THREE ESSAYS ON THE ECONOMICS OF PREFERENTIAL TRADE AGREEMENTS: FREE TRADE AREAS, RULES OF ORIGIN AND CUSTOMS UNIONS

by

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B.S., Huazhong University of Science and Technology, 2003
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AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

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Abstract

There have been considerable discussions about why countries have interests in forming preferential trade agreements (PTAs), which typically take the forms of a “free trade area” (FTA) with Rules of Origin (ROO) and a “customs union” (CU) (World Bank, 2005). This dissertation contains three essays with three different models of trade under oligopoly to analyze various issues on preferential trade agreements.

The first essay examines welfare implications of forming preferential trade arrangement (PTAs) between two asymmetric countries that differ in their market sizes. Key findings are as follows. First, when market size asymmetry between two countries is not too large and ROO requirements are not too restrictive, the formation of an FTA with effective ROO can be welfare-improving to both members. Second, the formation of a PTA is more likely to emerge between countries of similar in their market sizes, ceteris paribus. Third, compared to the pre-PTA equilibrium, there are greater reductions in external tariffs under an FTA than under a CU such that a non-member country is relatively better off under the FTA.

The second essay presents a three country model of trade under Bertrand price competition to analyze differences in welfare implications between an FTA with ROO and a customs union (CU). It is shown that the maximum limit of ROO requirements over which there are welfare gains from trade for FTA members depends crucially on the degree of substitutability of final goods (or the intensity of product market competition). It is also found that member countries and their final-good exporters are better off in a CU than in an FTA. There are greater reductions in external tariffs under an FTA than under a CU such that a non-member country is relatively better off under the FTA.

The third essay presents a three country model of FTA with Cournot quantity competition and derives the maximum enforceable level of ROO over which there are welfare gains from trade to each member country. It is shown that ROO and external tariffs are strategic complements such that the higher is the regional input restrictions, the higher is the external tariff necessary to induce firms to fully comply with ROO requirements. It is also shown that an FTA with effective ROO has a positive effect on the final-good trade. But the trade-diverting effect does not occur in the final-good sector.

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Essay One

Preferential Trade Agreements between Asymmetric Countries: Free Trade Areas (with Rules of Origin) vs. Customs Unions

1. Introduction

Will big countries with a fairly large market have economic incentives to form preferential trade agreements (PTAs) with small countries? Under what conditions will PTAs be welfare-improving for both big and small trading partners? The last two decades have witnessed an unprecedented proliferation of trade agreements, which typically take the forms of a "free trade area" (FTA) and a "customs union" (CU) (World Bank, 2005). An interesting observation is that countries forming an FTA or a CU are generally different in the sizes of their markets. In an FTA, member countries, small or large in their market sizes, collectively eliminate barriers on certain goods traded among them. But they individually set their own external tariffs toward non-members. This constitutes a significant difference between an FTA and a CU, the latter of which requires member countries to set a common external tariff on imports entering into the union (Krueger, 1993; Krishna and Krueger, 1995; Panagariya, 2000).

There are other distinctive aspects of an FTA. To prevent re-exportation or trade deflection from a country with a lower tariff to another country with a higher tariff, FTA members sign in preferential rules of origin (ROO) under which products cannot get *duty-free* access to a partner's market unless ROO requirements are met (Grossman and Helpman, 1995; Richardson 1995).[1] Several different criteria may be adopted. These include ROO requirements based on regional input or content restrictions, a change in tariff heading, particular processes that should be performed within an FTA; and a substantial transformation of a product.[2] Despite their differences in criteria, there generally involves an "ROO-induced extra cost" in producing a final good eligible for preferential treatment under an FTA. ROO not only generate production inefficiency,[3] they may also cause final-good markets within an FTA to be segmented. In a CU,

[1] Grossman and Helpman (1995) examine, among other things, the effects of FTA with ROO that prevent re-exportation from a lower tariff member to a higher tariff member. Richardson (1995) shows explicitly that there is no Nash equilibrium in setting external tariffs, because all members of an FTA compete to set the lowest tariff with respect to non-members.

[2] See, e.g., Krueger (1993), Thoening and Verdier (2004), Cadot, Estavadeoral, Suwa-Eisenmann, and Verdier (2006), and Krishina (2006). The North American Free Trade Agreement (NAFTA), the European Union, and the ASEAN Free Trade Area agreement (AFTA), for example, all contain certain criteria of the ROO provisions which provide preferential treatment for member countries.

[3] See Krishna and Krueger (1995) and Krishna (2006). Falvey and Reed (1998) analyze the cases of non-preferential ROO and indicate that ROO may be used strategically as policy instruments. This is due to the potential arbitrariness in categorizing the geographical sources of goods produced not in a single location. Falvey and Reed (2002) further show that producers may modify their production processes and input mix in response to content requirements in ROO.

however, there are no ROO provisions and arbitrage activities are relatively costless so that the prices of products tend to be uniform across members' markets (Mukunoki, 2004). In other words, there is internal market integration in a CU.

The objective of this paper is to examine differences in economic effects and welfare implications between an FTA and a CU when member countries are asymmetric in their market sizes. Based on a stylized three-country model of trade under oligopoly, we wish to answer the following questions that appear not to have been adequately analyzed or answered. Under imperfect competition in final-good markets, will the formation of an FTA or a CU be more likely to emerge between countries dissimilar in their market sizes? How will market size asymmetry affect their economic incentives of forming a PTA (either an FTA or a CU)? Does an FTA or a CU allow member countries to have a greater degree of market size asymmetry? What effects preferential ROO requirements have on the welfare of forming an FTA between asymmetric countries? Will the formation of a CU be preferred to that of an FTA with ROO, viewed from the perspectives of asymmetric member countries, a non-member country and the world as a whole?

Firms inside an FTA are required to comply with ROO to be eligible for preferential treatments in trade between member countries. ROO are effective only when extra costs resulting from obeying the rules are not too high; otherwise exporting firms within an FTA simply choose to pay tariffs (Ju and Krishna, 2002, 2005). The formation of a CU permits member countries to trade with each other without paying tariffs. One concern then is whether FTA or CU member countries will set high external tariffs to protect their own firms, which make non-member countries worse off. Article XXIV of the GATT tries to secure non-member countries from welfare losses by forbidding external tariffs set by members of a trade bloc to exceed their pre-PTA levels. In the present paper, we explicitly take this GATT requirement into account when determining optimal external tariffs for member countries.

Our analysis complements the contribution by Mukunoki (2004) in terms of welfare comparisons between an FTA and a CU. But the author does not take into account ROO requirements and their effects on increasing production costs of final goods for trade within an FTA. Mukunoki (2004) adopts an oligopoly model of product differentiation and shows the case that a free trade area entails endogenous change from segmented to integrated markets for internally produced goods. Our model differs from that of Mukunoki's in several import aspects.

First, we consider the decisions of exporting firms within an FTA in complying with ROO provisions. As such, in analyzing the case of an FTA, ROO-induced extra costs make internal market integration between member countries not a possibility. Second, our analysis allows for the case that two potentially participating members are asymmetric in terms of their different market sizes. Despite the differences in assumptions on economic conditions, our analysis complements the contribution by Mukunoki (2004) and has some interesting results common to both studies. Without market integration, FTA formation makes non-members better off because of lower external tariffs set by FTA countries. Under plausible conditions, welfare gain to each member country is higher in a CU than in an FTA.

Our analysis is closely related to two recent contributions on FTAs. One is Das and Ghosh (2006) who develop a model of asymmetric world economy in which there are at least four countries. The authors show that FTA formation is more likely to emerge among similar countries. In our analysis, we further take into account effects of preferential ROO provisions in an FTA. We also examine differences in welfare implications between an FTA and a CU. Our analysis also complements another contribution by Duttagupta and Panagariya (2007). The authors show that ROO are not always harmful as they could make a previously infeasible FTA feasible, assuming that external tariffs remain at their pre-FTA levels. In our analysis, we further allow external tariffs to be endogenously set by FTA members. We find that when ROO requirements are not too restrictive, an FTA with ROO can be welfare-improving to member countries of asymmetric in their market sizes.

In his contribution, Krishna (1998) examines the impact of FTAs on the internal incentives for multilateral liberalization. The author challenges the contention that FTAs are superior to multilateral trade liberalization as a way of moving to free trade for all. In his model of imperfect competition in segmented markets, Krishna (1998) looks at the issues on preferential trading arrangements from the political economy perspective and analyzes trade policy as the result of lobbying by interest groups.[4] In our analysis, we pay attention to the production efficiency perspective of preferential trade agreements and compare differences in welfare implications between an FTA and a CU.

[4] Grossman and Helpman (1995) further examine the political viability of FTAs when two countries negotiate a free-trade agreement. Based on a political-economy framework, in which industrial interest groups attempt to influence their government, the authors show that an FTA can be an equilibrium outcome. For further contributions on FTA formation and interest group politics see, e.g., Krishina (1998), Maggi and Rodríguez-Clare (1998), Mitra (2002) and Ornelas (2005).

The remainder of the paper is organized as follows. Section 2 presents a simple framework of trade under international oligopoly. In Section 3, we first discuss the benchmark case with no preferential trade agreements of any form. We then examine conditions under which two potential member countries find it beneficial to form an FTA, subject to the constraints that their exporting firms inside the FTA meet ROO. In Section 4, we derive conditions under which two asymmetric countries form a CU by setting a common external tariff. In Section 5, we analyze differences in welfare implications between an FTA and a CU. We also compare their effects on tariff reductions, consumers and firms in each member country, as well as world welfare. Section 6 contains concluding remarks.

2. The Analytical Framework

Consider a simple world that is composed of three countries, denoted as A, B, and C.[5] Countries A and B are located in the same region but are asymmetric with respect their different market sizes. In the absence of trading agreements, A and B engage in a two-way trade in final goods, with each country imposing a specific tariff on imports from the other (Brander and Spencer, 1984). Countries A and B consider the formation of a PTA (either an FTA or a CU). Country C represents the rest of the world.

In the three-country world, each country has a single firm called by its own country's name and produces a homogeneous final good q. Firms A and B do not export their final goods to country C, but firm C exports its final good to the markets in countries A and B. Denote q_{ik} as country i's consumption of the final good produced by firm k, where $i = A, B$ and $k = A, B, C$.

We assume country i's aggregate utility function to be $U_i = \alpha_i Q_i - (1/2)Q_i^2 + Y_i$, where α_i is a positive parameter, $Q_i = (q_{iA} + q_{iB} + q_{iC})$ represents the final-good consumption in country i, and Y_i is the consumption of a competitively produced numeraire good which is freely traded. The utility function implies that country i's demand for final good is $p_i = \alpha_i - Q_i$, where p_i is

[5] Although model setting and assumptions may differ, the use of a three-country model to analyze issues on FTA with ROO can be found in several recent studies such as Anson, Cadot, Estevadeordal, de Melo, Suwa-Eisenmann, and Tumurchudur (2005), Ju and Krishna (2005), and Ishikawa, Mizoguchi, and Mukunoki (2007).

the final-good price in the country and α_i represents its market size.

The asymmetry of the two potential member countries is captured by their difference in market sizes. Specifically, we assume that $\alpha_B = \theta\alpha_A$, where $\theta(>1)$ measures the degree of market size asymmetry between the small country, A and the big country, B.

As in Ishikawa et al. (2007), we focus our analysis on how FTA formation affects the final-good markets by assuming that input markets are perfectly competitive. We assume that, without ROO requirements of any form, the average and marginal costs of producing the final good for all firms are constant. For analytical simplicity, these costs are normalized to zero. This allows us to pay special attention to other types of costs that firms may incur.

Denote c_{ik} as the extra cost that firm k incurs in producing or exporting one unit of its final good to country i. When serving its own domestic market, $c_{ii} = 0$ for an inside firm regardless of whether or not there is an FTA or a CU.

Prior to forming a PTA, firm $j(j = A, B, j \neq i)$ is required to pay tariffs for each unit of its final good exported to country i. To firm j, its extra cost c_{ij} is equal to the tariff charged by country i. After an FTA is established, a firm exporting its final good within the FTA incurs an extra cost if it chooses to comply with ROO. In this case, c_{ij} represents ROO-induced extra cost and its value is positive (i.e., $c_{ij} > 0$).[6] Under a CU, member countries trade with each other without barriers. In this case, the extra cost to firm j, its c_{ij} is zero.

