full trade liberalization respectively.

4.1. Benchmark equilibrium

The model concentrates on the stakeholders: consumers, producers and government. Welfare of consumers is expressed by the consumer surplus. The consumer surplus is the area under the demand curve and above the price line. Besides, welfare of producers is expressed by the producer surplus which is the area above the supply curve and under the price line. Therefore, as shown in Figure 4.1, the consumer and producer surplus are the areas A and B respectively in case of an exporting country.

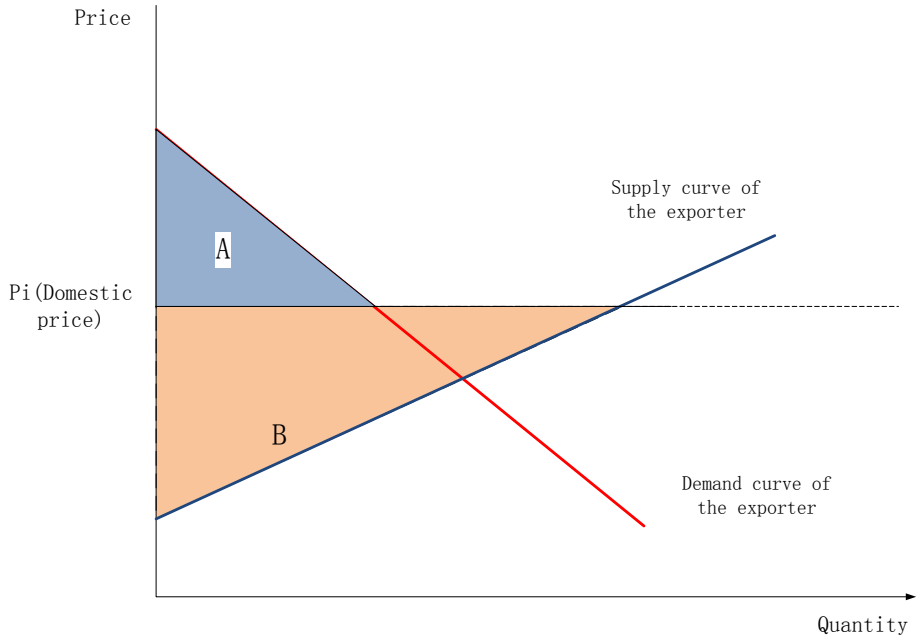


Figure 4.1 Consumer surplus (area A) and producer surplus (area B) in case of an exporting country (Australia and New Zealand).

China has a tariff rate quota (TRQ) for imports from New Zealand. However, the quota level is far less than the import amount (e.g., the quota was filled within 2 months in 2013). Besides, according to the free trade agreement between China and New Zealand, the quota amount will increase and the in-quota tariff will decrease year by year. From 2019, the tariff rate quota will be removed and the tariff on dairy products will be zero. Therefore, given its relevance the TRQ has been included in the model.

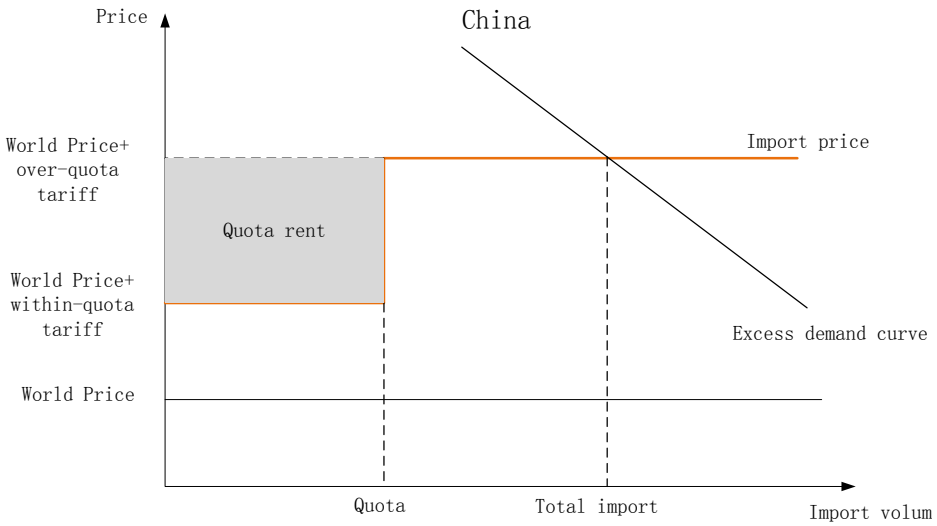


Figure 4.2 China's import from New Zealand under a TRQ

Figure 4.2 indicates the import of China in case of a tariff rate quota. The excess demand curve represents imports at the over-quota tariff level. In this case, the non-binding quota does not influence the import price of China. Therefore, the model includes the same functions as the model without TRQ. However, the TRQ alters the supply curve of China, which is presented in Figure 4.3.

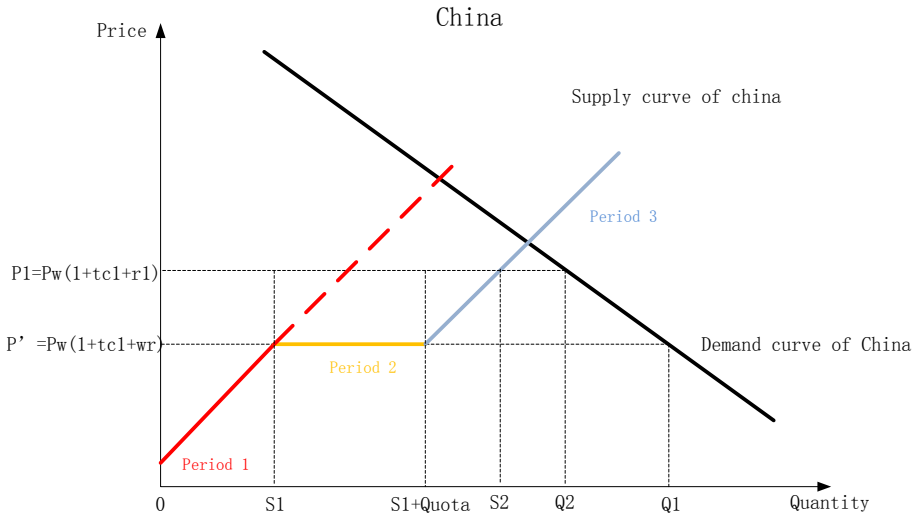


Figure 4.3 Supply curve of China under a TRQ

Where: P' The within-quota price, S1 The domestic supply at P', Q1 The domestic demand at P', S2 The domestic supply at P1, Q2 The domestic demand at P1, Quota: The quota level.

Different from a straight line in the exporting country, the supply curve of China consists of three parts under a TRQ. To explain the unusual shape of the supply curve, we introduce two related prices: P_1 is the domestic price of China, which is the world market price plus normal tariff and transportation cost; P' is the within-quota price, denoting the import price under the

within-quota tariff rate.

