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Trade Effects of Ensuring Export Disciplines through Parallelism: The Case of Skim Milk

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The purpose of this paper is to quantitatively analyze the trade effects of ensuring export disciplines through parallelism. A spatial equilibrium model is developed that includes export subsidies, exporting state trading enterprises (exporting STEs), and imperfect competition. The model is applied to the international skim milk trade. The main results of the policy simulations are as follows. First, the skim milk trade has been distorted by European Union (EU) export subsidies and exporting STEs in New Zealand and Canada. Second, the distortion may be substantially corrected by ensuring export disciplines through parallelism. Third, the EU will continue to advocate parallelism in ongoing WTO agricultural negotiations with support from the United States and Japan, which receive the benefits from such successful negotiations.

Key words: WTO agricultural negotiation, export discipline, parallelism, trade effect, policy simulation

1. Introduction

In July 2004, the World Trade Organization (WTO) Doha Round (DR) agricultural negotiation agreed on a framework; moreover, agreement was reached that export subsidies would be eliminated by a certain day.[1)] Additionally, an agreement was reached that other export measures with equivalent effects as represented by exporting state trading enterprises (exporting STEs) would be ensured similar disciplines and with parallel export subsidies. In short, in export competition, agreement was reached that export subsidies and other export measures with equivalent effects would be ensured disciplines in parallel, namely through parallelism.

The purpose of this paper is to quantitatively analyze the effects on agricultural trade of ensuring export disciplines through parallelism.

Previous studies that quantitatively analyzed export disciplines include Larivière and Meilke (1999), Poonyth and Westhoff (2000), Kawaguchi and Shono (2001), Gohin and Bureau (2006), and Maeda and Hokazono (2010). However, their analyses failed to consider exporting STEs and only conducted simulation analyses of the effects of eliminating export subsidies. Except for Maeda and Hokazono (2010), these studies also conducted their analyses under the assumption of perfect competition. Theoretically, under the assumption of perfect competition, the effects of various policies are measured more excessively than under the assumption of imperfect competition. Analysis of current agricultural trade as an oligopoly should be done under the assumption of imperfect competition and not perfect competition.

To overcome these problems, this paper expands the spatial equilibrium model to include simultaneous export subsidies, exporting STEs, and imperfect competition. Specifically, this study integrates the international spatial equi-

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librium model under imperfect competition as developed by Maeda (2010) and the dual structure spatial imperfect competition equilibrium model as developed by Kawaguchi and Suzuki (1994) and Kawaguchi, Suzuki, and Kaiser (1997). The model developed by Maeda (2010) is superior because it is explicitly introduced the Lerner index which indicate the level of imperfect competition in each country's market in addition to trade policies such as export subsidies, and it can be calibrated the Lerner index. In contrast, the model by Kawaguchi and Suzuki (1994) and Kawaguchi, Suzuki, and Kaiser (1997) is superior because it models competition among production areas engaged in cooperative selling, which represents the same principle as exporting STEs.

This paper overcomes the previously stated problems faced by these prior studies by integrating the models of Maeda (2010) and of Kawaguchi and Suzuki (1994) and Kawaguchi, Suzuki, and Kaiser (1997). Then, policy simulation analysis is conducted on the trade effects of ensuring export discipline based on parallelism by applying the model to skim milk, one of the most involved products with respect to export subsidies and exporting STEs.

The structure of this paper is as follows. Section 2 explains the current competitive situation for the skim milk trade. Section 3 and section 4 describe the model and the calibration method. Section 5 explains the data used in the calibration and policy simulation analysis. Section 6 presents the calibration results and considers the level of imperfect competition in the skim milk market. Section 7 engages in policy simulation analysis on the trade effects of export discipline insurance and considers the results and implications for future DR agricultural negotiation. Section 8 summarizes the paper and presents the remaining tasks for future studies.

2. Current Situation of Export Competition in the Skim Milk Trade

In the skim milk trade—the object of the analysis of this paper—export subsidies and exporting STEs were the targets of export competition during the DR agricultural negotiation.[2)]

First, with respect to export subsidies, the problem is that trade is distorted because counties which deliver export subsidies are able to export at low prices. Thus, the European Union (EU) and the United States have been the primary deliverers of large subsidies up to the present. However, these countries eliminated export subsidies through the DR agricultural negotiation.

In contrast, the problem with respect to exporting STEs is that trade is distorted by governmental or non-governmental enterprises which have been granted exclusive or special rights to set monopoly export prices for skim milk that are discriminatory in domestic and foreign markets.[3)] For skim milk, New Zealand and Canada have exporting STEs.[4)]

The exporting STE in New Zealand is Fonterra Co-operative Group Limited (Fonterra). Fonterra is a large dairy cooperative and holds a monopoly of more than 92% of the domestic production quantity and assembly of raw milk.[5)] Moreover, Fonterra sells assembled raw milk for drinking, processes raw milk into skim milk or butter, and engages in centralized sales to domestic and overseas markets.[6)]

New Zealand has reformed Fonterra by establishing the Dairy Industry Restructuring Act 2001 to address the DR agricultural negotiation. As a result, Fonterra must sell 5% of its assembled raw milk at an inexpensive price to other dairy industry makers. Although Fonterra has not lost its monopoly position, its share of the assembling process has decreased.[7)]

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1) After the Hong Kong Ministerial Declaration, the schedule was adopted to be 2013.

2) Export measures that have the same effect as export subsidies, except for export STEs, are food aid, export credit, and so on. Among these, food aid is constantly discussed by the WTO panel when problems occur. Regarding export credit, the United States has adopted it but not for skim milk. Therefore, no problem exists as long as export subsidies and exporting STEs are considered when ensuring export disciplines for the skim milk trade.

3) Refer to Kagatsume (2000) and Suzuki (2001).

4) New Zealand's share of skim milk exports is 20.2% (FAO 2009), making the country the second largest skim milk exporter in the world. Canada's share of skim milk exports is approximately 1.1% (FAO 2009), not as large as New Zealand's. However, other export countries view Canada as a powerful exporter.

5) Refer to MAF (2009) for Fonterra's share of milk collection.

The exporting STE in Canada is the Canadian Dairy Commission (CDC). The CDC is a crown corporation, controls the supply of raw milk (hence skim milk), and exports the highest volume of skim milk from Canada based on the Harmonized Milk Classification System and the National Milk Marketing Plan.