As for firm C that serves the final-good markets in A and B, this outside firm is required to pay tariffs. The extra cost c_{iC} to firm C is equal to a specific tariff, the amount of which depends on whether there is an FTA, a CU, or without any form of a trade agreement.

We consider a two-stage game. In the first stage, governments of countries A and B decide whether or not to form an FTA or CU and thereafter determine their external tariffs. In the second stage, firms choose their output levels and compete in the final-good markets in the region. We use backward induction to solve for the sub-game perfect Nash equilibrium of the three alternative trade regimes. We begin with the second stage at which firms make their production decisions.

[6] In Section 3, we will discuss in more details the increase in costs resulting from complying with preferential ROO requirements.

3. Optimal Output Decisions of Firms without Market Integration

Product markets in small and big countries are segmented prior to the formation of a PTA. This is because of import tariffs under a two-way trade. For the case in which the two asymmetric countries establish an FTA, an inside firm is required to comply with ROO to be eligible for tariff-free in exporting final good within the FTA. Product markets in the two countries remain to be segmented because of ROO-induced extra costs. For the pre-PTA and FTA regimes without market integration, firm $k(=A,B,C)$ sells q_{ik} units of final good to country $i(=A,B)$. Depending on extra cost c_{ik} in different situations discussed earlier, the total profit of firm k is:

$$\Pi_k = \sum_{i=A,B} (p_i - c_{ik}) q_{ik}. \tag{1}$$

We assume that each firm employs a Cournot strategy in its production decision, taking as given the quantities of the final good produced by all other firms. Based on equation (1), we calculate the quantity of the final good exported to country $i(=A,B)$ by firm $k(=A,B,C)$ as follows:

$$q_{ik} = \frac{(\alpha_i + c_{ij} + c_{iC})}{4} - c_{ik}. \tag{2}$$

Total consumption, $Q_i = (q_{iA} + q_{iB} + q_{iC})$, of the final good and its price in country i are given, respectively, as:

$$Q_i = \frac{(3\alpha_i - c_{ij} - c_{iC})}{4}; \quad p_i = \frac{(\alpha_i + c_{ij} + c_{iC})}{4}. \tag{3}$$

The sufficient conditions for q_{ik} and Q_i to be positive are when the market size α_i is large enough such that $\alpha_i > 4c_{ik} - c_{ij} - c_{iC}$ and $\alpha_i > \frac{1}{3}(c_{ij} + c_{iC})$. These conditions are assumed to hold.

We then calculate consumer surplus and producer surplus for country i as follows:

$$S_i = \frac{(3\alpha_i - c_{ij} - c_{iC})^2}{32}; \quad \Pi_i = \frac{(\alpha_i + c_{ij} + c_{iC})^2 + (\alpha_j - 3c_{ji} + c_{jC})^2}{16}; \tag{4}$$

where $j = A,B$ and $j \neq i$.

Denoting t_{ij} and t_{iC} as the tariff rates that country i charges on imports from country j

and country C, we calculate total tariff revenue for country i as follows:

$$R_i = t_{ij} q_{ij} + t_{iC} q_{iC} = \frac{t_{ij}(\alpha_i - 3c_{ij} + c_{iC}) + t_{iC}(\alpha_i + c_{ij} - 3c_{iC})}{4}. \tag{5}$$

Each potential member country's social welfare, which is taken as the sum of consumer surplus, producer surplus, and tariff revenue, is:

$$W_i = S_i + \Pi_i + R_i$$

$$= \frac{(3\alpha_i - c_{ij} - c_{iC})^2}{32} + \frac{(\alpha_i + c_{ij} + c_{iC})^2 + (\alpha_j - 3c_{ji} + c_{jC})^2}{16} + \frac{t_{ij}(\alpha_i - 3c_{ij} + c_{iC}) + t_{iC}(\alpha_i + c_{ij} - 3c_{iC})}{4}. \tag{6}$$

3.1 Pre-PTA

In the absence of trade agreements, country $i(=A,B)$ charges a uniform tariff to all imports of the final good from countries $j(=A,B,\, j \neq i)$ and C. Denoting $\overline{t_i}$ as country i's pre-PTA tariff on each unit of its imports, we have

$$c_{iC} = c_{ij} = t_{iC} = t_{ij} = \overline{t_i}. \tag{7}$$

Substituting equation (7) into W_i in equation (6), setting the first-order condition that $dW_i / d\overline{t_i} = 0$, we derive the pre-PTA optimal tariff rate:[7]

$$\overline{t_i} = \frac{3}{10}\alpha_i. \tag{8}$$

The pre-PTA optimal tariff is positively related to market size in that the big country sets a higher tariff rate than the small one.

Using equations (7) and (8), we calculate the equilibrium quantities, price, and total consumptions of the final good in country i as follows:

$$\overline{q_{ii}} = \frac{2}{5}\alpha_i;\quad \overline{q_{ij}} = \frac{1}{10}\alpha_i;\quad \overline{q_{iC}} = \frac{1}{10}\alpha_i;\quad \overline{p_i} = \frac{2}{5}\alpha_i;\quad \overline{Q_i} = \frac{3}{5}\alpha_i. \tag{9}$$

Substituting the above equations back into equations (4)-(6), we have consumer surplus, producer surplus, tariff revenue, and social welfare for country i as follows:

$$\overline{\Pi}_i = \frac{4}{25}\alpha_i^2 + \frac{1}{100}\alpha_j^2;\ \overline{S}_i = \frac{9}{50}\alpha_i^2,\ \overline{R}_i = \frac{3}{50}\alpha_i^2;\ \overline{W}_i = \frac{2}{5}\alpha_i^2 + \frac{1}{100}\alpha_j^2. \tag{10}$$

In what follows, we use the pre-PTA equilibrium as the benchmark to evaluate the

[7] It is easy to verify that the second-order condition for welfare maximization is satisfied.

alternative trade regimes.

3.2 FTA with Effective ROO

FTA countries do not charge tariffs on imports from their partners so that $t_{ij} = 0$, for $i, j = A, B$, and $i \neq j$. But they have independence in setting external tariffs on their imports. Denoting the tariff rates as t_i^{FTA} for $i = A, B$, we have $t_{iC} = t_i^{FTA}$. Differences in tariffs may cause a re-exportation of the final good from a lower-tariff member to a higher-tariff member. To eliminate trade deflection, the FTA countries agree that products cannot get duty-free access to other countries in the FTA unless their productions satisfy the ROO requirements.[8]

Under preferential ROO, each inside firm's cost of exporting its final good eligible for duty-free treatments increases. With these constraints, we denote $\delta (> 0)$ as the ROO-induced extra cost. That is, $c_{ij} = \delta$.

Despite the formation of an FTA, final-good exporters within the FTA may or may not choose to comply with ROO (Ju and Krishna, 2005). Whether an FTA firm decides to meet ROO depends crucially on (i) import tariffs set by FTA members, t_i^{FTA}, and (ii) the ROO-induced extra cost, δ. For each unit of the final good exported to country i by firm j, if

$$t_i^{FTA} > \delta, \tag{11}$$

it is beneficial to the firm to comply with ROO. Otherwise, the firm prefers to export the final good to country i by simply paying tariff. In this case, ROO becomes ineffective. For the efficacy of ROO, member countries set their external tariff rates above δ. Equation (11) thus defines the ROO-complying condition.

For firm C outside of the FTA, it pays the specific tariff t_i^{FTA} when exporting its final good to country i. In this case, $c_{iC} = t_i^{FTA}$. Given that $c_{ij} = \delta$, positive quantities of the final good as shown in equation (2) requires that

$$\alpha_i + \delta - 3t_i^{FTA} > 0 \text{ and } \alpha_i - 3\delta + t_i^{FTA} > 0. \tag{12}$$

We calculate the FTA level of social welfare for country i by substituting $t_{ij} = 0$,

[8] There are different criteria for ROO in terms of (i) regional content requirements, (ii) a change in tariff heading, (iii) particular processes that should be performed within an FTA; and (iv) a substantial transformation of a product. See, e.g., Thoening and Verdier (2004), Cadot, Estavadeoral, Suwa-Eisenmann, and Verdier. (2006), and Krishina (2006). The North American Free Trade Agreement (NAFTA), the European Union (EU), and the ASEAN Free Trade Area agreement (AFTA) all contain ROO provisions which provide preferential treatment for member countries.

$t_{iC} = t_i^{FTA}$, $c_{ij} = \delta$ and $c_{iC} = t_i^{FTA}$ into equations (6) to obtain

$$W_i^{FTA} = \frac{1}{32}[-21(t_i^{FTA})^2 + (14\delta + 6\alpha_i)(t_i^{FTA}) + 3\delta^2 + 11\alpha_i^2 - 2\delta\alpha_i] + (\frac{\alpha_j + t_j^{FTA} - 3\delta}{4})^2. \qquad (13)$$

Unless the formation of an FTA is based on noneconomic or political objectives, it is plausible to assume that each potential member is willing to sign in ROO provisions that improve its social welfare. Country i decides to join an FTA with effective ROO only when the FTA welfare is higher than the pre-PTA welfare. That is,

$$W_i^{FTA} > \overline{W}_i. \qquad (14)$$

Equation (14) defines the welfare-improving condition of forming an FTA.

The next step is to determine the degree of market size asymmetry and the range of the ROO-induced extra cost that guarantee welfare gains from trade for each member country. Also, we wish to determine each member's optimal tariff. The problem facing each member country is to choose t_i^{FTA} that maximizes W_i^{FTA} in equation (13), subject to the ROO-complying condition in equation (11), the welfare-improving condition in equation (14), and the constraints that quantities of the final good produced are positive as given in equation (12).

For the big country, B, its solution to the constrained welfare optimization problem exists when the following conditions are satisfied (see A-1 in the Appendix):

$$1 < \theta < 1.2928 \text{ and } 0 < \delta < \hat{\delta}, \text{ where } \hat{\delta} = \alpha_A(\frac{24}{77} - \sqrt{\frac{27}{385}\theta^2 - \frac{5949}{296450}}). \qquad (15)$$

For the small country, A, its solution to the constrained welfare optimization problem also exists if the above conditions are satisfied. When the degree of market size asymmetry is not too large ($1 < \theta < 1.2928$) and the ROO-induced extra cost is sufficiently small ($0 < \delta < \hat{\delta}$), forming an FTA is welfare-improving to both the big and small countries. Nevertheless, when the market size asymmetry is too large ($\theta \geq 1.2928$), forming an FTA with effective ROO may be welfare-deteriorating to at least one country (especially the big country, B). Investigation of equation (15) reveals that for $1 < \theta < 1.2928$, the critical value of $\hat{\delta}$ is negatively associated with θ.

The findings of the analyses permit us to establish

PROPOSITION 1. *Forming an FTA with ROO is welfare-improving to two participating countries when the asymmetry in their market sizes is not too large and ROO requirements are not too restrictive. The critical value of the ROO-induced extra cost that makes FTA formation* *welfare-improving is lower when the market size asymmetry is greater.*

The economic implications of Proposition 1 are straightforward. Other things being equal, the likelihood of forming a successful FTA with ROO between two asymmetric countries is higher when their market sizes are similar. Moreover, this likelihood is higher when ROO requirements are less restrictive.

Assuming that the conditions in equation (15) hold, we use the welfare function in equation (13) to solve for the optimal tariff rate for each member country as

$$t_i^{FTA} = \frac{1}{7}\alpha_i + \frac{1}{3}\delta. \tag{16}$$

This indicates that the FTA optimal tariff is higher the larger the market size asymmetry, α_i, or the higher *the* ROO-induced extra cost, δ.

A comparison between equation (8) and equation (16) indicates that

$$t_i^{FTA} < \overline{t_i}. \tag{17}$$

This result is consistent with the requirement as specified by the Article XXIV of GATT that an external tariff should not be set above the pre-PTA level to avoid a negative impact on a non-member country.