As shown in the Figure 4.3, for the range where the price is lower than the within-quota price P' (Period 1), no import will take place. With a price of P' the domestic producers produce S1 units of products. In period 2, where the price equals the within-quota price level, China imports products until the quota is filled. Therefore, in period 2, the supply curve turns into a horizontal line and the maximum import volume is equal to the quota level. In the last period, since the price is higher than P', the supply curve becomes an upward sloping straight line. Because when the import reaches the over-quota tariff trigger level, the price increases and domestic producers produce until the price equals P_1. However, at $P_1(Q_2)$ China restarts to import from another countries. In all, the total import amount is equal to (Q2-S2) + Quota.

Next, we derive the welfares of different stakeholders in the Chinese market under the TRQ and price P_1, which is presented in Figure 4.4.

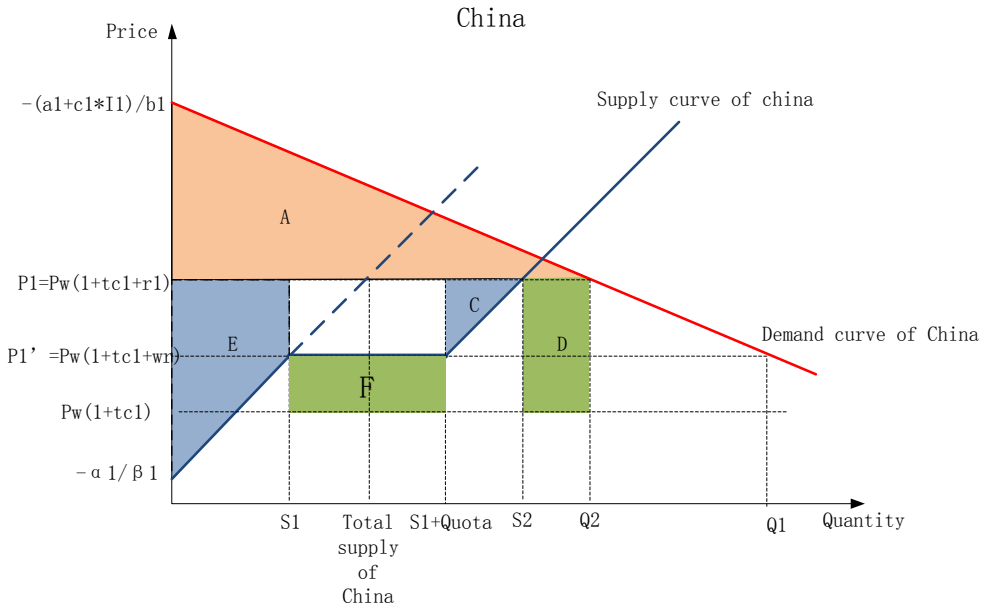


Figure 4.4 Welfares of stakeholders in China under TRQ

Where: P' The within-quota price, S1 The domestic supply at P', Q1 The domestic demand at P', S2 The domestic supply at P1, Q2 The domestic demand at P1, Quota: The quota level.

(1) Consumer surplus (CS): The area under the demand curve and above the domestic price line (P1), shown as area A in Figure 4.4;

(2) Producer surplus (PS): The areas above the supply curve and below the import price line. As described before, the Chinese suppliers produce during part 1 and 3, so the producer surplus is the sum of two parts: E + C;

(3) Tariff revenue (TR): It equals the trade quantity times tariff rate. The Chinese government

imposes two different levels of tariffs, so the tariff revenue consists of two parts. Under the within-quota tariff, the tariff revenue is the area F and the area D represents the tariff revenue under the over-quota tariff rate. Thus, TR=F+D.

Next we will discuss the effects of different level of trade liberalization on the stakeholders' welfares in each country by means of a graphic analysis.

4.2. Welfare Change

This section focuses on the welfare impacts of trade liberalization under different scenarios. Figure 4.4 is taken as the baseline representing situation of trade of a dairy product under a TRQ in 2011. Subsections 4.2.1 - 4.2.3 graphically illustrate the influence of different trade liberalization on the stakeholders' welfares.

4.2.1. Welfare change of an import tariff rate reduction

In this case, the TRQ is assumed to be fixed, and the import tariff is cut by a certain percentage. The lower tariff will lead to an increase in imports, and therefore, to an increase in China's demand and world price according to the large country assumption. The increased world price leads to a change of the domestic price in each country. Figure 4.5 presents the producer and consumer surpluses and tariff revenue at a new world price as caused by a lower tariff rate for China.

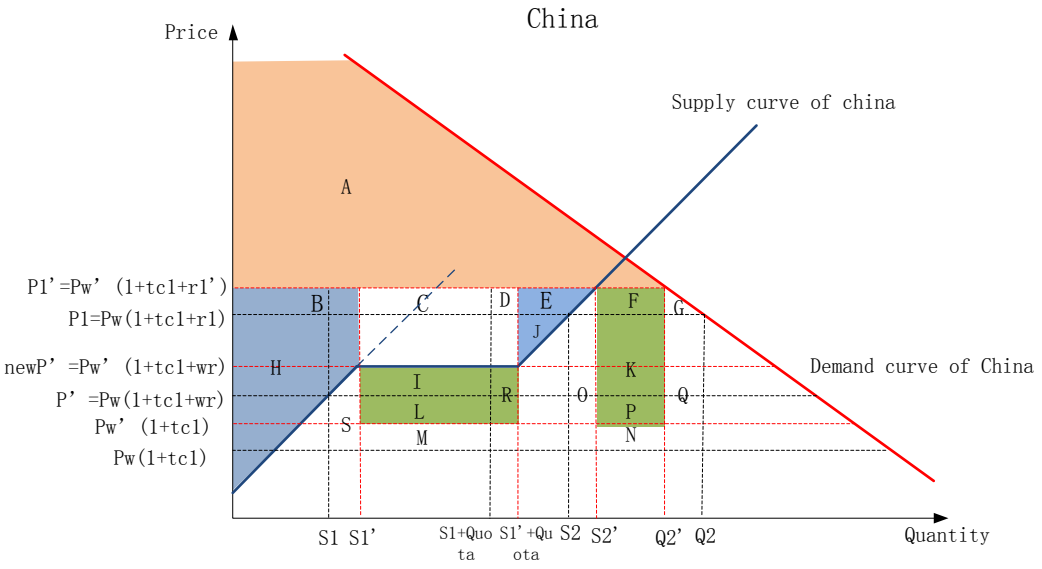


Figure 4. 5 Welfare change of a tariff cut

Where: P1 The domestic price of China, tc1 transportation cost, P' The within-quota price, Pw The world market price, wr: within-quota tariff rate, S1 The domestic supply of China at P', S2 The domestic supply at P1, Q2: The domestic demand under P1, r1' The reduced tariff rate, Pw' The world market price under the lower tariff, newP' within-quota price

under the lower tariff , S1' The domestic price of China under newP', S2':The domestic supply at P1', Q2' The domestic demand at P1'.