In contrast to Fonterra, the CDC does not directly process dairy products but supply management of raw milk for processing and supply and demand management of dairy products have been carried out by the CDC. Specifically, CDC decides quantity of raw milk for processing (Market Sharing Quota) based on National Milk Marketing Plan and allocates the quota to raw milk producers through marketing boards under the umbrella of CDC in each State. The CDC manages the production of each dairy product by setting support prices for every end use and showing them to processors based on the Harmonized Milk Classification System. Similar to New Zealand, raw milk producers in Canada receive pool prices through the marketing board, but the base is support prices for every end use based on the Harmonized Milk Classification System. In particular, a special class (class 5) of support prices for raw milk used in skim milk for export is lower than the support prices for raw milk used in skim milk for domestic consumption because the class 5 price is related to the cost of processing raw milk in the United States. In short, skim milk prices within Canada differ from those outside of Canada's market.[8] Further, as previously described, exceptionally skim milk is exported by the CDC. Therefore, the CDC substantially decides on the production and sale of skim milk and the pool price seems to be decided only for skim milk.

In January 1998, the CDC's dairy export practices at discriminatory prices were presented to the court as a case of exports with subsidies by the United States and New Zealand. In December 2002, Canada lost its case in front of the WTO dispute settlement committee. As a result, Canada reformed its Harmonized Milk Classification System and decreased the export value and export quantity of dairy products all the way up to the current WTO bidding level. However, the CDC continues to strictly control the supply of dairy products based on the Harmonized Milk Classification System and the National Milk Marketing Plan; moreover, Canada insists that additional compromise is out of the question in the DR agricultural negotiation.[9]

As previously stated, export subsidies have been eliminated in the skim milk trade; however, exporting STEs, particularly in Canada, are against ensuring discipline. In short, in the future, progress to ensure export disciplines based on parallelism through DR agricultural negotiation is uncertain.

3. Model

1) Notations

This paper analyzes policy simulation through trade effects by ensuring export disciplines based on parallelism using a spatial equilibrium model. The developed model includes export subsidies and exporting STEs, after simplifying the current condition of exporting STEs as previously explained.

The model uses the following notations. The notations i and j represent each country, up to m and n $(m \leqq n)$, where m and n are natural numbers attached to each country. However, countries engaged in state export trade are not included in i, and i is replaced by h.[10]

P_j : Market price in country j

6) The profits that Fonterra obtains from selling these products are returned to raw milk producers at the pool price according to the unit quantity of solid milk included in the raw milk. In short, raw milk producers are paid the pool price based on the quantity of raw milk consigned to Fonterra regardless of whether the raw milk is for drinking or processing. The unit of payment for 1 kg of solid milk was in NS$4.1 per ton in 2005 (Fonterra 2006). The raw milk producer received a price of US$351.9 per ton when the price in US$ per ton of raw milk, including whole raw milk, was 12.6% less than the solid milk rate.

7) For the aforementioned Fonterra and Dairy Industry Restructuring Act, refer to Tamai and Sugiwaka (2010).

8) In contrast, the 2005 pool price in Canada for class 5 was US$280.5 per ton, and the average pool price of whole raw milk was US$577.0 per ton (CDC 2006), a more than double price differential. Still, the raw milk producer price was US$335.9 per ton (FAO 2009), inferring that Canada strengthened its international competitiveness by discriminating using domestic and foreign prices.

9) Refer to Ozawa (2007) for Canada's dairy policy and trade issues.

D_j : Demand function in country j
Y_i : Production quantity in country i
X_{ij} : Quantity exported from country i to j
C_i : Production cost in country i
MC_i : Marginal cost in country i
TC_{ij} : Unit transportation cost from country i to j
AT_{ij} : Ad valorem tariff rate in country i to j
SD_{ij} : Specific duty rate in country i to j
ES_{ij} : Unit export subsidy in country i to j
PP_h : Pool price in country h

2) Assumptions

The key preconditions for the spatial equilibrium model as expanded in this paper are as follows.

(i) In countries with exporting STEs, producers consign the selling of all farm products to the exporting STEs. Further, producers in these countries are price takers and produce to maximize their profits under the given pool price returned by the exporting STEs.

(ii) In each country, the exporting STEs engage in single desk (central) selling of farm products consigned by a number of domestic producers in domestic and foreign markets and return the obtained profits to producers through the pool price.

(iii) The unit transportation cost between countries and the export subsidies in each country are fixed, and transportation costs within each own country are zero.

(iv) For each country, the demand function and the marginal cost function are specified as linear functions as follows, provided that α_j, β_j, γ_i, and δ_i are parameters that typically have positive values except for γ_i.

$$D_j = \alpha_j - \beta_j P_j \tag{1}$$

$$MC_i = \gamma_i + \delta_i Y_i \tag{2}$$

The model expanded in this paper covers one product. Therefore, the following assumptions are made to apply the model to skim milk.

(v) In countries with exporting STEs, producers produce skim milk and consign the sale of skim milk. The exporting STEs return the obtained profits to the producers at the pool price. Alternatively, in countries without exporting STEs, producers produce and sell skim milk.[11]

3) Principles of the model structure

Under the previously stated preconditions, the spatial equilibrium model is constituted assuming the Necessary conditions for profit maximization of exporting STEs, producers in countries with exporting STEs, producers in countries without exporting STEs, and the market equilibrium condition of each country's markets.

(i) Necessary conditions for profit maximization of exporting STEs

The profit maximization behavior of exporting STEs in country h is formulated given selling quantities Y_h, which are consigned by producers in the same country.[12]

$$\underset{X_{hj}}{MAX}\ \pi_h = \sum_{j=1}^{n} P_j X_{hj} - \sum_{j=1}^{n} TC_{hj} X_{hj} - \sum_{j=1}^{n} AT_{hj}\,(Ph + TC_{hj})\ X_{hj} - \sum_{j=1}^{n} SD_{hj} X_{hj} \tag{3}$$

$$s.t. \sum_{j=1}^{n} X_{hj} \leqq Y_h \tag{4}$$

$$X_{hj} \geqq 0 \tag{5}$$

Then, for the Kuhn-Tucker condition to be met, the maximization problem in functions (3)–(5) is expressed as necessary conditions for profit maximization of exporting STEs in the following functions (6) and (7). L_h is the Lagrange function corresponding to the previously noted maximization problems. Further, λ_h is the Lagrange multiplier corresponding to function (4). And it represents the marginal cost equivalent of sales volume limit.