Substituting the optimal tariff from equation (16) into equations (2-6), taking into account the cost conditions that $t_{ij} = 0$, $c_{ij} = \delta$ and $t_{iC} = c_{iC} = t_i^{FTA}$, we have equilibrium outputs, prices, consumptions, consumer surplus, producer surplus, tariff revenue, and social welfare as follows:

$$q_{ii}^{FTA} = \frac{2}{7}\alpha_i + \frac{1}{3}\delta;\ q_{ij}^{FTA} = \frac{2}{7}\alpha_i - \frac{2}{3}\delta;\ q_{iC}^{FTA} = \frac{1}{7}\alpha_i; \tag{18a}$$

$$p_i^{FTA} = \frac{2}{7}\alpha_i + \frac{1}{3}\delta;\ Q_i^{FTA} = \frac{5}{7}\alpha_i - \frac{1}{3}\delta; \tag{18b}$$

$$\Pi_i^{FTA} = (\frac{2}{7}\alpha_i + \frac{1}{3}\delta)^2 + (\frac{2}{7}\alpha_j - \frac{2}{3}\delta)^2;\quad S_i^{FTA} = \frac{1}{2}(\frac{5}{7}\alpha_i - \frac{1}{3}\delta)^2; \tag{18c}$$

$$R_i^{FTA} = \frac{1}{7}(\frac{1}{7}\alpha_i + \frac{1}{3}\delta)\alpha_i;\ W_i^{FTA} = \frac{11}{18}\delta^2 - \frac{8}{21}\alpha_j\delta + \frac{5}{14}\alpha_i^2 + \frac{4}{49}\alpha_j^2. \tag{18d}$$

4. A Customs Union with Internal Market Integration

In a CU where member countries trade with each other with zero tariffs, they collectively set a common external tariff with respect to non-member countries. Also, firms producing within the CU are not subject to ROO requirements. Denoting the external tariff rate as t^{CU}, we have from the cost conditions that $c_{ij} = 0\ (i, j = A, B, i \neq j)$ and $c_{iC} = t^{CU} (> 0)$. Because of free trade, the final good q may be resold between member countries A and B until their prices are identical, $p_i^{CU} = p^{CU}$. In the subsequent analysis, we allow for such an internal market integration between the CU members.[9]

Inside and outside firms treat the two markets in countries A and B as an integrated one under a CU. As such, the total quantity of final good sold by firm $k(= A, B, C)$ to the single CU market is q_k^{CU}, where $q_k^{CU} = q_{Ak}^{CU} + q_{Bk}^{CU}$. Depending on extra cost c_{ik} in different situations discussed earlier, the profit functions of inside firm i and outside firm C are given, respectively, as

$$\Pi_i^{CU} = p^{CU} q_i^{CU}, \tag{19a}$$

and

$$\Pi_C^{CU} = (p^{CU} - t^{CU}) q_C^{CU}. \tag{19b}$$

All firms independently determine their total output levels of the final good, q_k^{CU}, that maximize individual profits, subject to the uniform-price condition. We calculate the solutions as follows:

$$q_i^{CU} = \frac{1}{4}(1+\theta) + \frac{1}{2}t^{CU};\ \ q_C^{CU} = \frac{1}{2}(1+\theta)\alpha_A - \frac{3}{2}t^{CU}. \tag{20}$$

Equilibrium market price and total consumption of the final good in a CU country are:

$$p^{CU} = \frac{1}{8}(1+\theta)\alpha_A + \frac{t^{CU}}{4};\ Q_i^{CU} = \frac{1}{8}(7\alpha_i - 2t^{CU} - \alpha_j). \tag{21}$$

We calculate consumer surplus and firm profit in country i as follows:

$$S_i^{CU} = \frac{1}{128}(7\alpha_i - 2t^{CU} - \alpha_j)^2;\ \ \Pi_i^{CU} = \frac{1}{32}[(1+\theta)\alpha_A + 2t^{CU}]^2. \tag{22}$$

Because of internal market integration in the CU, we cannot determine tariff revenue collected by each member separately. Given a common external tariff (t^{CU}) on imports from country C, total tariff revenue collected by the CU is:

[9] See, e.g., Ishikawa, Mizoguchi, and Mukunoki (2007).

$$R_{AB}^{CU} = R_A^{CU} + R_B^{CU} = t^{CU} q_C^{CU} = \frac{1}{4}(1+\theta)t^{CU} + \frac{1}{2}(t^{CU})^2. \tag{23}$$

Based on equations (20)-(23), we calculate welfare for each CU country as

$$W_i^{CU} = S_i^{CU} + \Pi_i^{CU} + R_i^{CU} = \frac{(7\alpha_i - 2t^{CU} - \alpha_j)^2}{128} + \frac{(\alpha_i + \alpha_j + 2t^{CU})^2}{32} + R_i^{CU}, \tag{24}$$

where R_i^{CU} depends on the distribution of the total tariff revenue, R_{AB}^{CU}. It is plausible to assume that two potential member countries form a CU when each one's welfare, SW_i^{CU}, is higher than its pre-PTA welfare, $\overline{W}_i$. That is,

$$W_i^{CU} > \overline{W}_i. \tag{25}$$

We take into account this welfare-improving condition in determining the common external tariff.

Article XXIV of the GATT requires that the post-CU tariff be no greater than the pre-PTA tariff in order not to negatively affect non-member countries. In this case, we have $t^{CU} \leq \overline{t}_i$. Given $\alpha_A < \alpha_B$ and the pre-PTA optimal tariff, $\overline{t}_i = \frac{3}{10}\alpha_i$ (see equation (9)), we have $\overline{t}_A < \overline{t}_B$. It follows that

$$t^{CU} \leq \overline{t}_A. \tag{26}$$

In setting a common external tariff, the CU member countries jointly maximize the sum of their social welfare, $(W_A^{CU} + W_B^{CU})$, subject to the welfare-improving condition in equation (25) and the GATT tariff-reduction condition in equation (26). Making use of equations (23) and (24), we calculate overall welfare (W_{AB}^{CU}) for the CU as

$$W_{AB}^{CU} = W_A^{CU} + W_B^{CU} = -\frac{19}{16}(t^{CU})^2 + \frac{5}{16}(1+\theta)\alpha_A t^{CU} + \left[\frac{29}{64}(1+\theta^2) - \frac{3}{32}\theta\right]\alpha_A^2. \tag{27}$$

The solution to the welfare-maximization problem exists and the equilibrium quantity of the final good consumption in the small country A is positive, $Q_A^{CU} > 0$,[10] when market size asymmetry falls into the following range: $1 < \theta < 6.4$. Considering this condition and the GTAA/WTO tariff requirement (see equation (26)), we have two interesting cases in solving for the common external tariff by the CU:

<u>Case 1</u>: When $1 < \theta < 1.28$, there is an interior solution. We solve for the CU optimal tariff as:

[10] When $\theta \geq 6.4$, $Q_S^{CU} = 0$. We rule out this case.

$$t^{CU} = \frac{5(1+\theta)}{38}\alpha_A. \tag{28}$$

Substituting t^{CU} from equation (28) into equations (20)-(24) yields the equilibrium outputs, price, consumer surplus, producer surplus, social welfare for each CU member and total tariff revenue in a CU:

$$q_i^{CU} = \frac{6}{19}(1+\theta)\alpha_A;\ \ q_C^{CU} = \frac{1}{19}(1+\theta)\alpha_A; \tag{29a}$$

$$Q_i^{CU} = \frac{16}{19}\alpha_i - \frac{3}{19}\alpha_j;\ \ p^{CU} = \frac{3(1+\theta)\alpha_A}{19}; \tag{29b}$$

$$S_i^{CU} = \frac{1}{2}(\frac{16}{19}\alpha_i - \frac{3}{19}\alpha_j)^2;\ \Pi_i^{CU} = \frac{18(1+\theta)^2\alpha_A^2}{361}; \tag{29c}$$

$$W_i^{CU} = \frac{1}{2}(\frac{16}{19}\alpha_i - \frac{3}{19}\alpha_j)^2 + \frac{18}{361}(1+\theta)^2\alpha_A^2 + R_i^{CU}. \tag{29d}$$

$$R_{AB}^{CU} = \frac{5}{722}(1+\theta)^2\alpha_A^2. \tag{29e}$$

<u>Case 2</u>: When $1.28 \le \theta < 1.8234$ or $3.5099 < \theta < 6.4$, there is a corner solution. But when $1.8234 < \theta < 3.5099$, there remains to have a corner solution provided that the amount of tariff revenue collected by the big country is large enough. That is when $R_B^{CU} > \hat{R}_B^{CU}$, where $\hat{R}_B^{CU} = \frac{3}{10}(-\frac{3\theta^2}{64} + \frac{\theta}{4} - \frac{3}{10})\alpha_A^2$. This condition ensures that forming a CU is welfare-improving to the big country, i.e., $W_B^{CU} > \overline{W}_B$. For these two possibilities of a corner solution, we find that the CU optimal tariff is:

$$t^{CU} = \overline{t}_A = \frac{3}{10}\alpha_A. \tag{30}$$

Substituting t^{CU} from equation (30) into equations (20) yields the equilibrium outputs,

$$q_i^{CU} = (\frac{2}{5} + \frac{\theta}{4})\alpha_A;\ \ q_C^{CU} = (\frac{\theta}{4} - \frac{1}{5})\alpha_A; \tag{31a}$$

We further calculate total consumption of the final good, equilibrium market price, consumer surplus, producer surplus, social welfare for each member country and total tariff of a CU as follows:

$$Q_A^{CU} = (\frac{4}{5} - \frac{\theta}{8})\alpha_A;\ \ Q_B^{CU} = (\frac{7\theta}{8} - \frac{1}{5})\alpha_A;\ \ p^{CU} = (\frac{1}{5} + \frac{\theta}{8})\alpha_A; \tag{31b}$$

$$S_A^{CU} = \frac{(5\theta - 32)^2}{3200}\alpha_A{}^2;\; S_B^{CU} = \frac{(35\theta - 8)^2}{3200}\alpha_A{}^2;\; \Pi_i^{CU} = (\frac{1}{32}\theta^2 + \frac{1}{10}\theta + \frac{2}{25})\alpha_A{}^2; \tag{31c}$$

$$W_A^{CU} = \frac{(25\theta^2 + 256)}{640}\alpha_A{}^2 + R_A^{CU};\; W_B^{CU} = \frac{(265\theta^2 - 48\theta + 64)}{640}\alpha_A{}^2 + R_B^{CU}; \tag{31d}$$

$$R_{AB}^{CU} = \frac{3}{10}(\frac{\theta}{4} - \frac{1}{5})\alpha_A^2; \tag{31e}$$

For the small country A, its post-CU welfare is greater than its pre-PTA welfare. This is because $W_A^{CU} > \overline{W}_A$ even for $R_A^{CU} = 0$. But for the big country B, whether or not forming a CU is welfare improving cannot be determined unambiguously. When the degree of market size asymmetry is "moderate" ($1.8234 < \theta < 3.5099$), a welfare improvement to the big country requires a sufficient amount of tariff revenue from the non-member country C to cover the potential losses. This is because $\hat{R}_B^{CU} > 0$ when $1.8234 < \theta < 3.5099$. Thus, for $1.8234 < \theta < 3.5099$, with an appropriate distribution of tariff revenue between the member countries, there will be welfare gains to each one under a CU. We thus have

PROPOSITION 2. *Forming a CU is always welfare-improving to small and big countries when their market size asymmetry is "sufficiently low"* ($1 < \theta \leq 1.8234$) *or "sufficiently high"* ($6.4 > \theta \geq 3.5099$). *However, when the asymmetry in market size is moderate* ($1.8234 < \theta < 3.5099$), *it is not in the interest of the big country to join a CU, unless its tariff revenue from the rest of the world is sufficiently large.*

5. Different Effects and Implications between an FTA and a CU

As discussed in Section 3.2, relative to the pre-PTA equilibrium, there are welfare gains to both the small and big countries when their market size asymmetry is not too large ($1 < \theta < 1.2928$) and the ROO requirements are less restrictive ($0 < \delta < \hat{\delta}$). Further, Proposition 2 shows that there are welfare gains to two asymmetric countries from forming an CU when their market size asymmetry is small enough ($1 < \theta < 6.4$) and when the big country receives sufficient amount of tariff revenue from a non-member country. In terms of differences in the degree of market size asymmetry between an FTA and a CU, we have

PROPOSITION 3. *Other things being equal, forming a welfare-improving CU allows for a greater degree of market size asymmetry than forming a welfare-improving FTA.*

When market size asymmetry is not too large ($1<\theta<1.2928$), either forming an FTA with less restrictive ROO requirements ($0<\delta<\hat{\delta}$) or forming a CU is welfare-improving to each member. In what follows, when comparing differences between an FTA and a CU, we assume that both the asymmetry condition and the ROO restrictions hold unless otherwise specified.