According to the figure 4.5, it is clear that at a lower tariff rate, the consumer surplus is represented by areas A, and the producer surplus is the sum of areas B+H and E+J. Besides, the green areas (I+L+R)+(O+K+P+Q) denotes the new tariff revenue.

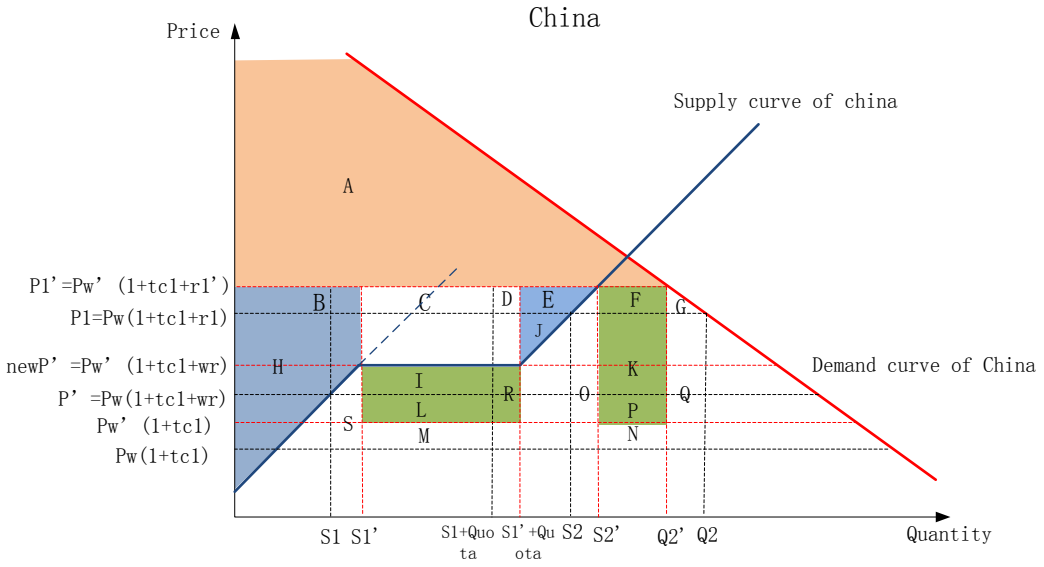
Comparing figure 4.5 with 4.4 where a higher tariff rate is assumed, the change of welfare caused by the tariff cut are indicated clearly:

In the figure 4.4, the tariff revenue are areas F+D, and it is shown as areas (S+L+M)+(F+K+P+N) in the figure 4.5. After the tariff cut, the tariff revenue are the areas (I+L+R)+(O+K+P+Q). Therefore, ΔTR =(R+I-M-S)+(O+Q-F-N).

Besides, it is clear that

ΔCS= B+C+D+E+F+G;

ΔPS=-(B+E).



Based on the above description, we can derive the new tariff revenue in China as follows: Tariff revenue $= (\mathrm{I}+\mathrm{L}+\mathrm{R})+(\mathrm{F}+\mathrm{K}+\mathrm{P}) = (\mathrm{newP}'-\mathrm{Pw}'(1+\mathrm{tc1}))*\mathrm{Quota}+(\mathrm{P1}'-\mathrm{Pw}'(1+\mathrm{tc1}))*(\mathrm{Q2}'-\mathrm{S2}')$.

Equally, the tariff revenue is derived as:

$$TR = (P' - P^W)Q^q + (P_1 - P^W)(Q_1^d - Q^q)$$
$$= P^W wrQ^q + P^W r_1(Q_1^d - Q^q) \quad (29)$$

Where: TR The tariff revenue of China, Q^q The quota level.

Provided a lower tariff rate, the model will give the new values of $\mathrm{P^W}$, $\mathrm{P_1}$ and $\mathrm{Q_1^d}$. Based on equation (26), we are able to derive the change of tariff revenue:

$$\Delta TR = \mathrm{TR}(\mathrm{P^{W\prime}}, \mathrm{P_1'}, \mathrm{Q_1^{d\prime}}, r_1') - \mathrm{TR}(\mathrm{P^W}, \mathrm{P_1}, \mathrm{Q_1^d}, r_1) \quad (30)$$

Where: ΔTR The change of tariff revenue of China, $\mathrm{P^{W\prime}}$ The world price under the

lower tariff, P_1' The domestic price of China under the lower tariff, $Q_1^{d\prime}$ The demand of China under the lower tariff.

The consumer surplus and producer surplus are functions of the domestic price. The trade liberalization increases the import of China, resulting in a higher world market price. Therefore, in the export countries, the welfare of the consumers decreases, while that of the producers is affected positively. And we can derive the change of CS_i and PS_i:

$$\Delta CS_i = \int_{P_i^{old}}^{P_i^{new}} Q_i^d(P_i)dP_i \quad \text{For i=1...3} \tag{31}$$

$$\Delta PS_i = -\int_{P_i^{old}}^{P_i^{new}} Q_i^s(P_i)dP_i \quad \text{For i=1...3} \tag{32}$$

Where: ΔCS_i The change of consumer surplus of the country i, ΔCS_i The change of producer surplus of country i, P_i^{new} The domestic price of country i at new tariff rate, P_i^{old} The domestic price of country i at old tariff rate .

4.2.2. Welfare change of a removal of the TRQ

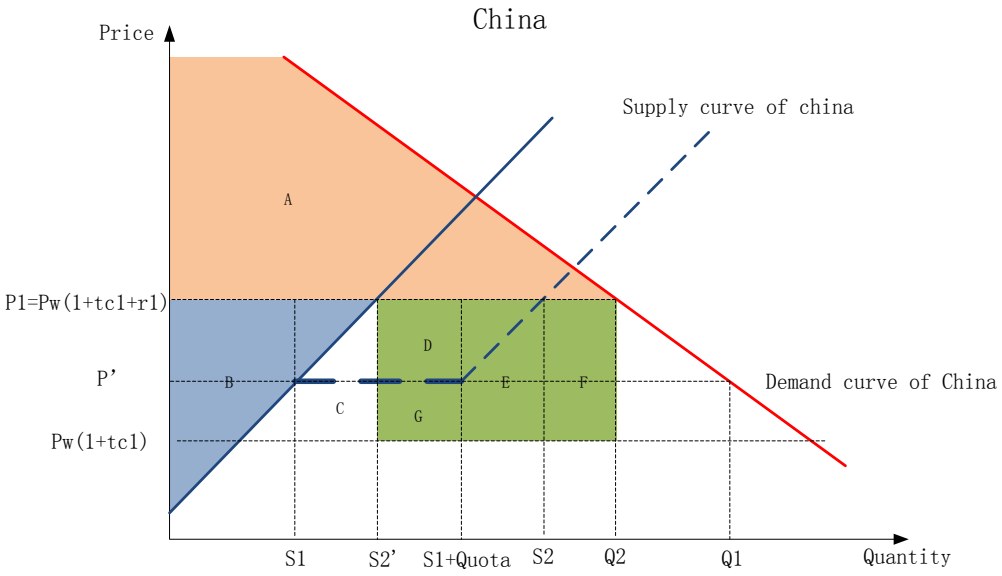


Figure 4.5 Welfare change of the removal of a TRQ

Where: P1 The domestic price of China, tc1 transportation cost, Pw The world market price, Quota The quota level, S1 The domestic supply of China at P', S2 The domestic supply at P1, Q2 The domestic demand at P1, S2' The domestic supply at the world market price.