10) The variable h refers to random natural numbers to 1 (provided that $1 \leqq n$).

11) The preference is to analyze joint products such as drinking milk, butter, and so on simultaneously when analyzing skim milk. Assumption (v) is conformable when the pool price is set for every item using the Harmonized Milk Classification System in Canada, but when the pool price is set comprehensively such as in New Zealand this is not necessarily conformable. Regarding this point, development of an analytical model is necessary and should be noted in the analytical result.

12) If exporting STEs' profits are regarded as an average, Formularization (3) shows that exporting STEs would act based on the CIF price, calculated by deducting unit transportation cost and tariff cost per unit export quantity from the market price. The same point applies to formula (10).

$$\frac{\partial L_h}{\partial X_{hj}} = P_j - TC_{hj} - AT_{hj}(P_h + TC_{hj}) - SD_{hj} - \lambda_h - LI_jP_j \leqq 0,\ X_{hj} \geqq 0,\ X_{hj}\frac{\partial L_h}{\partial X_{hj}} = 0 \quad (6)$$

$$\frac{\partial L_h}{\partial \lambda_h} = Y_h - \sum_{j=1}^{n} X_{hj} \geqq 0,\ \lambda_h \geqq 0,\ \lambda_h \frac{\partial L_h}{\partial \lambda_h} = 0 \quad (7)$$

The parameter LI_j is the Lerner index in market j. Or, LI_jP_j is the price margin in market j. Furthermore, if the price elasticity of demand in country j is ε_j, then function (8) follows.

$$0 \leqq -\varepsilon_j LI_j \leqq 1 \quad (8)$$

In short, $-\varepsilon_j LI_j$ equals zero for a perfectly competitive market structure, has a positive value for an imperfectly competitive market structure, and equals 1 if the market is monopolized by one country's producer.[13)]

(ii) Necessary conditions for profit maximization of producers in countries with STEs

Given the maximum profit for country h's exporting STEs of π_h, the pool price received by the country is expressed as function (9).

$$PP_h = \frac{\pi^*_h}{\sum_{j=1}^{n} X_{hj}} \quad (9)$$

In country h, producers produce given the pool price, PP_h. In short, subordinate to the marginal cost function (2), country h produces such that its marginal cost equals the pool price.

(iii) Necessary conditions for profit maximization of producers in countries without exporting STEs

The profit maximization behavior of country i's producers is formulated as follows.

$$\underset{X_{ij},\ Y_i}{MAX}\ \pi_i = \sum_{j=1}^{n} P_jX_{ij} - C_i(Y_i) - \sum_{j=1}^{n} TC_{ij}X_{ij} - \sum_{j=1}^{n} AT_{ij}(P_i + TC_{ij})X_{ij} - \sum_{j=1}^{n} SD_{ij}X_{ij} + \sum_{j=1}^{n} ES_{ij}X_{ij} \quad (10)$$

$$s.t.\ \sum_{j=1}^{n} X_{ij} \leqq Y_i \quad (11)$$

$$X_{ij} \geqq 0,\ Y_i \geqq 0 \quad (12)$$

For the Kuhn-Tucker condition to be met, the maximization problem in functions (10)–(12) is expressed as the necessary conditions for profit maximization of country i's producers in the following functions (13)–(15). L_i is the Lagrange function corresponding to the previously noted maximization problems. Further, λ_i is the Lagrange multiplier corresponding to function (11) and indicates the marginal cost in country i.

$$\frac{\partial L_i}{\partial X_{ij}} = P_j - TC_{ij} - AT_{ij}(P_i + TC_{ij}) - SD_{ij} + ES_{ij} - \lambda_i - LI_jP_j \leqq 0,\ X_{ij} \geqq 0,\ X_{ij}\frac{\partial L_i}{\partial X_{ij}} = 0 \quad (13)$$

$$\frac{\partial L_i}{\partial Y_i} = -\gamma_i - \delta_i Y_i + \lambda_i \leqq 0,\ Y_i \geqq 0,\ Y_i\frac{\partial L_i}{\partial Y_i} = 0 \quad (14)$$

$$\frac{\partial L_i}{\partial \lambda_i} = Y_i - \sum_{j=1}^{n} X_{ij} \geqq 0,\ \lambda_i \geqq 0,\ \lambda_i\frac{\partial L_i}{\partial \lambda_i} = 0 \quad (15)$$

(iv) Market equilibrium conditions

Market price in country j is adjusted such that each country's aggregate demand quantity and aggregate supply quantity are equal. Function (16) expresses this market equilibrium condition.

$$\alpha_j - \beta_j P_j \leqq \sum_{h=1}^{l} X_{hj} + \sum_{i=1}^{m} X_{ij},\ P_j \geqq 0,\quad P_j\left[\sum_{h=1}^{l} X_{hj} + \sum_{i=1}^{m} X_{ij} - \alpha_j + \beta_j P_j\right] = 0 \quad (16)$$

The spatial equilibrium model in this paper is composed of functions (2), (6), (7), (9), and (13)–(16). In short, the spatial equilibrium model composed of these functions is formulated as a nonlinear complementarity problem (NCP).[14)]

4. Method of Calibration

To conduct a simulation analysis to ensure export disciplines using the spatial equilibrium model as previously described, certain data are required, such as each country's trade policy, demand function, marginal cost function, and Lerner index, and the unit transportation cost between countries.

However, in this paper, each country's Lerner index, marginal cost, and pool price are calibrated in the method identical to that of Maeda (2010). Moreover, the marginal cost functions are linearized using the calibrated marginal cost

13) Refer to Maeda (2010) for an introduction to and details on the Lerner index.
14) Refer to Facchinei and Pang (2003) regarding NCP.

and pool prices.