5.1 Effects on External Tariffs

From $\bar{t}_i$ in equations (8) and t_i^{FTA} in equation (16), we find that the ratio of the post-FTA tariff to the pre-PTA tariff for the big country is smaller than that for the small country. This implies that there is a greater tariff reduction by the big country than by the small country after the formation of an FTA.

Moreover, we find that, for given ROO-induced extra cost, δ, $\frac{t_i^{FTA}}{\bar{t}_i}$ decreases as the degree of market size asymmetry, θ, increases. Thus, there is a greater reduction in the FTA optimal tariffs for both member countries when the degree of market size asymmetry is greater.

Equation (16) indicates that the FTA optimal tariffs for both member countries are increasing functions of δ. We then have

$$\frac{\left.t_i^{FTA}\right|_{\delta=0}}{\bar{t}_i}<\frac{\left.t_i^{FTA}\right|_{0<\delta<\hat{\delta}}}{\bar{t}_i}<\frac{\left.t_i^{FTA}\right|_{\delta=\delta}}{\bar{t}_i}<1. \qquad (32)$$

Figure 1 illustrates for each country the upper and lower limits of the ratio of tariff after forming an FTA to its pre-FTA tariff.

After forming a CU, although both member countries set a common tariff t^{CU} (see equations (28) and (30)), the ratios of the related CU tariff to the pre-PTA tariff for the small and big countries are different due to their differences in the pre-PTA tariffs $\bar{t}_i$ (see equation (9)). As can be seen from Figure 1, this ratio for the small country increases as θ increases until $\theta=1.28$. For the big country, the reduction in external tariff after forming a CU becomes relatively greater when θ is larger.

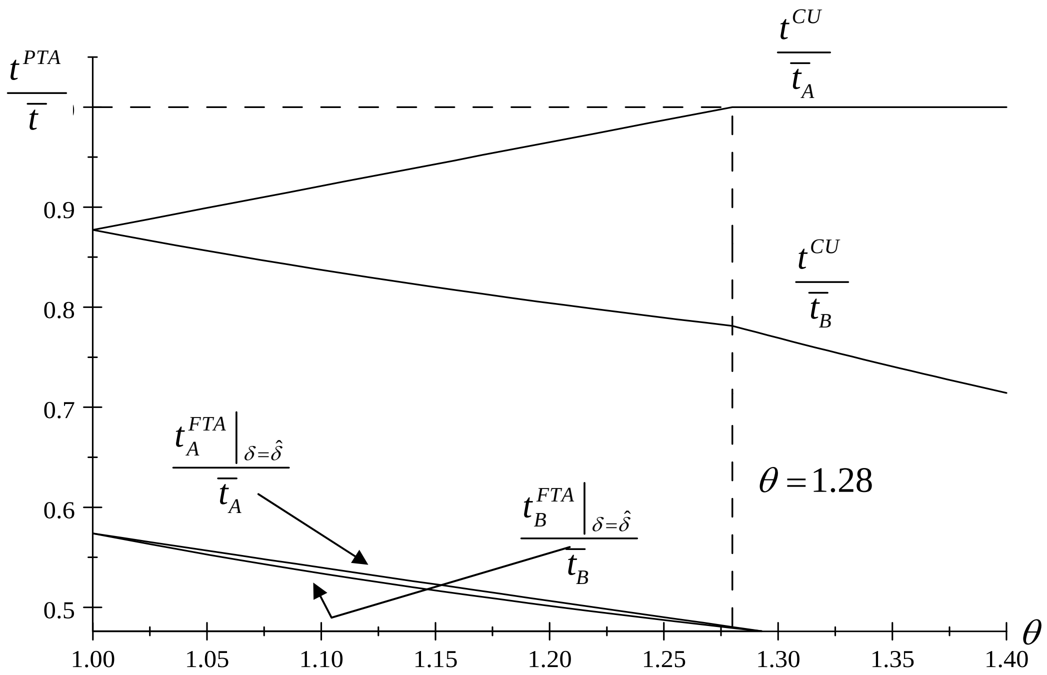

Figure 1. *Tariff Reductions under the formation of a PTA*

As illustrated in Figure 1, the optimal CU tariff is always higher than the upper limit of the optimal FTA tariffs for both the small and big countries. We thus have

PROPOSITION 4. *Despite the fact that there are ROO-induced extra costs when big and small countries form an FTA, tariff reductions by the two FTA members remain relatively greater than those when they form a CU. Interestingly, the big country lowers its optimal tariff by an amount that is greater than that by the small country, regardless of whether they form an FTA or a CU.*

5.2 Comparing Profits of Inside Firms within a PTA

In an FTA, there are fundamentally no trade barriers between small and big member countries other than their preferential ROO provisions. But the ROO-induced trade cost, δ, is set at a level lower than the external tariff imposed by each member. It is interesting to see how ROO requirements would affect firms inside the small and big countries where market sizes are different.

As shown in equation (18c), the small country's producer surplus, Π_A^{FTA}, is an decreasing function of δ. It follows that

$$\Pi_A^{FTA}\Big|_{\delta=\hat{\delta}} < \Pi_A^{FTA}\Big|_{0<\delta<\hat{\delta}} < \Pi_A^{FTA}\Big|_{\delta=0}. \tag{33a}$$

But for the big country's producer surplus, Π_A^{FTA}, it is a increasing function of δ. It follows that

$$\Pi_B^{FTA}\Big|_{\delta=0} < \Pi_B^{FTA}\Big|_{0<\delta<\hat{\delta}} < \Pi_B^{FTA}\Big|_{\delta=\hat{\delta}}. \tag{33b}$$

Equations (33a) and (33b) indicate that, due to differences in market sizes, the small country firm prefers ROO requirements to be *less* restrictive whereas the big country firm prefers them to be *more* restrictive.

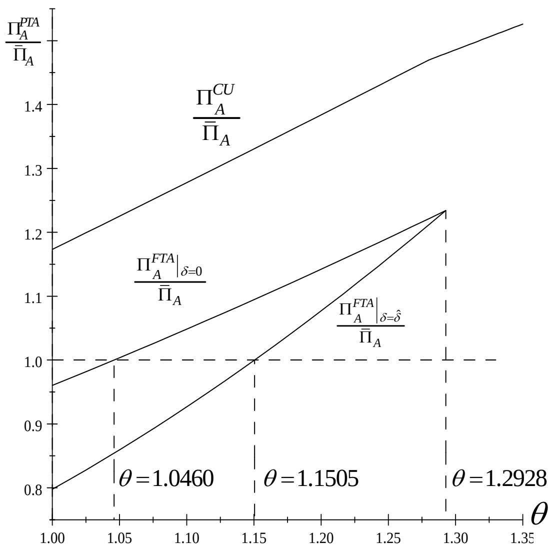

Figure 2.1 *Producer surplus of country A*

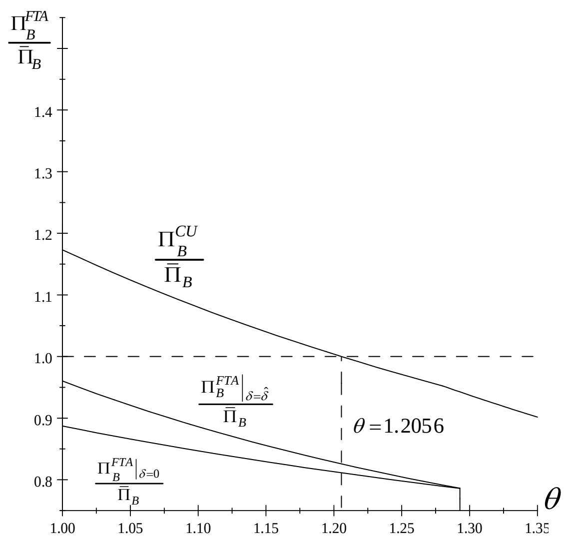

Figure 2.2 *Producer surplus of country B*

Figures 2.1 and 2.2 illustrate for each country the ratio of firm profit or producer surplus before and after the formation of an FTA. The figures also illustrate the ratio of firm profit before and after the formation of a CU. We find that the final-good producers in both the small and big countries are better off under a CU than under an FTA since

$$\frac{\Pi_i^{CU}}{\bar{\Pi}_i} > \frac{\Pi_i^{FTA}\Big|_{\delta=\hat{\delta}}}{\bar{\Pi}_i}.$$

Note that despite market size asymmetry between the small and big countries, firms producing inside the trade block are assumed to be identical in our analysis. We find that the ratios of firm profits are decreasing functions of θ for the big country, but are increasing functions for the small country. After forming a trade agreement (either an FTA or a CU), member countries will share their markets with each other. The small country firm is able to enter the large market in the big country. When the market size differential is greater, the small country firm finds it more profitable from accessing to the large market. Although the big country firm shares the market in the small country, the loss to the big country firm in its own large market may outweigh the gain to the firm in the small market. This is especially true when the degree of market size asymmetry is significantly large.

As presented in Figure 2.1, the formation of an FTA always makes the final-good producers in the big country worse off. The effect on the final-good producers in the small country cannot be determined unambiguously, however. It depends on the degree of market size asymmetry, θ, as well as the ROO-induced extra cost, δ. As shown in Appendix A-2, we have the following two possibilities:

(i) $\Pi_A^{FTA} < \overline{\Pi}_A$ when (i) $1 < \theta < 1.0460$ or (ii) $1.0460 < \theta < 1.1505$ and $0 < \delta < \tilde{\delta}$;

(ii) $\Pi_A^{FTA} > \overline{\Pi}_A$ when (i) $1.1505 \leq \theta < 6.4$ or (ii) $1.0460 < \theta < 1.1505$ and $\tilde{\delta} < \delta < \overline{\delta}$.

It comes as not a surprise that the formation of a CU always makes the final good producers in the smaller country better off. The effect on the final-good producers in the larger country cannot be determined unambiguously, however. It depends on the degree of market size asymmetry, θ. As shown in Appendix A-3, we have two possibilities:

(i) $\Pi_B^{CU} > \overline{\Pi}_B$ when $1 < \theta < 1.2056$;

(ii) $\Pi_B^{CU} < \overline{\Pi}_B$ when $1.2056 < \theta < 6.4$.

We summarize the above findings in the following proposition:

PROPOSITION 5. *In two asymmetric countries that form a PTA, inside firms unambiguously make more profits under a CU than under an FTA. The big country producer is hurt by an FTA but may be better off in a CU when the degree of market size asymmetry is sufficiently low. The small country producer is better off under a CU but may be hurt by an FTA.*

5.3 Effects on the Non-Member Country

In the model of trade under oligopoly, the non-member country exports the final good to the region where two asymmetric countries may form an FTA or a CU. Making uses of equations (1) and (19b), we calculate profits of the outside firm under different trade regimes as follows:

$$\overline{\Pi}_C = \frac{1}{100}(1+\theta^2)\alpha_A^2; \tag{34a}$$

$$\Pi_C^{FTA} = \frac{1}{49}(1+\theta^2)\alpha_A^2 > 0 \text{ when } 1<\theta<1.2928 \text{ and } 0<\delta<\hat{\delta}; \tag{34b}$$

$$\Pi_C^{CU} = \begin{cases} \frac{1}{722}(1+\theta)^2\alpha_A^2 \text{ when } 1<\theta<1.28; \\ \frac{(5\theta-4)^2}{800}\alpha_A{}^2 \text{ when } 1.28\le\theta<6.4. \end{cases} \tag{34c}$$

It is straightforward to verify that $\Pi_C^{FTA} > \Pi_C^{CU}$ and $\Pi_C^{FTA} > \overline{\Pi}_C$ when $1<\theta<1.2928$ and $0<\delta<\hat{\delta}$. Also, we find that $\Pi_C^{CU} < \overline{\Pi}_C$ for $1<\theta<$ 2.1322 , but $\Pi_C^{CU} > \overline{\Pi}_C$ for $2.1322\le\theta<6.4$. We thus have

PROPOSITION 6. *For the three trade regimes we consider, non-member country finds it most beneficial under an FTA. Nevertheless, the non-member country may be negatively affected by a CU when market size asymmetry between member countries is small.*

Forming a PTA has two opposing effects on a non-member country. One effect is positive in that FTA countries reduce their external tariffs. The other effect is negative in that the non-member country is hurt due to the fact that the outside firm's trade costs remain to be higher than those for the inside firms. Proposition 6 indicates that, the positive effect may outweigh the negative effects under an FTA or a CU when the degree of market size asymmetry in member countries is large enough.