Because the TRQ is removed, the supply curve turns into a straight line. Comparing with the baseline, the change of welfares shown in the Figure 4. 7 are:

1. ΔCS= 0;
2. ΔPS=0;
3. ΔTR=E+D-C.

Therefore, the change of tariff revenue in China is equal to the size of area (E+D-C), which equals (D+E+G) - (C+G). The size of area D+E+G equals the original quota amount times the price difference between the domestic price and the world market price. The size of area C+G equals the quota times the difference between the original within-quota price and the world market price. So,

$$\Delta \mathrm{TR} = Q^q(P_1 - P^W) - Q^q(P' - P^W)$$

$$= Q^q(P_1 - P') \qquad (33)$$

The abolishment of the TRQ does not influence the world market price, the exports of New Zealand and Australia are not affected. Therefore, the welfares of the stakeholders in the two countries remain unchanged.

4.2.3. Full trade liberalization

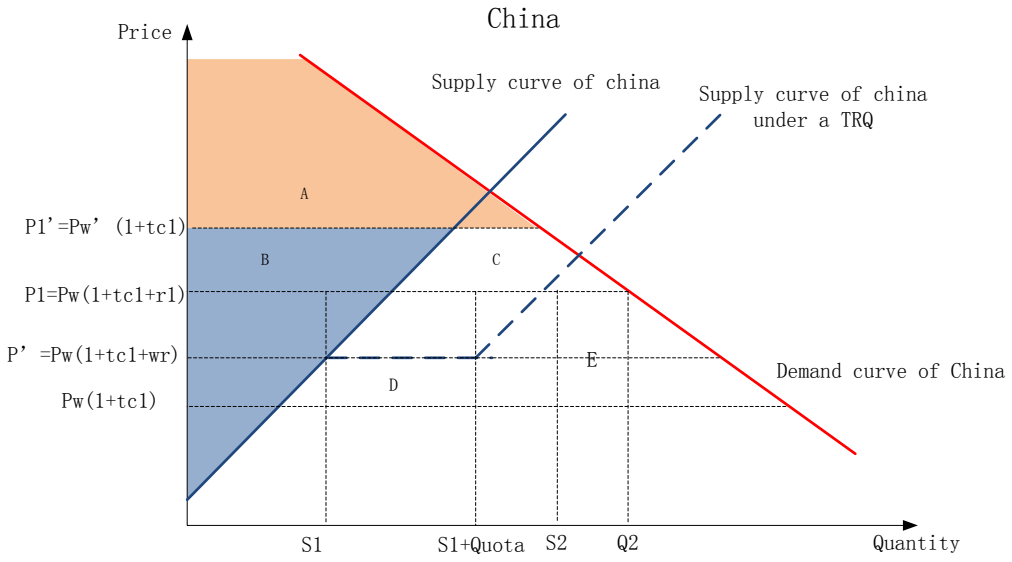


Figure 4.6 Welfare change of full trade liberalisation

Where: P1 The domestic price under trade policies, P' The within-quota price of China, Pw The world market price under trade policies, tc1 The transportation cost, wr The within-quota tariff rate, P1' The domestic price under the full trade liberalization, Pw' The world market price under the full trade liberalization, S1 The domestic supply at the within-quota price , S2 The domestic supply at the original domestic price under the trade policies, Q2 The domestic demand at the original domestic price under trade policies.

Figure 4.8 indicates the effects of full trade liberalization on the stakeholders' welfares. When all the market distorting policies are abolished, the domestic price of China is equal to the world market price including transportation cost. Because the import quantity of China increases, the world market price increases. Meanwhile, the domestic prices of exporters are influenced, and so do their welfares.

Comparing to the baseline scenario, the consumer surplus declines and the producer surplus increases. Besides, tariff revenue decreases to zero. In all, in Chinese market:

1. ΔCS= B+C;
2. ΔPS= -B;
3. ΔTR=-(D+E).

Equally，

$$\Delta CS_1 = \int_{P_1^{old}}^{P_1^{new}} Q_1^d(P_1)dP_1 \qquad (34)$$

$$\Delta PS_1 = -\int_{P_1^{old}}^{P_1^{new}} Q_1^s(P_1)dP_1 \qquad (35)$$

In a similar way, we are able to derive the change of CS and PS in exporting countries where the domestic price increases. So, for all the countries, the ΔCS and ΔPS are derived as follow:

$$\Delta CS_i = -\int_{P_i^{old}}^{P_i^{new}} Q_i^d(P_i)dP_i \quad \text{For i=1…3} \qquad (36)$$

$$\Delta PS_i = \int_{P_i^{old}}^{P_i^{new}} Q_i^s(P_i)dP_i \quad \text{For i=1…3} \qquad (37)$$

Because all the tariffs have been removed, the change of tariff revenue of China equals the minus value of the tariff revenue (26) under the trade policies.

$$\Delta \text{TR} = -TR = -[(P' - P^W(1+tc_1))Q^q + (P_1 - P^W)(Q_1^d - Q^q)]$$

$$= -P^W wrQ^q - P^W r_1(Q_1^d - Q^q) \qquad (38)$$

5. Scenarios and results

In Section 5.1, the scenarios are designed reflecting the effects of China's trade liberalization on the domestic and international dairy market. Then, the simulation results are presented and analyzed in Section 5.2.

5.1. Policy Scenarios

Based on the analysis in Chapter 4, the following policy scenarios have been formulated and simulated with the model:

Scenario 1: The multilateral trade liberalization specifies a 50% reduction of the import tariff of China.

Scenario 2: Simulation of a TRQ adjustmentremoval.

Scenario 3: Full trade liberalization where all the market distorting policies are abolished.

5.2. Simulation Results

In this section, the effects of trade liberalization on the welfares of the consumers, producers, and governments of China, Australia and New Zealand are analyzed. The model takes 2011 as the base case, for which the equilibrium domestic prices, trade amount and the tariff revenue of China are shown in the Table 5.1. Moreover, the Table 5.2 indicates the world market price of each product in 2011.

Table 5.1 Benchmark domestic price, trade amount and tariff revenue of all the players (2011)

Country	Commodity	Baseline(2011)		
		Pd	Trade	TR
China	Butter	2879.41	-25.202	1601.04
	Nonfat Dry Milk	2545.46	-89.943	16406.10
	Whole Milk Powder	3993.11	-197.323	19125.02
	Cheese	4682.83	-17.367	987.86
Australia	Butter	2469.92	48.733	0.00
	Nonfat Dry Milk	2329.72	131.998	0.00
	Whole Milk Powder	2957.61	102.886	0.00
	Cheese	3817.82	137.297	0.00
New Zealand	Butter	2452.13	485.583	0.00
	Nonfat Dry Milk	2226.59	408.5	0.00
	Whole Milk Powder	2595.60	977.901	0.00
	Cheese	3292.61	343.385	0.00

Where: Pd The domestic price ($/ton), Trade The trade amount (1000 tons), if positive trade refers to export amount, otherwise, Trade is the import amount, TR The tariff revenue (1000$).