First, AY_i, AX_{ij}, and AP_j represent instances of production in country i, the quantity transported between country i and country j, and the market price in country j for a certain year, respectively. Next, the subjects are set newly.[15]

$$\sum_{h=1}^{l} X_{hj} + \sum_{i=1}^{m} X_{ij} \leqq \sum_{h=1}^{l} AX_{hj} + \sum_{i=1}^{m} AX_{ij} \quad (17)$$

Furthermore, the necessary condition for profit maximization of exporting STEs, $Y_h = AY_h$, as previously shown is reformulated (not taking into account the Lerner index) by reformulating the profit-maximizing behavior of exporting STEs by adding function (17) to functions (3)–(5), resulting in functions (18)–(20).

$$\frac{\partial L_h}{\partial X_{hj}} = P_j - TC_{hj} - AT_{hj}(P_h + TC_{hj}) - SD_{hj} - \lambda_h - \mu_j \leqq 0,\ X_{hj} \geqq 0,\ X_{hj}\frac{\partial L_h}{\partial X_{hj}} = 0 \quad (18)$$

$$\frac{\partial L_h}{\partial \lambda_h} = AY_h - \sum_{j=1}^{n} X_{hj} \geqq 0,\ \lambda_h \geqq 0,\ \lambda_h \frac{\partial L_h}{\partial \lambda_h} = 0 \quad (19)$$

$$\frac{\partial L_h}{\partial \mu_j} = \sum_{h=1}^{l} AX_{hj} + \sum_{i=1}^{m} AX_{ij} - \sum_{h=1}^{l} X_{hj} - \sum_{i=1}^{m} X_{ij} \geqq 0,\ \mu_j \geqq 0,\ \mu_j \frac{\partial L_h}{\partial \mu_j} = 0 \quad (20)$$

Alternatively, the necessary conditions for profit maximization of producers in countries without exporting STEs, $Y_i = AY_i$, is shown in functions (21)–(23) by reformulating the profit-maximizing behavior of countries without exporting STEs (not taking into account the Lerner index) by adding function (17) to functions (10)–(12).

$$\frac{\partial L_i}{\partial X_{ij}} = P_j - TC_{ij} - AT_{ij}(P_i + TC_{ij}) - SD_{ij} + ES_{ij} - \lambda_i - \mu_j \leqq 0,\ X_{ij} \geqq 0,\ X_{ij}\frac{\partial L_i}{\partial X_{ij}} = 0 \quad (21)$$

$$\frac{\partial L_i}{\partial \lambda_i} = AY_i - \sum_{j=1}^{n} X_{ij} \geqq 0,\ \lambda_i \geqq 0,\ \lambda_i \frac{\partial L_i}{\partial \lambda_i} = 0 \quad (22)$$

$$\frac{\partial L_i}{\partial \mu_j} = \sum_{h=1}^{l} AX_{hj} + \sum_{i=1}^{m} AX_{ij} - \sum_{h=1}^{l} X_{hj} - \sum_{i=1}^{m} X_{ij} \geqq 0,\ \mu_j \geqq 0,\ \mu_j \frac{\partial L_i}{\partial \mu_j} = 0 \quad (23)$$

Further, μ_j is a Lagrange multiplier corresponding to function (17) and is assumed to be fixed in each country market. At this point, a comparison of (6) ((13)) and (18) ((21)) clarifies that μ_j corresponds to LI_jP_j. Therefore, given AY_i, AY_h, AX_{ij}, and AX_{hj} in a certain year, LI_jP_j is estimated as a linear complementarity problem (LCP) consisting of functions (16) and (18)–(22).[16] Alternatively, LI_j is estimated by dividing LI_jP_j by AP_j in each year. Moreover, the marginal cost and the pool price in each country may be estimated using function (24) and function (9).

$$MC_i = \lambda_i \quad (24)$$

5. Data

1) Countries for analysis and trade structure

The seven major exporting countries and regions (the United States, New Zealand, the EU, Australia, Argentina, India, and Canada), and the six major importing countries (Mexico, China, Japan, Indonesia, Thailand, and Malaysia) in the international skim milk market are included in the model.

Table 1 shows the trade structure of skim milk in 2005, given the 13 countries included in this study and that production, demand, exports, and imports are deducted trade quantities for rest of the world.[17] Moreover, production and demand in each country are deducted quantities of stock variation in each country.[18]

15) Thus, AY_i, AX_{ij}, and AP_j are treated as fixed numbers. Further, country h product instances use the same notation.

16) Function (24) is excluded when solving the LCP because it is the same as function (21). For more on LCP, refer to Cottle, Pang, and Stone (1992).

17) This paper uses data from 2005, which is the year before the EU and the United States eliminated export subsidies. In 2005, the EU delivered export subsidies and, of the subject countries analyzed, New Zealand and Canada engaged in exporting STE trade. The countries included in the model accounted for 89.5% of world production, 89.6% of world exports and 57.1% of world imports in 2005.

18) The domestic transportation quantity of each country is calculated by deducting import quantity from demand.

Table 1. Trade structure of skim milk (2005)

(Unit: ton, US$/ton)

Country	Production	Exports	Imports	Net exports	Demand	Market price
USA	813,305	198,032	812	197,220	616,085	2,166.504
NZL	143,299	107,954	587	107,367	35,932	2,282.761
EU	1,026,934	51,135	6,213	44,922	982,012	2,475.825
AUS	124,018	78,732	4,429	74,303	49,715	2,202.385
ARG	27,374	4,549	0	4,549	22,825	2,383.930
IND	255,451	3,545	216	3,329	252,122	2,111.120
CND	75,304	9,528	3,599	5,929	69,375	5,019.483
MEX	155,971	0	152,991	−152,991	308,962	5,220.150
CHN	59,929	48	47,731	−47,683	107,612	2,482.607
JPN	192,990	8	28,364	−28,356	221,346	2,015.972
IDN	—	—	83,628	−83,628	83,628	2,240.796
THA	—	—	68,217	−68,217	68,217	2,392.676
MLS	—	—	56,744	−56,744	56,744	2,260.717

Source: FAO (2009), USDA (2009), and WTO (2009b).

Note: 1) USA: United States, NZL: New Zealand, AUS: Australia, ARG: Argentine, IND: India, CND: Canada, MEX: Mexico, CHN: China, JPN: Japan, IDN: Indonesia, THA: Thai, MLS: Malaysia.

2) Amount of trade between countries, except for the subjects of the analysis, are deducted from production, exports, imports, net exports, and demand.

3) Stock variation is deducted from production and demand.