5.4 Effect on Consumers in a Member Country

From Q_i^{FTA} in equation (18b), we know that the FTA level of the final-good consumption in each member country decreases with δ. Under this circumstance, we have

$$Q_i^{FTA}\Big|_{\delta=\hat{\delta}} < Q_i^{FTA}\Big|_{0<\delta<\delta} < Q_i^{FTA}\Big|_{\delta=0}. \tag{35}$$

Figures 3.1 and 3.2 illustrate for the big and small countries the lower and upper limits of the final-good consumption after forming an FTA, as compared to their pre-FTA consumption levels. We find that this consumption ratio is strictly greater than one. This implies that, due to tariff reductions and lower trade costs between member countries, total consumption of the final good in each member country increases after forming an FTA. We expect the FTA formation to result in a decrease in the equilibrium market price of the final good, causing consumer surplus in each member country to increase.

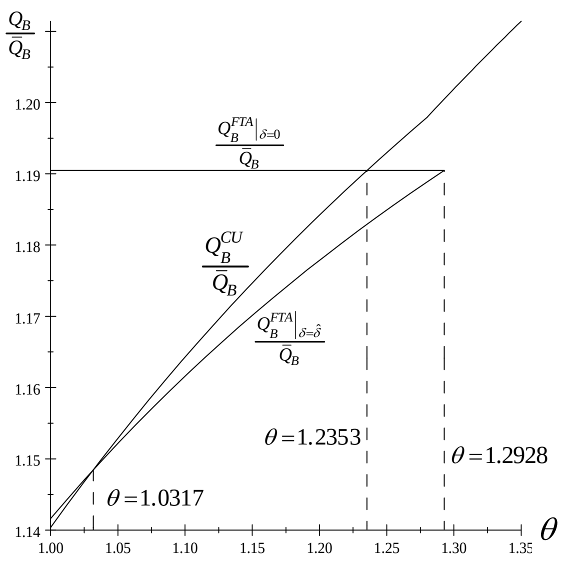

Figure 3.1 *Total consumption in country B*

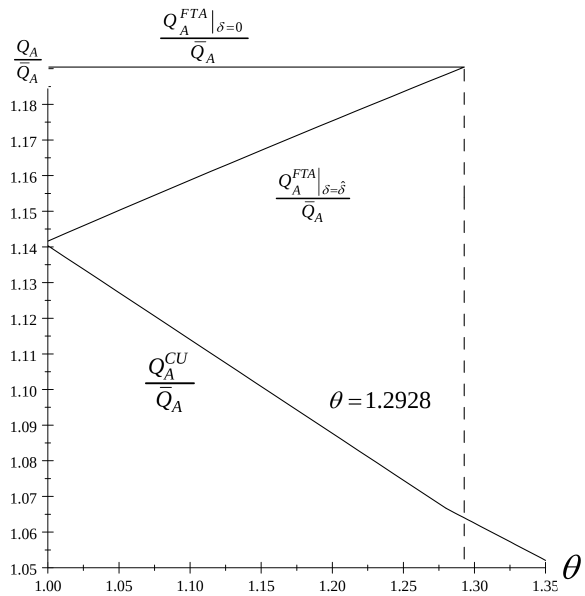

Figure 3.2 *Total consumption in country A*

Figures 3.1 and 3.2 also illustrate for each country the ratio of the final-good consumption after forming a CU to its pre-PTA consumption. For the big country, this ratio increases as the degree of market size asymmetry increases. Note that this consumption ratio is strictly greater than 1, which means that the final-good consumption increases after the formation a CU. However, for the small country, its consumption decreases as the degree of market size asymmetry increases. We show in Appendix A-4 that the consumption ratio for the small country is greater than 1 when $1 < \theta < 1.6$, but is less than 1 when $\theta > 1.6$. These results indicate that if the market size asymmetry is critically high $(\theta > 1.6)$, consumers in the small country are worse off under a CU.

If the degree of market size asymmetry is not too large ($1 < \theta < 1.2928$), the final-good consumption in the small country is unambiguously higher under an FTA than under a CU or without a PTA. As a result, consumers in the small country prefer an FTA over a CU.

For the big county, the relationship in the final-good consumption between the FTA case and the CU case cannot be determined unambiguously. As shown in Appendix A-5, the levels of the final-good consumption depend crucially on θ and δ. When (i) $1 < \theta < 1.0317$ or (ii) $1.0317 < \theta < 1.2353$ and $(\frac{9}{19} - \frac{51}{133}\theta)\alpha_A < \delta < \hat{\delta}$, consumers in the big country are better off under an FTA since $Q_B^{FTA} > Q_B^{CU}$. But when (i) $1.0317 < \theta < 1.2353$ and $0 < \delta < (\frac{9}{19} - \frac{51}{133}\theta)\alpha_A$ or (ii) $1.2353 < \theta < 1.2929$, consumers in the big country are better off under a CU since $Q_B^{CU} > Q_B^{FTA}$.

We summarize the findings of the analyses in the following proposition:

PROPOSITION 7. *Forming an FTA with ROO makes consumers in each member country better off. If the member countries are dissimilar as their symmetry in market size is large, consumers in the larger country prefer a CU over an FTA. Although consumers in the smaller country are better off under an FTA than under a CU, they may be worse off in a CU when the market size asymmetry is sufficiently large.*

5.5 Effects on Welfare of Each Member

We show in the previous section (see Proposition 2) that for each member county, there is a welfare improvement under a CU when $1 < \theta < 6.4$. We now discuss this welfare increase after the formation of a CU in more detail.

For the small country, From Proposition 5, its producer surplus is always greater than its pre-PTA producer surplus. From proposition 7, its consumer surplus decrease as market size asymmetry, θ, increases and is greater than that without any PTA when $1 < \theta < 1.6$. For $\theta > 1.6$, the increase in producer surplus after forming a CU outweighs the decrease in consumer surplus and the loss in tariff revenue. This explains why for the small country, social welfare under a CU is unambiguously higher.

But for the big country, we find that the result is ambiguously. Under a CU, producer surplus decreases as market size asymmetry increases and is less than 1 when θ is significantly large. The big country's consumer surplus increases as θ increases. When market size asymmetry is not too large $(1 < \theta \le 1.8234)$ or is large enough $(3.5099 \le \theta < 6.4)$, the increase in customer surplus outweighs the loss in both producer surplus and tariff revenue. When market size asymmetry is "moderate" $(1.8234 < \theta < 3.5099)$, the increase in customer surplus is more than offset by the decrease in producer surplus. For the big country to be able to improve its social welfare from forming a CU, it would need to collect a sufficient amount of tariff revenues from a non-member country.

Recall that after forming a CU, the total tariff revenue to the CU countries is given in equations (29e) and (30e). Thus one member country's tariff revenue is maximized when the other one's is zero. We know that each member country's welfare is an increasing function of its tariff revenue (see equations (29d) and (31d)). Thus,

$$\frac{W_i^{CU}\Big|_{R_i^{CU}=0}}{\overline{W}_i} \le \frac{W_i^{CU}\Big|_{R_i^{CU}}}{\overline{W}_i} \le \frac{W_i^{CU}\Big|_{R_j^{CU}=0}}{\overline{W}_i}. \tag{36}$$

We also know that for $1 < \theta < 1.2928$, the FTA welfare is a decreasing function of the ROO-induced extra cost, δ, where $0 < \delta < \hat{\delta}$ (see equation (19e)). In this case, we have

$$\frac{W_i^{FTA}\Big|_{\delta=\hat{\delta}}}{\overline{W}_i} < \frac{W_i^{FTA}\Big|_{0<\delta<\hat{\delta}}}{\overline{W}_i} < \frac{W_i^{FTA}\Big|_{\delta=0}}{\overline{W}_i}. \tag{37}$$

Figures 4.1 and 4.2 illustrate the ratios of post-PTA welfare of each member country to its pre-PTA levels. For the big country, the lower limit of the welfare ratio under an FTA is equal to one. The big country prefers a CU over an FTA if $1.0807 < \theta < 1.2928$. For $1 < \theta < 1.0807$, CU formation is a preferred choice to the big country if its tariff revenue (R_B^{CU}) is "significantly large." For an acceptable value of δ, we see from Figure 4.2 that there is a greater welfare gain to the small country under a CU than under an FTA, provided that its tariff revenue is also significantly large.

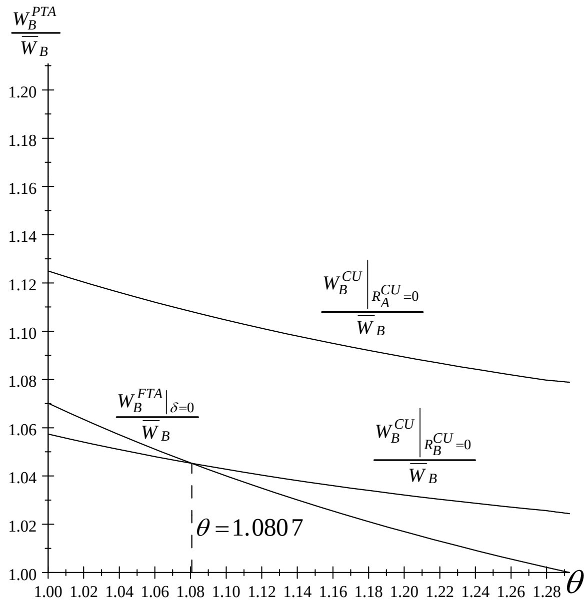

Figure 4.1 *Social welfare of Country B*

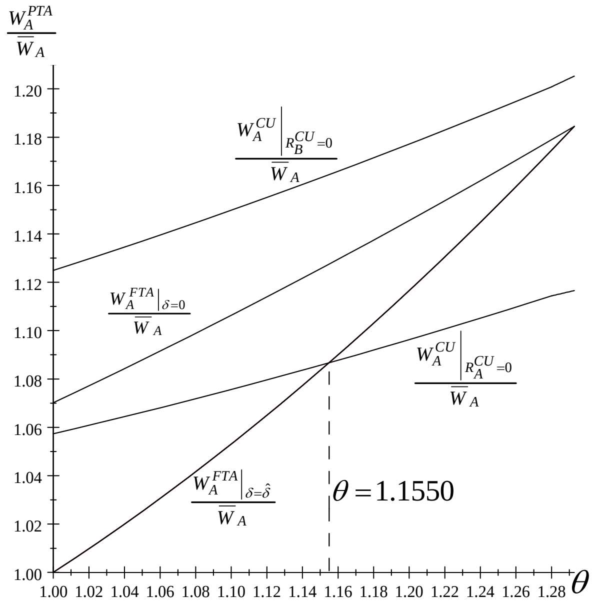

Figure 4.2 *Social welfare of Country A*

But we cannot tell whether both the small and big countries will prefer a CU over an FTA at the same time. It depends crucially on tariff revenue to the two countries. With internal market integration, we only know the overall tariff revenue collected by the CU (see equations (29e) and (30e)) but not the amount to each individual member. It is interesting to identify the conditions under which both countries are better off under a CU than under an FTA. This leads to the following proposition:

PROPOSITION 8. *Whether there will be a greater welfare improvement for both asymmetric countries under a CU than under an FTA cannot be determined unambiguously. But when each of the small and big countries collects a sufficient amount of tariff revenue, forming a CU is a preferred choice over an FTA.*

PROOF: See Appendix A-6. ■

Proposition 8 implies that the distribution of tariff revenue plays a role in affecting social welfare when there is internal market integration in a CU.