Table 5.2 Benchmark world market price (2011)

Baseline(2011)	Pw
Butter	2452.128
Nonfat Dry Milk	2226.592
Whole Milk Powder	2595.596
Cheese	3292.611

Where: Pw The world market price ($).

Next, this section shows the deviation of the welfares from the benchmark equilibrium. Sub-section 5.2.1 indicates how the import tariff cut affects the international dairy market simulating the first scenario. In sub-section 5.2.2, we analyse the influence of the TRQ adjustment in the sceond scenario. Finally, the third scenario is simulated and its impact on the welfares are presented in sub-section 5.2.3.

5.2.1. Effects of import tariff adjustment

Table 5.3 and 5.4 summarize the simulation results of the scenario concentrating on the import tariff cut.

Table 5.3 Effects of import tariff decrease on world market price

Scenario 1	ΔPw	
	$/ton	%
Butter	5.284	0.22%
Nonfat Dry Milk	10.075	0.45%
Whole Milk Powder	15.526	0.60%
Cheese	7.970	0.24%

Where: ΔPw The change of world market price.

Table 5.4 Effects of a tariff cut on domestic price, trade amount and stakeholders' welfares (1000 $) in three countries

Country	Commodity	Scenario 1								
		ΔPd		ΔTrade		ΔCS	ΔPS	ΔT		SUM
		level	%	Volume	%			value	%	
China	Butter	-116.67	-4.05%	-1.67	6.63%	15935.36	-12897.73	37.63	2.35%	3075.26
	Nonfat Dry Milk	-100.31	-3.94%	-2.52	2.81%	14792.44	-5643.29	94.59	0.58%	9243.74
	Whole Milk Powder	-106.67	-2.67%	-13.75	6.97%	148225.07	-126443.20	1021.13	5.34%	22803.01
	Cheese	-186.70	-3.99%	-5.27	30.34%	58680.52	-54946.14	121.23	12.27%	3855.60
Australia	Butter	5.32	0.22%	0.04	0.08%	-368.27	627.76	0.00	0.00%	259.49
	Nonfat Dry Milk	10.54	0.45%	0.37	0.28%	-1136.43	2529.94	0.00	0.00%	1393.51
	Whole Milk Powder	17.69	0.60%	0.54	0.52%	-802.91	2627.99	0.00	0.00%	1825.08
	Cheese	9.24	0.24%	0.53	0.39%	-2231.71	3503.06	0.00	0.00%	1271.34
New Zealand	Butter	5.28	0.22%	0.22	0.05%	-371.79	2938.38	0.00	0.00%	2566.59
	Nonfat Dry Milk	10.08	0.45%	0.86	0.21%	-500.10	4620.28	0.00	0.00%	4120.18
	Whole Milk Powder	15.53	0.60%	4.19	0.43%	-1030.32	16246.58	0.00	0.00%	15216.26
	Cheese	7.97	0.24%	0.70	0.20%	-566.58	3306.31	0.00	0.00%	2739.73

Where: ΔPd The change of the domestic price ($/ton), ΔTrade The change of trade amount (1000 tons), for exporters the positive value refers to an increase of export volume, and for an importer the negative value means increase of import amount, ΔCS The change of consumer surplus (1000 $), ΔPS The change of the producer surplus (1000 $), ΔTR The change of the tariff revenue(1000 $), SUM The sum of ΔCS, ΔPS and ΔTR (1000 $).

From Table 5.3, we see increased world market prices caused by the lower tariff rates in the first scenario. This is because the decreased tariff rate for the exporters brings about a lower import price of China, leading to the increased imports in China. Accordingly, the world

market price goes up at the same time. From the equations of the model, we know that the domestic price is linked to world market price by the transportation cost and tariff rate. Given the assumed exogenous transportation cost, the domestic price is determined by world market price and tariff rate. In the exporting countries, provided the fixed transportation costs, the higher world market price bring about higher domestic prices. Additionally, according to the model, the tariff revenue equals to unit tariff revenue times the import amount. Because of the lower tariff rate, the unit tariff revenue falls. Considering the increased import volume, the tariff revenue is unpredictable theoretically. Moreover, the producer and consumer surplus expand/contract in the same direction as the domestic price. Consequently, to know the effect on the welfares we have to refer to the simulation results.

According to the simulation results (Table 5.4), in spite of the higher world market price, the overall effect on China's domestic price of the tariff cut is negative. According to the model, the domestic price is equal to the sum of tariff, world price and transportation cost. In China the world price increase is offset by the lower tariff. In the first scenario, the tariff cut is sufficient enough to offset the increased world market prices. Overall, China's new domestic price is lower than before. Besides, it is clear that the tariff revenues of China go up; indicating the positive influence of increased import quantities has offset the negative effect of lower tariff rates.

Next, we have a look at the details of the welfare changes. From Table 5.4, we see that when the import tariff rates drop by 50% for all the exporters, the domestic prices of Australia and New Zealand rise slightly, less than 1%. Meanwhile, China's domestic prices change more; the changes are around 4%. Besides, the tariff cut leads to a higher trade level where the changes of China's import quantities are most remarkable. China imports 30.34% more Cheese than before, and the both the import amount of Butter and Whole milk power increase by more than 6.5%. However, the 50% tariff cut implies a smaller impact on the exporters, where the export volumes increases are less than 0.5%.

Next, we come to analysis the effect on welfare. The higher world market prices result in a decreased consumer surplus and increased producer surplus in the exporting countries. In the importing countries, it is the other way around. It is important to point out that the consumer surplus and producer surplus of Whole milk powder in China are influenced by the tariff cut most. The producer surplus decreases by 126.4 million dollars and the consumer surplus increase by 148.2 million dollars which is more than twice as much as those of other products. Meanwhile, the welfares related to Cheese and Whole milk powder are affected most in Australia and New Zealand, respectively. Furthermore, despite the tariff rates go down, the expanded import amount brings about higher levels of the tariff revenues.

In all, the sum of different stakeholders' welfare is positive and we can conclude that the trade liberalization in the first scenario has a positive influence for all the countries.

5.2.2. Effects of a removal of the TRQ

This subsection analyses the simulation result of scenario 2 which examines the impacts of the abolishment of the TRQ. Table 5.5 and 5.6 present the simulation results.

Table 5.5 Effects of TRQ removal on the world market price

Scenario 2	ΔPw	
	$/ton	%
Butter	0	0.00%
Nonfat Dry Milk	0	0.00%
Whole Milk Powder	0	0.00%
Cheese	0	0.00%

Where: ΔPw The change of world market price.