4) Market price of countries from the U.S. to India is the FOB price and from Mexico to Malaysia is the CIF price plus the tariff. Moreover, Canada's market price is the FOB price plus the producer-financed subsidy.

2) Trade policies of each country

Table 2 shows the applied tariff rates and the applied unit export subsidies in 2005.[19] Moreover, regarding the tariff rate of countries that apply a tariff quota, including the United States, the EU, Canada, Mexico, and Japan, a comparison of the tariff quota quantity and the resulting import quantity shows that countries in which the former exceeds the latter (the United States, the EU, and Japan) adopt in quota rate, whereas countries in which the latter exceeds the former (Canada and Mexico) adopt out quota rate.

3) Demand functions of each country

Table 3 shows the demand functions of each country. Market price for the linear approximation of the demand function is the FOB price of each country in 2005 for net exporter (the United States, New Zealand, the EU, Australia, Argentina, and India) with the exception of Canada and is CIF price plus the tariff for net importer (Mexico, China, Japan, Indonesia, Thailand, and Malaysia). Further, the market price for Canada which is performing the price discrimination between domestic and foreign countries under Harmonized Milk Classification System is FOB price plus producer-financed subsidy.[20] Moreover, demand quantity uses the data shown in Table 1 and the price elasticity of demand refers to FAPRI (2009) and USDA (2002).

4) Unit transportation costs among countries

Typically, skim milk is transported among foreign countries using container marine trans-

19) All data except for the *ad valorem* tariff are converted into U.S. dollars using the exchange rate at the end of a term in 2005. Further, in Maeda and Hokazono (2010), who also analyzed skim milk, the Japanese tariff rate was set very high, at US$2,576.926 per ton as a specific duty, and the *ad valorem* tariff was set at 25.0% ; however, this point was incorrect. The Japanese tariff for skim milk was US$2,576.926 ton as a specific duty and the *ad valorem* tariff was 25.0% if Alic imports, but was duty-free when private companies import. Moreover, a zero skim milk tariff is appropriate because private companies do the actual importing using a tariff quota. This paper fixes this point.

Table 2. Trade policy of each country (2005)

(Unit:% , US$/ton)

Country	*Ad valorem* tariff	Specific duty	Unit of export subsidy
USA	0.000	33.000	0.000
NZL	5.000	0.000	0.000
EU	0.000	560.142	147.154
AUS	0.000	0.000	0.000
ARG	16.000	0.000	0.000
IND	60.000	0.000	0.000
CND	201.500	0.000	0.000
MEX	125.100	0.000	0.000
CHN	10.000	0.000	0.000
JPN	0.000	0.000	0.000
IDN	5.000	0.000	0.000
THA	5.000	0.000	0.000
MLS	0.000	0.000	0.000

Source: The figures are calclated based on the following data. *Ad valorem* tariff and specific duty: WTO (2009a), Europa (2010), and Jikkou Kanzeiritsuhyou Hensaniinkai (2005). Unit of export subsidy: WTO (2009 b). Foreign exchange rate: UN (2007).

Note: 1) All tariffs show the HS number 0402.10 tariff rate.

2) Tariff rates are based on WTO (2009a). However, rates for the EU are based on Europa (2010) and rates for Japan are based on Jikkou Kanzeiritsuhyou Hensaniinkai (2005).

3) Tariff rates for the U.S., the EU, and Japan are quota tariffs, those for Canada and Mexico are out-of quota tariffs.

4) Tariff rates for Argentina and Mexico are from 2004 and rates for India and Malaysia are from 2006. These tariff rates are inferred to be the same as those for 2005 because each tariff rate is the same as those from 2009, 2007, 2002, and 2001.

5) The unit of the EU's export subsidy is the value during the market year.

portation. First, we identified each country's main trade port and obtained the distances of conventional route between each port. Second, we assumed that container marine transportation charges are US1.8 cent per mile (Cox and Zhu 1997) and which are multiplied by the distance between each country's ports. Table 4 shows the estimated unit transportation costs for skim milk.

6. Calibration Results

Table 5 shows the calibration results. The calibration was satisfactory to reproduce completely the product quantities, net export quantities, demand quantities, and market prices of 2005.[21,22] These results support that the calibration method Maeda (2010) was developed for the trade of wheat, is also effective for trade of skim milk.

20) Canada's export subsidy reported to the WTO (2009b) is not a direct export subsidy but is a producer-financed subsidy. In short, the CDC-generated domestic-foreign price difference, which is the STE price difference, is reported as an export subsidy to the WTO. Therefore, in this paper, Canada's producer-financed subsidy is excluded from the export subsidy and is added to the FOB price as the domestic-foreign price difference.

21) LCP is solved using GAMS. A pathsearch damped Newton method (Dirkse and Ferris 1996) is used as a solution for NCP including LCP, and Lemke (1965) and symmetric PPPM (Cottle, Pang, and Stone 1992) are available as other solution methods.

Table 3. Demand function in each country

(Unit: ton, US$/ton)

Country	Demand	Market price	Price elasticity of demand	Demand function				
USA	616,085	2,166.504	−0.65	$D=$	1,016,540.250	−	184.839	P
NZL	35,932	2,282.761	−0.53	$D=$	54,975.960	−	8.343	P
EU	982,012	2,475.825	−0.27	$D=$	1,247,155.240	−	107.093	P
AUS	49,715	2,202.385	−0.28	$D=$	63,635.200	−	6.321	P
ARG	22,825	2,383.930	−0.14	$D=$	26,020.500	−	1.340	P
IND	252,122	2,111.120	−0.31	$D=$	330,279.820	−	37.022	P
CND	69,375	5,019.483	−0.19	$D=$	82,556.250	−	2.626	P
MEX	308,962	5,220.150	−0.13	$D=$	349,127.060	−	7.694	P
CHN	107,612	2,482.607	−0.30	$D=$	139,895.600	−	13.004	P
JPN	221,346	2,015.972	−0.63	$D=$	360,793.980	−	69.172	P
IDN	83,628	2,240.796	−0.12	$D=$	93,663.360	−	4.478	P
THA	68,217	2,392.676	−0.45	$D=$	98,914.650	−	12.830	P
MLS	56,744	2,260.717	−0.10	$D=$	62,418.400	−	2.510	P

Source: The values in the table are estimated based on the following data. Demand and market price: FAO (2009), USDA (2009), and WTO (2009a). Price elasticity of demand: FAPRI (2009), USDA (2009).