5.6 Effects on World Welfare

Finally, we examine differences between an FTA and a CU in terms of their effects on the overall welfare of the three-country world. In our setting world welfare is defined as the sum of social welfare in the two member countries and producer surplus in the non-member country. That is,

$$W_G^m = W_A^m + W_B^m + \Pi_C^m, \tag{38}$$

where $m = \text{pre-PTA}, \text{FTA}, \text{CU}.$

We first calculate the pre-PTA level of world welfare by substituting $\overline{W}_i$ in equation (10), and (34a) into W_G^m in equation (38) to obtain

$$\overline{W}_G = \overline{W}_A + \overline{W}_B + \overline{\Pi}_C = \frac{21}{50}\left(1+\theta^2\right)\alpha_A^2. \tag{39}$$

We then calculate the FTA level of world welfare by substituting equations (18d) and (34b) into W^m in equation (38) to obtain

$$W_G^{FTA} = W_A^{FTA} + W_B^{FTA} + \Pi_C^{FTA} = \left\{\frac{11}{9}\left[\frac{\delta}{\alpha_A} - \frac{12}{77}\left(\theta+1\right)\right]^2 + \frac{463}{1078}\theta^2 - \frac{32}{539}\theta + \frac{463}{1078}\right\}\alpha_A^2. \tag{40}$$

For the case that market size asymmetry is not too large $(1 < \theta < 1.2928),$ the FTA level of world welfare decreases as δ increases for $0 < \delta < \hat{\delta}.$ That is,

$$W_G^{FTA}\Big|_{\delta=\hat{\delta}} < W_G^{FTA}\Big|_{0<\delta<\hat{\delta}} < W_G^{FTA}\Big|_{\delta=0}. \tag{41}$$

Figure 5 illustrates the lower and upper limits of world welfare under an FTA. For $0 < \delta < \hat{\delta},$ the FTA level of world welfare increases with the degree of market size asymmetry, $\theta.$ Even though the FTA level of welfare for the big country decreases, when θ is critically larger, the increase in the sum of the small country's welfare and the non-member country's producer surplus outweighs the decrease in the big country's welfare.

Next, we calculate the CU level of world welfare by substituting equations (29d), (31d) and (34c) into W^m in equation (38) to obtain

$$W_G^{CU} = W_A^{CU} + W_B^{CU} + \Pi_C^{CU} = \begin{cases} \dfrac{343\theta^2 - 360\theta + 343}{722}\alpha_A^2 \text{ when } 1 < \theta < 1.28, \\ \dfrac{775\theta^2 - 80\theta + 736}{1600}\alpha_A^2 \text{ when } 1.28 \le \theta < 6.4. \end{cases} \tag{42}$$

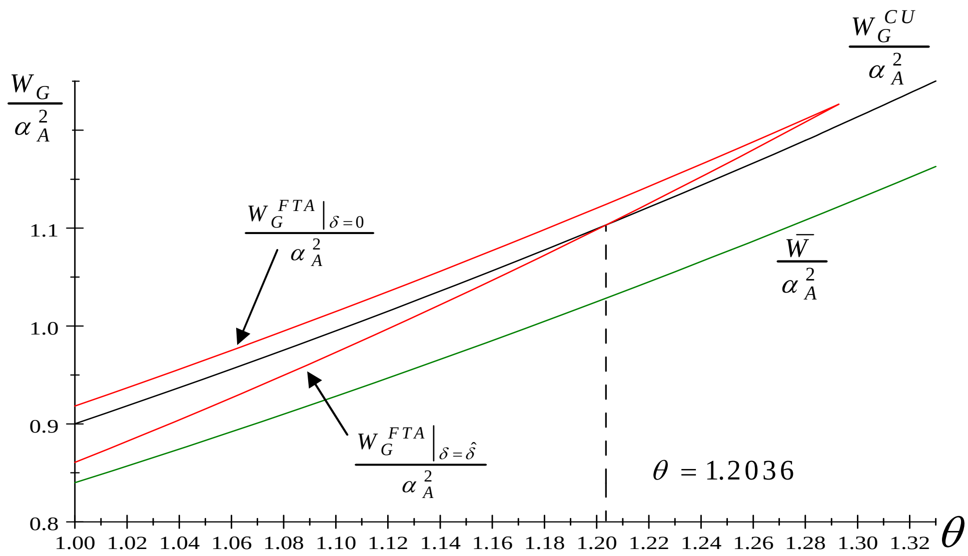

Figure 5. *World welfare under the alternative trade regimes*

As illustrated in Figure 5, world welfare increases with market size asymmetry when there is a CU. Even though welfare for the big country decreases, when the value of θ is larger, the increase in the sum of the small country's welfare and the non-member country's producer surplus outweighs the decrease in the big country's welfare.

There is an overall welfare improvement for the three-country world, regardless of whether the two asymmetric countries form an FTA or a CU. As for welfare comparison between an FTA and a CU, we find conditions under which world welfare is higher under an FTA than under a CU. That is $W_G^{FTA} > W_G^{CU}$ when (i) $1.2036 < \theta < 1.2928$ or (ii) when $1 < \theta < 1.2036$ and $0 < \delta < \left[\frac{12}{77}(\theta+1) - 0.19309\sqrt{\theta^2 + \frac{1850}{8867}\theta + 1}\right]\alpha_A$. We thus have

PROPOSITION 9. *World welfare improves when small and big countries form a PTA (either FTA or CU), other things being equal. World welfare is greater under an FTA than under a CU if either one of the following conditions is satisfied:*

(i) The market size asymmetry is "moderate" (i.e., $1.2036 < \theta < 1.2928$*);*

(ii) The ROO-induced extra cost is small.

It has been observed that there are more FTAs than CUs (World Bank, 2005). From the perspective of world welfare, our analysis may help explain conditions under which such an observation would occur.

6. Concluding Remarks

In this paper, we have derived the conditions under which there are welfare gains from forming a preferential trade agreement for countries differing in their market sizes. These conditions are shown to depend on the degree of market size symmetry between countries, the form of trade agreement as either a FTA or a CU, and ROO requirements in the case of an FTA. We have discussed differences in welfare implications between the two alternative trade agreements. In analyzing the welfare effect of an FTA, we explicitly take into account the decisions of exporting firms in complying with ROO. Key findings are presented as follows. (i) The formation of an FTA with effective ROO is welfare-improving when the asymmetry in market size between member countries is not too large and the ROO requirements are less restrictive. (ii) Forming a CU is more likely to emerge between countries of similar in their market sizes. (iii) However, forming a welfare-improving CU for participating countries allows for a greater degree of their market size asymmetry than forming a welfare-improving FTA. (iv) Compared to the pre-PTA equilibrium, tariff reductions are relatively greater in an FTA than in a CU which makes a non-member country is relatively better off under the FTA. (v) If the asymmetry in market size is moderate and the ROO are not too restrictive, global welfare is higher under an FTA than under a CU.

Appendix

A-1. ***The constrained welfare maximization problem under an FTA***

The mathematical model of choosing t_i^{FTA} to maximizes W_i^{FTA} in equation (14), subject to the ROO-complying condition in equation (12), the welfare-improving condition in equation (15), and the constraints that quantities of the final good produced are positive as given in equation (13) is:

$$\max_{\{t_i^{FTA}\}} W_i^{FTA} = \frac{1}{32}[-21(t_i^{FTA})^2 + (14\delta + 6\alpha_i)(t_i^{FTA}) + 3\delta^2 + 11\alpha_i^2 - 2\delta\alpha_i] + (\frac{\alpha_j + t_j^{FTA} - 3\delta}{4})^2,$$

subject to $t_i^{FTA} > \delta$, $\alpha_i + \delta - 3t_i^{FTA} > 0$, $\alpha_i - 3\delta + t_i^{FTA} > 0$, and $W_i^{FTA} > \overline{W}_i$.

For the big country, we solve this problem by the Kuhn-Tucker method and find that its optimal tariff exists only when the following conditions hold:

$$1 \le \theta < 1.2928 \text{ and } 0 < \delta < \hat{\delta}, \text{ where } \hat{\delta} = \alpha_A(\frac{24}{77} - \sqrt{\frac{27}{385}\theta^2 - \frac{5949}{296450}}).$$

The optimal tariff is $t_B^{FTA} = \frac{1}{7}\alpha_B + \frac{1}{3}\delta.$

For the small country, when $1 < \theta < 1.2928$ and $0 < \delta < \hat{\delta}$, if there are not constraints, the solution of maximizing W_B^{FTA} is $t_A^{FTA} = \frac{1}{7}\alpha_A + \frac{1}{3}\delta.$ It is straightforward to prove that ROO-complying condition, sufficient conditions and social welfare improving condition are all satisfied. Thus, when $1 < \theta < 1.2928$ and $0 < \delta < \hat{\delta}$, the optimal tariff set by the small country exists and is equal to $t_A^{FTA} = \frac{1}{7}\alpha_A + \frac{1}{3}\delta$. Unlike Country *B*, which has optimal tariff rate only when $1 < \theta < 1.2928$ and $0 < \delta < \hat{\delta}$, Country A may have solution of the problem when this condition does not hold.

A-2. ***Profits of firms under an FTA***

When $1 < \theta < 1.2928$ and $0 < \delta < \hat{\delta}$, the FTA level of producer surplus in the small country is:

$$\Pi_A^{FTA} = (\frac{2}{7}\alpha_A + \frac{1}{3}\delta)^2 + (\frac{2}{7}\theta\alpha_A - \frac{2}{3}\delta)^2.$$

It is straightforward to prove that Π_A^{FTA} is an increasing function of δ ($0 < \delta < \hat{\delta}$), when $1 < \theta < 1.2928$. Thus for any given θ ($1 < \theta < 1.2928$), we have:

$$\Pi_A^{FTA}\big|_{\delta=0} = \Pi_A^{FTA}\big|_{0<\delta<\hat{\delta}} = \Pi_A^{FTA}\big|_{\delta=\hat{\delta}}.$$

The producer surplus of the small country A before forming any PTA is:

$$\overline{\Pi}_A = (\frac{4}{25} + \frac{1}{100}\theta^2)\alpha_A^2.$$

It is easy to prove that when $1 < \theta < 1.0460$, $\Pi_A^{FTA}\big|_{\delta=\hat{\delta}} < \overline{\Pi}_A$. Since Π_A^{FTA} is an increasing function of δ for $0 < \delta < \hat{\delta}$, we have $\Pi_A^{FTA}\big|_{0<\delta<\hat{\delta}} < \overline{\Pi}_A$, when $1 < \theta < 1.0460$. It is also straightforward to derive $\Pi_A^{FTA}\big|_{\delta=0} > \overline{\Pi}_A$ when $1.1505 < \theta < 1.2928$. Given $\Pi_A^{FTA}\big|_{0<\delta<\hat{\delta}} > \Pi_A^{FTA}\big|_{\delta=0}$, we have

$$\Pi_A^{FTA}\Big|_{0<\delta<\hat{\delta}} > \overline{\Pi}_A \text{ when } 1.1505 < \theta < 1.2928.$$

It follows that $\Pi_A^{FTA}(\delta) = \overline{\Pi}_A$ is solvable when $1.0460 < \theta < 1.1505$. There are two solutions:

$$\tilde{\delta} = \left[\frac{6}{35}(2\theta - 1) - \frac{9}{10}\sqrt{-\frac{31}{2205}\theta^2 - \frac{64}{441}\theta + \frac{464}{2205}}\right]\alpha_A$$

and

$$\tilde{\delta}' = \left[\frac{6}{35}(2\theta - 1) + \frac{9}{10}\sqrt{-\frac{31}{2205}\theta^2 - \frac{64}{441}\theta + \frac{464}{2205}}\right]\alpha_A.$$

We find that

$$0 < \tilde{\delta} < \hat{\delta} < \tilde{\delta}' \text{ when } 1.0460 < \theta < 1.1505.$$