Table 5.6 Effects of TRQ removal on domestic price, trade amount and stakeholders' welfares (1000 $) in three countries

Country	Commodity	Scenario 2								
		ΔPd		ΔTrade		ΔCS	ΔPS	ΔT		SUM
		level	%	Volume	%			value	%	
China	Butter	0.00	0.00%	0.00	0.00%	0.00	0.00	3048.67	190.42%	3048.67
	Nonfat Dry Milk	0.00	0.00%	0.00	0.00%	0.00	0.00	18661.51	113.75%	18661.51
	Whole Milk Powder	0.00	0.00%	0.00	0.00%	0.00	0.00	134565.08	703.61%	134565.08
	Cheese	0.00	0.00%	0.00	0.00%	0.00	0.00	4805.19	486.42%	4805.19
Australia	Butter	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
	Nonfat Dry Milk	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
	Whole Milk Powder	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
	Cheese	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
New Zealand	Butter	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
	Nonfat Dry Milk	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
	Whole Milk Powder	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00
	Cheese	0.00	0.00%	0.00	0.00%	0.00	0.00	0.00	0.00%	0.00

Where: ΔPd The change of the domestic price ($/ton), ΔTrade The change of trade amount (1000 tons), for exporters the positive value refers to an increase of export

volume, and for importers the negative value implies an increase of the import amount, ΔCS The change of the consumer surplus (1000 $), ΔPS The change of the producer surplus (1000 $), ΔTR The change of the tariff revenue (1000 $), SUM The sum of ΔCS, ΔPS and ΔTR (1000 $).

Table 5.5 indicates that the abolition of the non-binding TRQ does not affect the world market price. Therefore, as shown in Table 5.5, the welfares of producers and consumers in all the countries are not affected. The welfare of the Chinese government, however, is influenced. According to the model, the tariff revenue is divided into two parts: the within-quota and over-quota tariff revenues. The first part is the product of the quota level and unit within-quota tariff, and the second part is derived from the unit over-quota tariff and over-quota import amount. Provided the fixed domestic price, the model has a constant total import amount which is the sum of the within- and over-quota import.

Scenario 2 shows what happens if China eliminates the TRQ. In this case, the within-quota becomes zero and all imports face the higher over-quota tariff. So the tariff revenue goes up. Based on Table 5.6, the Chinese government gains largely from the removal of the TRQ. For Whole milk powder, the government receives 134.6 million dollars more tariff revenue, an increase of 703.61%. Additionally, in the case of Butter, Nonfat Dry Milk and Cheese, the tariff revenue grows up by 190.42%, 113.75% and 486.42% respectively.

5.2.3. Effects of full liberalization

In this scenario, all the trade policies are eliminated. Similar as the first scenario, the world market prices of all the dairy products go up, shown in Table 5.7.

Table 5.7 Effects of market distorting policies abolishment on world market price

Scenario 3	ΔPw	
	$/ton	%
Butter	10.592	0.43%
Nonfat Dry Milk	20.243	0.91%
Whole Milk Powder	31.240	1.20%
Cheese	15.980	0.49%

Where: ΔPw The change of world market price.

Table 5.8 presents the welfare changes due to the full trade liberalization. Compared to the previous trade liberalization scenarios, the full trade liberalization shows larger effects as expected.

Table 5.8 Effects of market distorting policies abolishment on domestic price, trade amount and stakeholders' welfares (1000 $) in three countries

Country	Commodity	Scenario 3								
		ΔPd		ΔTrade		ΔCS	ΔPS	ΔT		SUM
		level	%	Volume	%			Value	%	
China	Butter	-233.83	-8.12%	-3.35	13.29%	32093.60	-25809.07	-1601.04	-100.00%	4683.49
	Nonfat Dry Milk	-201.54	-7.92%	-5.07	5.64%	29915.72	-11277.65	-16406.10	-100.00%	2231.96
	Whole Milk Powder	-214.62	-5.37%	-27.67	14.02%	299158.41	-253838.71	-19125.02	-100.00%	26194.67
	Cheese	-374.30	-7.99%	-10.57	60.83%	117778.22	-109300.31	-987.86	-100.00%	7490.04
Australia	Butter	10.67	0.43%	0.08	0.16%	-738.03	1258.34	0.00	0.00%	520.31
	Nonfat Dry Milk	21.18	0.91%	0.75	0.57%	-2281.57	5085.24	0.00	0.00%	2803.67
	Whole Milk Powder	35.60	1.20%	1.09	1.06%	-1613.90	5295.74	0.00	0.00%	3681.85
	Cheese	18.53	0.49%	1.07	0.78%	-4471.97	7025.79	0.00	0.00%	2553.82
New Zealand	Butter	10.59	0.43%	0.45	0.09%	-745.08	5890.53	0.00	0.00%	5145.45
	Nonfat Dry Milk	20.24	0.91%	1.72	0.42%	-1003.36	9289.95	0.00	0.00%	8286.59
	Whole Milk Powder	31.24	1.20%	8.44	0.86%	-2067.73	32749.69	0.00	0.00%	30681.96
	Cheese	15.98	0.49%	1.40	0.41%	-1134.57	6632.92	0.00	0.00%	5498.35

Where ΔPd The change of the domestic price ($/ton), ΔTrade The change of the trade amount (1000 tons), for exporters the positive value refers to an increase of export volume, and for importers the negative value means an increase of the import amount, ΔCS The change of the consumer surplus (1000 $), ΔPS The change of the producer surplus (1000 $), ΔTR The change of the tariff revenue (1000 $), SUM The sum of ΔCS, ΔPS and ΔTR (1000 $).

First we analyze the domestic markets of all the players. As shown in Table 5.8, the full trade liberalization results in a lower domestic price and an increased import volume in China. The enlarged import demand leads to a rise of the world market price, increasing the domestic price level of exporters. Further, the increased domestic price stimulates their exports of dairy products. Therefore, the trade amount of all the players are going up.

Next, we turn to the tariff revenue of Chinese government. Because all the tariffs are removed, the government gives up all the tariff revenues, so they show a decrease of 100%. Next, we look at the consumer and producer welfares in China. From Table 5.8, it is obvious that the producer and consumer surplus go down and up, respectively. Despite both the tariff revenue and producer surplus fall, the full trade liberalization has a positive effect on the total social welfare in China. The total welfare associated to Whole milk powder gains most among all the products with 26.2 million dollars more compared to the baseline case.

Finally, we check the result of the exporters. In Australia, the stakeholders of Cheese are

influenced most. The producers of Cheese gain 7.0 million dollars more profit than in the case where the trade policies are implemented. However, the domestic consumers lose 4.5 million of their welfare. In New Zealand, the largest influence appears in the Whole milk powder market where the producers make an extra profit of 32.8 million dollars. Meanwhile, the consumer surplus shows a decrease of 2.1 million dollars. Overall, from the total welfare perspective, the elimination of trade policies have a positive influences on all the markets in each country and the Whole milk powder market is most susceptible among all the markets.