Note: 1) Refer to Table 1 for demand and market price.

2) Price elasticities of demand of the U.S. and Japan are based on USDA (2002) and those of other countries are based on FAPRI (2009).

First, marginal costs, which range from US$862.5 to US$3,821.7 per ton, are less than market prices in all countries without exporting STEs.[23)]

Second, Lerner indexes are estimated at 0.268 to 0.813 for the countries. Multiplying the Lerner index values with the $-\varepsilon_j$ values results in a range of 0.035 to 0.370, indicating that the market structures in every country reflect imperfect competition but nearly perfect competition on a relative basis.

The values resulting from multiplying $-\varepsilon_j$ by the Lerner index that are higher than 0.3 show highly imperfect competition, particularly for the United States, New Zealand, and Japan, for the following reasons. In the United States and Japan, industry leaders tend to be oligopolies, such as Dairy America and Meiji Dairies Corporation. In New Zealand, Fonterra is an exporting STE with centralized sales of skim milk both domestically and abroad.

In contrast, in Canada, the imperfect competition level is 0.154, which is not as high as New Zealand. The Lerner index is 0.813, the highest of the subject countries analyzed. The reason for this result is that the price flexibility of demand is very high in Canada,[24)] at 5.623, compared with New Zealand and others. Therefore, producers in Canada are given high market prices, such as US$5,019.5 per ton, and high pool prices, such as US$4,776.9 per ton, given the multiplier effect of high price flexibility of demand and the CDC's market power.

In each country, the marginal cost functions

22) Regarding the calibration results, the analysis by Maeda and Hokazono (2010) on the skim milk trade in the same year had differences with this paper. These differences resulted from fixing the Maeda and Hokazono (2010) data at Note 18. The calibration method is suggested as being robust because the method used in this paper and in Maeda and Hokazono (2010) are based on Maeda (2010), and both studies produced almost the same values except for Japan, which date has problem in Maeda and Hokazono (2010).

23) Note that the possibility exists that product subsidy units are included in the estimated records for marginal cost. If the dates for all countries' product subsidy units are obtainable, marginal cost may be distinguished by deducting the product subsidy unit from these estimated records.

24) The price flexibility of demand is shown as the reciprocal of the price elasticity of demand.

Table 4. Unit transportation cost of skim milk among countries

(Unit: US$/ton)

From \ To	USA (Milwaukee, San Francisco)	NZL (Oakland)	EU (Rotterdam)	AUS (Melbourne, Freemantle)	ARG (Rosario)	IND (Calcutta, Mumbai)	CND (Quebec, Vancouver)	MEX (Tampicp)	CHN (Shanghai)	JPN (Tokyo)	IND (Jakarta)	THA (Bangkok)	MLS (Penang)
USA	0.000	102.402	77.598	125.388	137.592	162.108	14.688	78.750	97.164	82.062	137.826	134.028	139.176
NZL	102.402	0.000	204.390	29.610	113.652	120.744	111.618	156.330	92.556	86.562	84.690	103.302	97.812
EU	77.598	204.390	0.000	172.314	117.432	113.724	56.718	92.556	189.342	201.348	153.828	164.034	143.910
AUS	125.388	29.610	172.314	0.000	134.226	66.312	132.228	181.548	72.666	81.000	31.734	54.000	45.990
ARG	137.592	113.652	117.432	134.226	0.000	151.938	116.712	118.836	204.192	195.246	162.432	184.698	164.916
IND	162.108	120.744	113.724	66.312	151.938	0.000	143.964	176.652	69.966	81.972	38.520	44.658	23.418
CND	14.688	111.618	56.718	132.228	116.712	143.964	0.000	57.870	92.052	76.968	133.506	129.204	134.244
MEX	78.750	156.330	92.556	181.548	118.836	176.652	57.870	0.000	193.338	177.642	216.756	226.962	206.838
CHN	97.164	92.556	189.342	72.666	204.192	69.966	92.052	193.338	0.000	18.864	45.414	40.518	47.034
JPN	82.062	86.562	201.348	81.000	195.246	81.972	76.968	177.642	18.864	0.000	58.212	53.838	59.040

Source: The values in the table are estimated from the countainer sea fare of US$0.018 per ton-mile of Cox and Zhu (1997) and World News Network (2009).

Note: The port name is included in the parentheses under the country name.

are linearly approximated, as shown in Table 6, using 2005 data on estimated marginal cost or pool price values, product quantities, and supply price elasticity. The price elasticity of supply refer to FAPRI (2009) and USDA (2002).

Under the previously provided Lerner indexes and marginal cost function, the next section analyzes policy simulation to ensure export discipline.

7. Analysis of Policy Simulation

1) Scenarios

As previously mentioned, in DR agricultural negotiation, export discipline is ensured based on parallelism. However, practically, eliminating export subsidies is becoming a reality, thus ensuring that the discipline of exporting STEs does not progress concretely and future trends are unclear. Then, this paper uses the following two scenarios under these circumstances.

Scenario A: Only the EU's export subsidy is eliminated not based on parallelism.[25]

Scenario B: The EU's export subsidy is eliminated based on parallelism and exporting STEs in New Zealand and Canada are broken up.

In the case in which exporting STEs are broken up, producers in said countries are assumed to sell by themselves. In short, the analysis for scenario B assumes that New Zealand and Canada are treated as countries without exporting STEs. In this case, the level of imperfect competition in both countries that maintain their exporting STEs' competitive export power decreases. The level is not a certainty and, originally, both countries established exporting STEs to be more competitive than other exporting countries. Therefore, for such countries to break up their exporting STEs implies that their level of imperfect competition decreased to lower than that of other exporting countries, or that other exporting countries increased their competitive levels. Therefore, this paper assumes that, for scenario B, imperfect levels of competition for both countries are the same as that of Argentina, at 0.089, which is the lowest level for exporting countries.[26]

2) Results

(i) Scenario A

Table 7 shows the results of the policy simulation analysis for scenario A. In short, by eliminating export subsidies, the EU's net export decreased by 100% relative to 2005 and its position as a net exporting country changed to

Table 5. Result of calibration

(Unit: US$/ton)

Country	Lerner index	$-\varepsilon_j \times$ Lerner index	Marginal cost	Pool price
USA	0.569	0.370	934.098	—
NZL	0.593	0.314	—	2,155.603
EU	0.584	0.158	1,030.654	—
AUS	0.564	0.158	985.384	—
ARG	0.638	0.089	862.494	—
IND	0.524	0.163	1,003.992	—
CND	0.813	0.154	—	4,776.944
MEX	0.268	0.035	3,821.661	—
CHN	0.501	0.150	1,238.507	—
JPN	0.496	0.312	1,016.160	—
IDN	0.496	0.060	—	—
THA	0.518	0.233	—	—
MLS	0.546	0.055	—	—

Source: The values in the table were analyzed by the author.