Given that Π_A^{FTA} is an increasing function of δ for $0 < \delta < \hat{\delta}$, when $1 < \theta < 1.2928$, we can conclude that when $1.0460 < \theta < 1.1505$:

$$(1)\ \Pi_A^{FTA} < \overline{\Pi}_A \text{ if } 0 < \delta < \tilde{\delta}; \text{ and } (2)\ \Pi_A^{FTA} > \overline{\Pi}_A \text{ if } \tilde{\delta} < \delta < \hat{\delta}.$$

A-3. *Firm profits in the big country under a CU*

When $1 < \theta < 1.64$, the CU level of profit for the firm in the big country is:

$$\Pi_B^{CU} = \begin{cases} \frac{18}{361}(1+\theta)^2\alpha_A^2 & \text{if } 1 < \theta < 1.28; \\ \left(\frac{1}{32}\theta^2 + \frac{1}{10}\theta + \frac{2}{25}\right)\alpha_A^2 & \text{if } 1.28 \le \theta < 6.4. \end{cases}$$

Without forming any PTA, the level of profit for the firm in the big country is:

$$\overline{\Pi}_B = \left(\frac{4}{25}\theta^2 + \frac{1}{100}\right)\alpha_A^2.$$

The difference between Π_B^{CU} and $\overline{\Pi}_B$ is given as:

$$\Pi_B^{CU} - \overline{\Pi}_B = \begin{cases} \frac{1}{36100}\left(-3976\theta^2 + 3600\theta + 1439\right)\alpha_A^2 & \text{when } 1 < \theta < 1.28; \\ \frac{1}{800}\left(-103\theta^2 + 80\theta + 56\right)\alpha_A^2 & \text{when } 1.28 \le \theta < 6.4. \end{cases}$$

It is straightforward to prove that $(\Pi_B^{CU} - \overline{\Pi}_B)$ decreases as θ increases when $1 < \theta < 6.4$. By setting $\Pi_B^{CU} - \overline{\Pi}_B = 0$, we have the solution of $\theta = 1.2056$. Given that $(\Pi_B^{CU} - \overline{\Pi}_B)$ is a decreasing function of θ, there are two possibilities:

(i) $\Pi_B^{CU} > \overline{\Pi}_B$ when $1 < \theta < 1.2056$;

(ii) $\Pi_B^{CU} < \overline{\Pi}_B$ when $1.2056 < \theta < 6.4$.

A-4.

When $1 < \theta < 6.4$, the CU level of total consumption in the small country is:

$$Q_A^{CU} = \begin{cases} (\frac{16}{19} - \frac{3}{19}\theta)\alpha_A \text{ if } 1 < \theta < 1.28; \\ (\frac{4}{5} - \frac{1}{8}\theta)\alpha_A \text{ if } 1.28 \le \theta < 6.4. \end{cases}$$

The Pre-PTA level of total consumption in the small country is:

$$\overline{Q}_A = \frac{3}{5}\alpha_A.$$

When $1 < \theta < 6.4$, the ratio of total consumption under a CU over total consumption under a FTA for the small country is:

$$\frac{Q_A^{CU}}{\overline{Q}_A} = \begin{cases} \frac{80}{57} - \frac{5}{19}\theta \text{ if } 1 < \theta < 1.28; \\ \frac{4}{3} - \frac{5}{24}\theta \text{ if } 1.28 \le \theta < 6.4. \end{cases}$$

It follows that $\frac{Q_A^{CU}}{\overline{Q}_A}$ is a decreasing function of θ ($(1 < \theta < 6.4)$ as shown in Figure 3.2. By solving $\frac{Q_A^{CU}}{\overline{Q}_A} = 1$, we have $\theta = 1.6$. Given that $\frac{Q_A^{CU}}{\overline{Q}_A}$ decreases with θ, when $1 < \theta < 6.4$, we have $\frac{Q_A^{CU}}{\overline{Q}_A}$ being greater than 1 for $1 < \theta < 1.6$. But $\frac{Q_A^{CU}}{\overline{Q}_A}$ is less than 1 for $1.6 < \theta < 6.4$.

A-5.

When $1 < \theta < 6.4$, the CU level of total consumption in the big country is:

$$Q_B^{CU} = \begin{cases} (\frac{16}{19}\theta - \frac{3}{19})\alpha_A \text{ if } 1 < \theta < 1.28; \\ (\frac{7\theta}{8} - \frac{1}{5})\alpha_A \text{ if } 1.28 \le \theta < 6.4. \end{cases}$$

When $1 < \theta < 1.2928$ and $0 < \delta < \hat{\delta}$, the Pre-PTA level of total consumption in the big country is:

$$Q_B^{FTA} = \frac{5}{7}\theta\alpha_A - \frac{1}{3}\delta.$$

It is clear that for given θ, where $1 < \theta < 1.2928$, Q_B^{FTA} decreases with as δ increases. Thus, we have

$$Q_B^{FTA}\Big|_{\delta=\hat{\delta}} < Q_B^{FTA}\Big|_{0<\delta<\hat{\delta}} < Q_B^{FTA}\Big|_{\delta=0}.$$

It is easy to verify that when $1 \le \theta < 1.0317$, $Q_B^{FTA}\Big|_{\delta=\hat{\delta}} > Q_B^{CU}$. Since Π_B^{FTA} is an decreasing function of δ, we have $Q_B^{FTA}\Big|_{0<\delta<\hat{\delta}} > Q_B^{CU}$, when $1 < \theta < 1.0317$. It is also straightforward to show that $Q_B^{FTA}\Big|_{\delta=0} < Q_B^{CU}$ when $1.2353 < \theta < 1.2929$. Given $Q_A^{FTA}\Big|_{0<\delta<\hat{\delta}} < \Pi_A^{FTA}\Big|_{\delta=0}$, we have $Q_B^{FTA}\Big|_{0<\delta<\hat{\delta}} < Q_B^{CU}$, when $1.2353 < \theta < 1.2929$.

When $1.0317 < \theta < 1.2353$, the relation of Q_B^{FTA} and Q_B^{CU} is unambiguous. Solving

$Q_B^{FTA}\Big|_{0<\delta<\hat{\delta}} = Q_B^{CU}$ gives $\delta = (\frac{9}{19} - \frac{51}{133}\theta)\alpha_A$. Thus when $1.0317 < \theta < 1.2353$ and $(\frac{9}{19} - \frac{51}{133}\theta)\alpha_A < \delta < \hat{\delta}$, $Q_B^{FTA} > Q_B^{CU}$. But when $1.0317 < \theta < 1.2353$ and $0 < \delta < (\frac{9}{19} - \frac{51}{133}\theta)\alpha_A$, $Q_B^{CU} > Q_B^{FTA}$.

A-6. *Proof of Proposition 6*

With the formation of an FTA, the welfare of country $i(=A,B)$ is:

$$W_i^{FTA} = \frac{1}{32}[-21(t_i^{FTA})^2 + (14\delta + 6\alpha_i)(t_i^{FTA}) + 3\delta^2 + 11\alpha_i^2 - 2\delta\alpha_i] + (\frac{\alpha_j + t_j^{FTA} - 3\delta}{4})^2.$$

It is easy to verify that $\frac{\partial W_i^{FTA}}{\partial t_i^{FTA}} < 0$ when $0 < \delta < \hat{\delta}$. This implies that for any $\delta(0 < \delta < \hat{\delta})$, we have

$$\max W_i^{FTA}(\delta) = W_i^{FTA}(\delta = 0) = \frac{5}{14}\alpha_i^2 + \frac{4}{49}\alpha_j^2.$$

With the formation of a CU, instead, the levels of welfare for the two countries are:

$$W_A^{CU} = \begin{cases} \frac{(45\theta^2 - 24\theta + 292)}{722}\alpha_A^2 + R_A^{CU} & \text{when } 1 < \theta < 1.28; \\ \frac{(25\theta^2 + 256)}{640}\alpha_A{}^2 + R_A^{CU} & \text{when } 1.28 \le \theta < 6.4. \end{cases}$$

$$W_B^{CU} = \begin{cases} \frac{(45\theta^2 - 24\theta + 292)}{722}\alpha_A^2 + R_B^{CU} & \text{when } 1 < \theta < 1.28; \\ \frac{(265\theta^2 - 48\theta + 64)}{640}\alpha_A{}^2 + R_B^{CU} & \text{when } 1.28 \le \theta < 6.4. \end{cases}$$

WE compare W_i^{CU} and $\max W_i^{FTA}(\delta)$ for $1 < \theta < 1.2928$ and find that each country has to collect a sufficient amount of tariff revenue to achieve an improvement in welfare from forming a CU. That is, $W_i^{CU} > \max W_i^{FTA}(\delta)$ when $R_i^{CU} > \hat{\hat{R}}_i^{CU}$, where

$$\hat{\hat{R}}_A^{CU} = \begin{cases} \frac{683\theta^2 + 1176\theta - 1673}{35378}\alpha_A^2 & \text{if } 1 < \theta < 1.28; \\ \frac{1335\theta^2 - 1344}{31360}\alpha_A^2 & \text{if } 1.28 \le \theta < 1.2928, \end{cases}$$

and

$$\hat{\hat{R}}_B^{CU} = \begin{cases} \frac{-1673\theta^2 + 1176\theta + 683}{35378}\alpha_A & \text{if } 1 < \theta < 1.0807; \\ 0 & \text{if } 1.0807 \le \theta < 1.2928. \end{cases}$$

It is easy to verify that $(\hat{\hat{R}}_A^{CU} + \hat{\hat{R}}_B^{CU})$ is less than the total quantity of the final good imported to CU when $1 < \theta < 1.2928$.

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Essay Two

Free Trade Areas (with Rules of Origin) vs. Customs Unions: International Oligopoly under Bertrand Price Competition

1. Introduction

The last two decades have witnessed an unprecedented proliferation of preferential trade agreements (PTAs) which typically take the forms of "free trade area/arrangement" and "customs union" (World Bank, 2005). There have been considerable discussions about why countries form a free trade area (FTA) or a customs union (CU). Using a political-economy framework, Grossman and Helpman (1995) are among the first to analyze conditions under which countries join an FTA. [11] In the present paper, we look at the efficiency aspects of forming a PTA (FTA or CU) and discuss differences in welfare implications between the two alternative trade agreements. Specifically, we examine what effects forming an FTA or a CU have on consumers in member countries, on final-good producers inside and outside of a PTA, as well as on overall welfare of the member and non-member countries taken together.

Countries that form an FTA eliminate barriers such as tariffs and quotas on goods traded among them, but they independently determine their external tariffs toward non-members. This constitutes a significant difference between an FTA and a CU, the latter of which requires member countries to set a common external tariff on imports entering into the union (Krueger 1993, Krueger and Krishna 1995, Panagariya, 2000). Because FTA member countries do not have a harmonization of trade policies, a member country with a lower tariff on a product will benefit from the re-exportation of the product to other members (Grossman and Helpman, 1995; Richardson, 1995; Krishna, 2006). To eliminate trade deflection, member countries of an FTA agree that products cannot get duty-free access to partner countries within the FTA unless their productions satisfy Rules of Origin (ROO).[12] Krishna (2006) presents a systematic review of the studies on FTAs with ROO and calls for further studies on the economics of ROO in FTAs where markets are characterized by imperfect competition. There have been considerable concerns

[11] Grossman and Helpman (1995) examine the political viability of FTAs when two countries negotiate a free-trade agreement. In their study, industrial interest groups attempt to influence their government, the authors show that a free-trade agreement with ROO can be an equilibrium outcome. For further contributions on FTA formation and interest group politics see, e.g., Krishina (1998), Maggi and Rodríguez-Clare (1998), Mitra (2002) and Ornelas (2005). Duttagupta and Panagariya (2007) further show that preferential trading under ROO can enhance the political viability of FTAs.