6. Conclusions, recommendations and Discussion

6.1. Conclusions

Based on the pervious analysis, the research questions are resumed and answered in this section.

Chapter 2 describes the development of the Chinese dairy sector and sheds light on the trade policies that are relevant to dairy trade between China and its trade partners.

Therefore, from the Chapter 2, we can find an answer to the first two research questions:

(1) What is the current situation of China's dairy sector and how does China's dairy market develop?

(2) What policies are relevant to dairy trade between China and its trade partners now and in the future?

We can conclude that the development of China's dairy sector was closely associated with the general industrial and trade policies. The transition from a centrally planned economy to a modern market economy has a significant impact on the Chinese dairy market (Fuller and Huang, 2006). The previous policies which restricted the domestic consumption were abandoned, expanding the domestic demand and driving the market (Liu and Liu, 2007). The liberalization of trade policies also contributed remarkably to the development of the dairy sector.

Besides, in the Chapter 3 and 4 a spatial equilibrium model is constructed. It focuses on the Chinese dairy trade, throwing light on the third research question: 'How can dairy trade of China be modeled'. Therefore, next we concentrate on the next two research questions:

(3) What data on demand, supply and trade are necessary and available to construct a spatial equilibrium model?

The spatial equilibrium model is constructed based on the supply and demand functions of each country with the assumption that the excess demand equals excess supply (Samuelson, 1952). The domestic markets are linked by an assumed world market where the price equals the domestic prices of each country plus corresponding transportation costs and tariffs. Therefore, the model first calls for the data for calibrating the supply and demand functions.

The demand quantity is the function of domestic price and income and supply quantity only depends on the domestic price (Samuelson, 1952). Given the domestic price as well as demand and supply volumes, we are able to derive the coefficients of two functions with data of elasticities. In spite of the inconsistencies, the available data are extracted from different

sources. The supply and demand quantities and elasticities are gained from the FAPRI Database, and the prices are derived based on the trade volumes and values which are from the FAO Database. Besides, the food expenditure data from the Knoema Database are taken as the income in the model, because the food expenditure could reflect the effect of income on food consumption amount better than other types of income data. In addition, the supply functions consist of supply quantities and domestic price. The slopes and intercepts of the supply and demand functions are derived based on the production and consumption quantities, domestic price and elasticities.

The world market price is assumed to equal to domestic price of New Zealand, and the difference between domestic prices and the world price is the transportation cost and an ad valorem tariff. Data on tariff rates comes from China's Customs Import and Export Tariff and Reporting Guidelines (2011) which also presents the data for the TRQ. Using prices and ad valorem tariff rates we can obtain the transportation cost. In addition, to equalize the excess demand and excess supply the model includes another player: the rest of the world (ROW) which has an import function. The import volume of the ROW comes from the difference between the total import and supply amount. To derive the coefficients of the import function, we assume the value of elasticities and income in the ROW to be equal to that of China, and the price comes from Saudi Arabia.

Provided the above data, the model is able to calculate the change of stakeholders' welfare resulted from trade liberalization.

(4) What are the effects of trade liberalization on the dairy sector in China?

Through model simulations, we have examined the impacts of trade liberalization under three scenarios. The outcomes of the simulations confirm the positive contribution of liberalization to the dairy sectors. In each dairy product market of the three countries, taking the three groups of stakeholders as a whole, they are benefiting from the adjustment of trade policies. Here we focus on the dairy market of China.

Both the 50% cut of import tariff and the full trade liberalization stimulate the dairy trade of China through a lowered import price. After the market distorting policies are adjusted or abolished, the imports of dairy products are enlarged. Besides, the consumers and producers face different effects: on the one hand, the lower domestic price resulting from the tariff adjustment hurts the interests of producers who earn less profit; on the other hand, the consumers who face the cheaper products are benefiting. Moreover, it is significant to note that the consumers/producers lose/gain most in the case of the full trade liberalization. In addition, the change in welfare of the Chinese government is more complicated. It is obvious that the elimination of the TRQ increases the tariff rate for the import within the quota, leading to higher tariff revenue. Furthermore, the full trade liberalization means the government no longer has tariff revenue. Therefore, the tariff revenue goes down by 100% in the case of full trade liberalization. However, in the case of the 50% reduction in the tariff the overall influence of a lower tariff rate and higher domestic price is less clear. From the

simulations, we conclude that the lower tariff level in combination with the larger import volume increases the tariff revenue of China.

6.2. Recommendations

Based on the above analysis, the findings incorporate important policy implications. First, the Chinese government should take the proper measures to help the domestic dairy industry dealing with the impact of a liberalized international market. With trade liberalization, as an immature industry, the dairy industry faces chances and challenges coming from the outside. Because the prices of dairy products will decrease, the domestic dairy industry is less competitive. However, the transition period accompanying the trade liberalization gives producers time to adapt to the new market environment. Therefore, according to Liu and Liu (2007), the proper duration of the interim period is significant to the development of the Chinese dairy sector. The tariff reduction should be modest and gradual, leaving room for the domestic dairy industry to adjust. Second, the consumption preferences of different dairy products are diverse (Fuller and Huang, 2006). Therefore, the temporary protective trade policies within the interim period and depth of the tariff cut should be based on the market characteristics of the products (Liu and Liu, 2007). For example, the demands for Butter and Cheese are relatively small, but the market potential of them is probably large. So, the Chinese government might set a longer transition period for these two commodities. In contrast, to respond to high excess market demand for Nonfat dry milk and Whole milk powder, the import tariff might be cut to a lower level than for other dairy commodities

6.3. Discussion

This section critically reflects on the model restrictions and comes up with several suggestions for future research.

First, we simulated the product markets independently by separate models. However, in reality, there is substitution between the different dairy products as they are all produced from milk. Also on the consumption side, they are possible substitutes (e.g., Nonfat dry milk and Whole milk powder). This would add complexity to the modeling. Given data limitations, we did not model the substitution between the products. According to our knowledge, no research has shed light on the substitution of dairy products. Therefore, a future study might take the linkages between different dairy markets into account.

Second, the model merely includes the total imports or exports of each player, without knowing the trade flow between the trading partners. In this case, we can only simulate the scenarios where the tariff rate for all the exporters decreases. Therefore, we are not able to check the influence of bilateral trade liberalization. Stennes and Wilson (2010) employed a spatial equilibrium model which covers the specific trade volume between each pair of countries. Based on this model, they examined the effect of bilateral trade liberalization on lumber trade in North America. Therefore, to get a better model of the international dairy market, it is important to model the trade flows between different players.

Third, in the model we take countrie as a whole and assume fixed transportation cost which is calibrated endogenously. Nevertheless, transportation is a complex issue and it is determined by many factors such as the distance between certain harbors. Scholars have tried to provide an optimal solution minimizing the transportation cost of different products. Heikkinen (2013) presented a spatial equilibrium model which assumes a quadratic transport cost function, taking fully into account the network externalities. The findings prove the remarkable influence of transportation cost on trade. Considering this, it is important to construct a model which gives a more realistic way of modeling transport cost.