Note: The unit producer subsidy may be included in the estimated record.

that of a self-supporting country. Given this result, the EU's production decreased by 2.9%, demand increased by 1.5%, and the market price decreased by 5.6%.

The reduction in exports by the EU influences the trade of other countries.[27] Export countries that experienced a drastic increase in net exports relative to 2005 are India, Canada, and Argentina, with an increase in quantities of 326.9% (10,883 tons), 23.0% (1,363 tons), and 18.9% (862 tons), respectively.[28]

In contrast, Japan's net imports decreased dramatically, with a quantity decrease of 13.7% (3,871 tons) relative to 2005.

(ii) Scenario B

Table 8 shows the results of the policy simulation analysis for scenario B. In short, identical to scenario A, eliminating export subsidies decreased the EU's net export by 100% relative to 2005, and its position changed from that of a net-exporting country to a self-supporting country. Therefore, the EU's production decreased by 2.9%, demand increased by 1.5%, and the market price decreased by 5.6%.

In contrast, because the exporting STEs New Zealand were broken up, net exports decreased by 13.7%, and production decreased by 5.2% relative to 2005. Furthermore, in New Zealand, demand increased by 19.9% and the market price decreased by 37.6%.

Regarding Canada, net exports decreased by 100% and the country's position changed from that of a net exporting country to a self-supporting country, identical to the EU. Therefore, production decreased by 17.2%, demand increased by 19.9%, and the market price increased by 53.0%.

The reduction in exports by the EU, New Zealand, and Canada influenced the trade of other countries, similar to but to a greater degree than in scenario A.[29] Net exporting countries that largely expanded their net exports were India, Argentina, and the United States. Compared with 2005, net exports increased by 630.3

25) As noted in section 5, 2005 data are used in this paper and, of the countries analyzed, only the EU delivered export subsidies in 2005.

26) Conceivably, the level of imperfect competition after exporting STEs are broken up should be analyzed separately when referring to countries previously had been broken up exporting STEs of wheat and dairy, such as Australia.

27) Compared with 2005, production, demand, market price, and pool price have little influence, such as less than a 3.0% increase, less than a 2.3% decrease, less than a 4.7% increase, and less than a 6.2% increase.

28) Regarding absolute quantity, the net exports of the United States increased to 15,106 tons.

Table 6. Marginal cost function in each country

(Unit: ton, US$/ton)

Country	Production	Marginal cost or pool price	Price elasticity of supply	Marginal cost function				
USA	813,305	934.098	0.31	$MC=$	−2,079.121	+	0.004	Y
NZL	143,299	2,155.603	0.33	$MC=$	−4,376.527	+	0.046	Y
EU	1,026,934	1,030.654	0.52	$MC=$	−951.373	+	0.002	Y
AUS	124,018	985.384	0.19	$MC=$	−4,200.847	+	0.042	Y
ARG	27,374	862.494	0.56	$MC=$	−677.674	+	0.056	Y
IND	255,451	1,003.992	0.76	$MC=$	−317.050	+	0.005	Y
CND	75,304	4,776.944	1.18	$MC=$	728.686	+	0.054	Y
MEX	155,971	3,821.661	1.12	$MC=$	409.464	+	0.022	Y
CHN	59,929	1,238.507	0.25	$MC=$	−3,715.522	+	0.083	Y
JPN	192,990	1,016.160	0.22	$MC=$	−3,602.749	+	0.024	Y

Source: The values in the table are estimated based on the following data. Production: FAO (2009) and USDA (2009). Marginal cost and pool price: from results analyzed by the author. Price elasticity of supply: FAPRI (2009) and USDA (2002).

Note: 1) Refer to Table 1 for production.

2) Price elasticities of supply for the U.S. and Japan are based on USDA (2002) and those of other countries are based on FAPRI (2009).

3) Regarding marginal cost or pool price, the pool price shows the pool price for New Zealand and Canada, and marginal cost is shown for other countries.

% (20,932 tons), 36.5% (1,662 tons), and 11.5% (22,609 tons), respectively.

In contrast, Japan—primarily a net importing country—experienced a decrease in net imports of 20.4% (5,794 tons) relative to 2005.

3) Considerations and implications

The policy simulation analyses indicate the following results.

First, for the case in which only the EU's export subsidy is eliminated not based on parallelism, trade was notably influenced. In short, in this case, trade—which was distorted by the EU's export subsidy—was corrected.

In addition, in this case, Canada, which has an exporting STE, greatly expanded its net exports. Conceivably, the reason the EU insists on ensuring export disciplines based on parallelism in DR agricultural negotiation is because it cannot ignore a large expansion in exports by Canada caused by the elimination of its export subsidy.

Second, for the case in which the exporting STEs of New Zealand and Canada are broken up coincident with the elimination of the EU's export subsidy, the influence on trade is the same as for the case in which only the EU's export subsidy is eliminated but to a greater degree. In short, in this case, trade—which was distorted by the EU's export subsidy and by the exporting STEs of New Zealand and Canada—was corrected.

Then, in this case, New Zealand does not experience notable net export contracts; in contrast, Canada is greatly influenced through its change from a net exporting country to a self-supporting country. As noted in section 2, the Fonterra reform affected New Zealand. Also noted in section 2, Canada lost during the WTO dispute settlement and revised its Harmonized Milk Classification System that, however, resulted in a continued trade distortion of the CDC. In short, Canada's competitive export power is still supported by its exporting STE, considered one of the reasons why Canada does not attempt to ensure easy export disciplines through DR agricultural negotiation.