Finally, the model is constructed based on a set of static equations. Therefore, the market equilibrium is only reasonable at a certain time point. In reality, the market conditions keep changing all the time. Nagurney and Aronson (1988) and Barbagallo (2007) have built spatial equilibrium models which cover different time periods. So, a dynamic model which incorporates the changes over time is more realistic.

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Appendices

Appendix 1 Domestic and International Dairy Markets

Table A. 1 Food expenditure, demand and supply elasticities of four commodities in China, New Zealand and Australia, 2011

Commodity	Country	Elasticities		
		Income	Demand	Supply
Butter	China	0.2	-0.2	0.07
	Australia	0.03	-0.1	0.07
	New Zealand	0.04	-0.11	0.15
Nonfat Dry Milk	China	0.3	-0.3	0.25
	Australia	0.18	-0.28	0.19
	New Zealand	0.35	-0.53	0.33
Whole Milk Powder	China	0.3	-0.2	0.15
	Australia	0.38	-0.28	1.07
	New Zealand	0.31	-0.69	0.59
Cheese	China	0.25	-0.05	0.36
	Australia	0.26	-0.36	0.29
	New Zealand	0.44	-0.79	0.5

Source: FAPRI Elasticity Database

Table A. 2 Trade of four types of dairy products in China, New Zealand and Australia, 2011

Commodity	Country	Export		Import		Demand (1000 tonnes)	Supply (1000 tonnes)
		Quantity (tonnes)	Value (1000 $)	Quantity (1000 tonnes)	Value (1000 $)		
Butter	China	3.448	9.245	45.876	114.448	140.26	109.55
	Australia	83.466	178.612	16.361	39.989	70.28	116.67
	New Zealand	451.179	958.541	0.834	3.006	71.58	543.38
Nonfat Dry Milk	China	0.479	3.776	96.986	227.298	150.38	55.36
	Australia	167.435	359.145	4.559	10.103	110.54	236.01
	New Zealand	407.993	836.398	3.986	8.51	52.08	445.54
Whole Milk Powder	China	12.535	71.818	239.31	851.832	1419.91	1166.68
	Australia	133.358	351.594	8.245	21.985	47.03	140.12
	New Zealand	818.08	1892.844	0.529	2.425	72.63	974.4
Cheese	China	1.708	9.265	37.546	157.235	315.82	284.48
	Australia	162.412	554.512	59.045	238.807	252.34	366.34
	New Zealand	270.591	796.766	5.314	27.28	78.5	391.42

Source: Data of export and import are from the FAO Database, demand and supply levels are from the FAPRI Commodities Database

Appendix 2 Market Distorting Policies (Tariffs and tariff rate quotas)

Table A. 3 Tariffs on four dairy products, 2011

Commodity (Tariff Item)	Country	Tariff rates	
		Tariff Rate (%)	Tariff Type
Butter (04051000)	China	0	N/A
	Australia	10	Most Favored Nation Tariff Rate
	New Zealand	6	The Conventional Tariff Rate for New Zealand
Nonfat Dry Milk (04022900)	China	0	N/A
	Australia	10	Most Favored Nation Tariff Rate
	New Zealand	6.7	The Conventional Tariff Rate for New Zealand
Whole Milk Powder (04022100)	China	0	N/A
	Australia	10	Most Favored Nation Tariff Rate
	New Zealand	6.7	The Conventional Tariff Rate for New Zealand
Cheese(04063000)	China	0	N/A
	Australia	12	Most Favored Nation Tariff Rate
	New Zealand	7.2	The Conventional Tariff Rate for New Zealand

Source: China Customs Import and Export Tariff and Reporting Guidelines (2011)

Table A. 4 Decreasing tariff rate quotas for New Zealand

Commodity	TRQ	2011	2012	2013	2014	2015	2016	2017	2018	2019
Butter	Trigger level (1000 tonnes)	10.882	11.426	11.997	12.597	13.227	13.888	14.582	0	0
	In-quota tariff (%)	6	5	4	3	2	1	0	0	0
	Over-quota tariff (%)	10	10	10	10	10	10	10	10	0
Nonfat dry milk	Trigger level (1000 tonnes)	109.974	115.473	121.247	127.309	133.675	140.358	147.376	154.745	0
	In-quota tariff (%)	6.7	5.8	5	4.2	3.3	2.5	1.65	0.8	0
	Over-quota tariff (%)	10	10	10	10	10	10	10	10	0
Whole milk powder	Trigger level (1000 tonnes)	109.974	115.473	121.247	127.309	133.675	140.358	147.376	154.745	0
	In-quota tariff (%)	6.7	5.8	5	4.2	3.3	2.5	1.65	0.8	0
	Over-quota tariff (%)	10	10	10	10	10	10	10	10	0
Cheese	Trigger level (1000 tonnes)	4.167	4.376	4.595	4.824	5.066	5.319	5.585	0	0
	In-quota tariff (%)	7.2	6	4.8	3.6	2.4	1.2	0	0	0
	Over-quota tariff (%)	12	12	12	12	12	12	12	12	0

Source: Free Trade Agreement Between The Government of the People's Republic of China And The Government of New Zealand ANNEX 2: Special Agricultural Safeguard Measures

Appendix 3: Symbols Declaration

Table A. 5 Subscript, parameters and variables

Subscript：

i	Countries (i=1: China, i=2: Australia, i=3: New Zealand)

Parameters:

e_i^s	Price elasticity of supply in country i;
e_i^d	Price elasticity of demand in country i;
P'	Within-quota price in country i=1;
a_i	The price slope of the demand function of country i;
b_i	The intercept of the demand function of country i;
c_i	The income slope of the demand function of country i;
α_i	The price slope of the supply function of country i;
β_i	The intercept of the supply function of country i;
Q^q	Import quota for country i=3;
e_i^{xp}	Import price elasticity of country i;
e_i^{xi}	Import income elasticity of country i;
e_{im}^p	Import price elasticity of the ROW;
e_{im}^I	Import price elasticity of the ROW
η	The intercept of import function of the ROW;
θ	The slope of import functions in terms of price of the ROW;
λ	The slope of import function in terms of income of the ROW
wr_t	Within-quota tariff rate for country i=3 in year t;
ΔPS_i	Change of producer surplus in country i;
ΔCS_i	Change of consumer surplus in country i;
ΔT	Change of tariff revenue in country i=1;
ΔQR	Change of quota rent in country i=3;

Endogenous variables：

P_i	Price in country i;
Pr	Price in the ROW;
${P_1}'$	Within-quota price in country i=1
P^w	World market price
Q_i^d	Demand in country i;
Q_i^s	Supply in country i;
IM	Import amount of the ROW;
x_i	Trade amount of country i;

Exogenous variables

I_i	Income in country i;
Ir	Income in the ROW;
tc_i	Percentage transportation cost for country i;
r_i	Import tariff rate of country i;
Cr	Sum of tariff and transportation cost rate of the ROW;
Wr	Within-quota tariff rate.