29) Compared with 2005, production, demand, and market price have little influence, such as less than a 5.9% increase, less than a 2.9% decrease, and less than a 10.4% increase. However, these levels are slightly higher than for scenario A.

Table 7. Result of policy simulation for scenario A

(Unit: ton, US$/ton, %)

Country	Production	Net exports	Demand	Market price	Pool price
USA	5,836.149	15,105.840	−9,269.691	50.150	—
	0.718	7.659	−1.505	2.315	—
NZL	2,911.732	3,733.760	−822.027	98.535	132.728
	2.032	3.478	−2.288	4.316	6.157
EU	−30,017.688	−44,922.000	14,904.312	−139.172	—
	−2.923	−100.000	1.518	−5.621	—
AUS	967.184	1,549.497	−582.314	92.131	—
	0.780	2.085	−1.171	4.183	—
ARG	713.172	861.837	−148.664	110.908	—
	2.605	18.946	−0.651	4.652	—
IND	7,759.169	10,882.848	−3,123.679	84.374	—
	3.037	326.910	−1.239	3.997	—
CND	1,060.023	1,363.486	−303.463	115.560	56.986
	1.408	22.997	−0.437	2.302	1.193
MEX	3,856.083	4,742.694	−886.611	115.231	—
	2.472	3.100	−0.287	2.207	—
CHN	313.459	988.897	−675.438	51.941	—
	0.523	2.074	−0.628	2.092	—
JPN	903.440	3,870.687	−2,967.248	42.897	—
	0.468	13.650	−1.341	2.128	—
IND	—	400.522	−400.522	89.433	—
	—	0.479	−0.479	3.991	—
THA	—	1,200.317	−1,200.317	93.557	—
	—	1.760	−1.760	3.910	—
MLS	—	221.616	−221.616	88.293	—
	—	0.391	−0.391	3.906	—

Source: The values in the table were analyzed by the author.

Note: For each country, the upper number shows the balance from Table 1 and Table 5, and the lower number indicates the rate of variability from Table 1 and Table 5.

Third, the EU's change from a net exporting country to a self-supporting county had nothing to do with ensuring that export disciplines were, or were not, based on parallelism. In short, the EU (and producers in the EU) experienced no direct benefits from insisting on parallelism during the DR agricultural negotiation.

However, if export disciplines are ensured based on parallelism, countries (and producers in these countries) except for the EU, New Zealand, and Canada and including the United States and Japan receive benefits, such as an expansion in net exports or a reduction in net imports. In short, in DR agricultural negotiation, the United States, Japan, and other countries would be continue to support the EU's insistence of parallelism. And, it is considered that the EU would be using the insistence of parallelism as a material of negotiation to get concessions from these countries in the field of other than export competition.

8. Conclusions

This paper quantitatively analyzed the trade

Table 8. Result of policy simulation for scenario B

(Unit: ton, US$/ton,%)

Country	Production	Net exports	Demand	Market price
USA	8,735.385	22,609.998	−13,874.613	75.063
	1.074	11.464	−2.252	3.465
NZL	−7,519.797	−14,672.123	7,152.326	−857.335
	−5.248	−13.665	19.905	−37.557
EU	−30,017.688	−44,922.000	14,904.312	−139.172
	−2.923	−100.000	1.518	−5.621
AUS	1,755.208	3,200.271	−1,445.063	228.631
	1.415	4.307	−2.907	10.381
ARG	1,375.018	1,661.647	−286.629	213.833
	5.023	36.528	−1.256	8.970
IND	14,959.912	20,982.461	−6,022.548	162.675
	5.856	630.293	−2.389	7.706
CND	−12,915.922	−5,929.000	−6,986.922	2,660.653
	−17.152	−100.000	−10.071	53.007
MEX	5,771.677	7,098.731	−1,327.054	172.474
	3.700	4.640	−0.430	3.304
CHN	469.177	1,480.153	−1,010.977	77.744
	0.783	3.104	−0.939	3.132
JPN	1,352.243	5,793.536	−4,441.293	64.207
	0.701	20.431	−2.006	3.185
IND	—	754.161	−754.161	168.397
	—	0.902	−0.902	7.515
THA	—	1,514.883	−1,514.883	118.075
	—	2.221	−2.221	4.935
MLS	—	427.282	−427.282	170.232
	—	0.753	−0.753	7.530

Source: The values in the table were analyzed by the author.

Note: For each country, the upper number shows the balance from Table 1 and Table 5, and the lower number indicates the rate of variability from Table 1 and Table 5.

effects on skim milk from ensuring export disciplines through parallelism.

First, the spatial equilibrium model including export subsidies, exporting STEs, and imperfect competition was expanded.

Second, we showed the calibration method of the Lerner index, which is included in this model and shows the level of imperfect competition in each country.

Third, we revealed that the market structure of skim milk reflects imperfect competition but relative perfect competition. In particular, the level of imperfect competition was high in the United States and Japan, which have oligopolies in their respective dairy industries, and in New Zealand, which has an exporting STE. In contrast, although Canada has an exporting STE, the level of imperfect competition is not as high as that of New Zealand. But by synergy effect of the level of imperfect competition and high price flexibility of demand, high market price and high pool price have been achieved.

Fourth, the results of this paper show that both the export subsidy of the EU and the exporting STE of New Zealand distorted trade, and this distortion was corrected by ensuring drastic export disciplines based on parallelism. Alternatively, we quantitatively showed that the EU insisted on ensuring export disciplines based on parallelism, which Canada rejected. Furthermore, regarding implications for future agricultural negotiations, we revealed the compelling possibility that the EU would continue to insist on ensuring export discipline based on parallelism through support received from the United States and Japan and would use this insistence as material for negotiations in the field of other than export competition.

Finally, we note the research left for future studies and conclude this paper. The spatial equilibrium model developed in this paper is able to analyze a single product. Additional analysis may be conducted to develop a coupled model that simultaneously addresses plural products. The need exists to reveal the level of imperfect competition in countries in which exporting STEs are broken up by analyzing countries that experienced prior breakups of their exporting STEs. Furthermore, although this paper analyzed skim milk, it is said that wheat and other dairy products such as butter should be analyzed for the effects of ensuring export disciplines based on parallelism. Therefore, to analyze more comprehensive in the export competition field during DR agricultural negotiation, it is necessary to perform analysis similar to the paper about these products.

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