[12] There are different criteria for ROO in terms of (i) regional content requirements, (ii) a change in tariff heading, (iii) particular processes that should be performed within an FTA; and (iv) a substantial transformation of a product. See, e.g., Thoening and Verdier (2004), Cadot, Estavadeoral, Suwa-Eisenmann, and Verdier. (2006), and Krishina (2006). The North American Free Trade Agreement (NAFTA), the European Union (EU), and the ASEAN Free Trade Area agreement (AFTA) all contain ROO provisions which provide preferential treatment for member countries.

about the use of preferential ROO in free trade areas (FTAs) as trade barriers to international trade (Krueger, 1993; Krishna and Krueger, 1995, Krishna, 2006). Although preferential ROO have the potential to be strategically used as a protective device in international trade, they constitute an indispensible component of FTAs. Panagariya and Krishna (2002) point out that ROO are required to support the welfare-enhancing FTAs.

In analyzing firm behavior in an FTA with ROO, Ju and Krishna (2002, 2005) show the possibility of regime switches when firms exporting final goods within the FTA may or may not comply with ROO. There is compliance when external tariffs exceed extra costs induced by ROO. An FTA with overly restrictive ROO is practically unrealistic, because exporters may simply pay tariffs for their products to be sold to member countries in the FTA. One important issue that has not been adequately examined concerns the range of an ROO-induced extra cost that each member country of an FTA finds it welfare-improving to sign in ROO.

Forming either an FTA with effective ROO or a CU allows an inside firm to incur a lower cost in exporting its final good to other member countries than an outside firm, which is required to pay tariffs for the exports of its final good. So a concern about this is that the member countries will set a higher external tariff rate to make member countries worse off and protect inside firms after the formation of an FTA or a CU. Article XXIV of the GATT tries to secure non-member countries from welfare loss by forbidding external tariff to exceed the pre-PTA level (Mukunoki, 2004). In our paper, we consider this constraint to prevent member countries of a PTA to set too high tariff to hurt non-member countries. Moreover, we find that, this requirement on tariff reduction is automatically satisfied with the formation of an FTA, and it makes the tariff after forming a CU equals to the tariff before forming a CU when the degree of competition is high.

Taking into account ROO restrictions, we analyze how competition (or substitutability) between differentiated final goods affect the formation of an FTA or a CU. We wish to identify the maximum extent of ROO-induced extra costs that potentially participating countries have economic incentives to accept,[13] and the resulting effects on consumer surplus, producer surplus,

[13] We look at the efficiency aspects of forming a preferential trade agreement by assuming that social welfare improvement (or maximization) is the goal of becoming a PTA member. Grossman and Helpman (1995) examine the political viability of FTAs when two countries negotiate a free-trade agreement. Based on a political-economy framework, in which industrial interest groups attempt to influence their government, the authors show that an FTA can be an equilibrium outcome. For further contributions on FTA formation and interest group politics see, e.g., Krishina (1998), Maggi and Rodríguez-Clare (1998), Mitra (2002) and Ornelas (2005). Duttagupta and Panagariya

and social welfare of each member country after forming an FTA or a CU. Further, we show differences in equilibrium outcomes between forming an FTA and forming a CU.

Unless the formation of a PTA is based on noneconomic or political objectives, it is plausible to assume each potential member country is willing to sign in either an FTA or a CU that improves its social welfare. This "participation constraint" analysis constitutes the first stage of the two stage game at which potential member countries decided on forming a welfare-improving FTA with effective ROO or a CU with choosing external tariff(s). At the second and last stage of the game, given the trade cost among member countries and the optimal tariff(s), all firms inside and outside the PTA independently and simultaneously determine output levels that maximize their respective profits.

Our paper differs from those of Mukunoki (2004) and Ishikawa, Mizoguchi, and Mukunoki (2007) in several important aspects. First, we explicitly take into account ROO-induced extra costs in analyzing the welfare effects of FTA formation. To eliminate the possibility of regime switches (Ju and Krishna, 2002, 2005), we consider the ROO compliance conditions when FTA members determine optimal external tariffs that maximize individual social welfare. This is the present model's distinguishing feature that has been ignored in the literature on FTAs with ROO. Second, we derive the maximum extent of ROO-induced extra costs for an FTA. Although external tariffs only target the final-good imports from countries outside of the FTA, the final-good producers within the FTA are subject to the external tariffs when their productions of the final goods for exports do not meet ROO requirements. In this case, these producers are considered as "outside firms" under the preferential ROO provisions. This point indicates the importance of determining external tariffs that effectively induce firms producing within an FTA to comply with ROO.

The remainder of the paper is structured as follows. Section 2 presents a three-country model of trade under oligopoly with differentiated final goods. In Section 3, we examine production decisions of firms in the three alternative trade regimes (pre-PTA, FTA, and CU). We derive optimal external tariffs for the different regimes and examine the conditions under which potential member countries find it welfare-improving to form an FTA or a CU. In Section 4, we analyze and compare the alternative trade regimes in terms of their effects on product prices, outputs, consumer surplus, producer surplus, and social welfare. Section 5 contains

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(2007) further show that preferential trading under ROO can enhance the political viability of FTAs.

concluding remarks.

2. The Analytical Framework

2.1 Basic Assumptions

We consider a simple framework in which there are three countries: A, B, and C.[14] Countries A and B consider forming a preferential trading agreement (either an FTA or a CU). Country C represents the rest of the world. Each country has a single firm producing a single final good. Both the firm and the final good named by its country's name. All final goods are differentiated and the degrees of substitutability between any two of final goods A, B and C are same. Except that their final goods are differentiated, countries A and B in all other aspects are symmetrically identical. These two countries engage in a two-way trade in their final goods, with each country imposing a specific tariff on imports from the other before forming a trade block (Brander and Spencer, 1984). The two potential member countries do not export their final goods to country C. But country C exports its final good to both countries A and B.

Following Mukunoki (2004), we assume that the aggregate utility function in the potential member country $i(=A,B)$ is

$$U_i = \alpha(\sum_{k=A,B,C} q_{ik}) - \frac{\gamma}{2}(\sum_{k=A,B,C} q_{ik})^2 - \frac{1-\gamma}{2}\sum_{k=A,B,C}(q_{ik}^2) + Y_i, \tag{1}$$

where α is a positive parameter, q_{ik} represents the consumption of final good $k(=A,B,C)$ in country i, and Y_i is country i's consumption of a competitively produced numeraire good. The parameter $\gamma(0<\gamma<1)$ measures the degree of the substitutability between any two of final goods.[15]

Based on the preference function in (1), market demand for final good k in country i is:

$$q_{ik} = \frac{1}{1+2\gamma}\alpha + \frac{\gamma}{1+\gamma-2\gamma^2}\sum_{k=A,B,C}(p_{ik}) - \frac{1}{1-\gamma}p_{ik}, \tag{2a}$$

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[14] Although the set-up and assumptions may differ, the use of a three-country model to analyze issues on FTA with ROO can be found in several recent studies such as Anson, Cadot, Estevadeordal, de Melo, Suwa-Eisenmann, and Tumurchudur (2005), Ju and Krishna (2005), and Ishikawa, Mizoguchi, and Mukunoki (2007).

[15] As in Mukunoki (2004), the value of γ reflects the intensity of product market competition among the final goods. For γ close to zero, the final goods are almost independent such that their competition is moderate. For γ close to 1, the final goods are almost homogeneous such that their competition is severe.

where α represents identical market size in countries A and B, p_{ik} denotes the consumer price of final good k in country i.

By solving equation (2a), p_{ik} is given as

$$p_{ik} = \alpha - \gamma \sum_{k=A,B,C} (q_{ik}) - (1-\gamma) q_{ik}. \tag{2b}$$

Based on equation (1), (2a) and (2b), we calculate consumer surplus in each potential member country in terms of equilibrium outputs of firm k as follows:

$$S_i = \frac{1-\gamma}{2} (\sum_{k=A,B,C} q_{ik}^2) + \frac{\gamma}{2} (\sum_{k=A,B,C} q_{ik})^2. \tag{3}$$

As in Ishikawa et al. (2007), we focus our analysis on how FTA formation affects the final-good markets by assuming that input markets in all three countries are perfectly competitive. We assume that, without ROO requirements of any form, the average and marginal costs of producing the homogeneous final good for all firms are constant. For analytical simplicity, these costs are normalized to zero. This allows us to pay special attention to other types of costs that the firms may or may not incur. Denote c_{ik} as extra cost that firm k incurs in producing or exporting one unit of the final good to country $i (= A, B)$. This implies that when serving its own domestic market, $c_{ii} = 0$ for an inside firm regardless of whether or not there is an FTA or a CU.

Prior to the formation of a preferential trade agreement, firm $j (j = A, B, j \neq i)$ is required to pay tariffs for each unit of its final good exported to country i. To firm j, its extra cost c_{ij} is equal to the tariff charged by country i. After forming an FTA with effective ROO, a firm exporting its final good within the FTA incurs an extra cost. In this case, c_{ij} represents an ROO-induced extra cost and its value is positive (i.e., $c_{ij} > 0$).[16] Under a CU, member countries trade with each other without barriers of any form. In this case, the extra cost c_{ij} is zero.

As for firm C that serves the final-good markets in countries A and B, this outside firm is required to pay tariffs. The extra cost c_{iC} to firm C is equal to a specific tariff, the amount of which depends on whether there is an FTA, a CU, or without any form of a trade agreement.

Under each type of the trade regimes, firm $k (= A, B, C)$ sells q_{ik} units of its final good to

[16] In Section 3, we will discuss in more detailed the increase in costs resulting from preferential ROO requirements.

country $i(=A,B)$. Depending on different types of extra cost c_{ik} discussed above and q_{ik} in equation (2a), the total profit of firm k is given as

$$\begin{aligned}\Pi_k &= \sum_{i=A,B} (p_{ik} - c_{ik})q_{ik} \\ &= \sum_{i=A,B} \left\{ (p_{ik} - c_{ik}) \left[\frac{1}{1+2\gamma}\alpha + \frac{\gamma}{1+\gamma-2\gamma^2} \sum_{k=A,B,C} (p_{ik}) - \frac{1}{1-\gamma} p_{ik} \right] \right\}.\end{aligned} \tag{4}$$

Denoting the specific tariff rates that country i imposes on final goods imported from country j and country C as τ_i and t_i, respectively, we calculate tariff revenue as follows:

$$R_i = \tau_i q_{ij} + t_i q_{iC}. \tag{5}$$

Social welfare (W_i) is taken as the sum of consumer surplus S_i, producer surplus Π_i, and tariff revenue R_i.

$$W_i = S_i + \Pi_i + R_i. \tag{6}$$

In the three-country model, world welfare has three components: social welfare of the two potential member countries, as well as producer surplus of the final good exporter in the non-member country. It follows that world welfare is defined as

$$\overline{W}_G = W_A + W_B + \Pi_C. \tag{7}$$

Based on the above framework, we consider a two-stage game. In the first stage, governments of countries *A* and *B* decide whether or not to form an FTA or CU and thereafter determine their external tariffs. In the second stage, firms choose their optimal price levels and compete in the final good markets in the region. We use backward induction to solve for the sub-game perfect Nash equilibrium of the three alternative trade regimes. We begin with the second stage to analyze production decisions of the firms under the alternative trade regimes.

2.2 Optimal Pricing Decisions of the Firms

Each firm maximizes own profit by choosing its price, taking the product prices of other firms and tariffs as given. Solving for the Bertrand-Nash equilibrium prices[17] of the final goods

[17] This equilibrium results is solved under market segmentation. Before forming an FTA or a CU, there is no integration between member countries' final good markets, due to trade barrier. With the formation of an FTA, the restrictions of ROO reduce the market segmentation. After the formation of a CU, there is market integration between member countries' market. However, the equilibrium results with market integration and without it are same, because two countries are symmetric in our model.

produced by the firms by maximizing each firm's profit in equation (4), we have

$$p_{ik} = \frac{1-\gamma}{2}\alpha + \frac{\gamma(1+\gamma)}{2(2+3\gamma)}(c_{ij} + c_{iC}) + \frac{1+\gamma}{2+3\gamma}c_{ik}. \tag{8a}$$

Substituting p_{ik} in equation (8a) into equation (2a) yields the equilibrium outputs of firm k as follows:

$$q_{ik} = \frac{1+\gamma}{(1-\gamma)(1+2\gamma)}\left[\frac{(1-\gamma)}{2}\alpha + \frac{\gamma(1+\gamma)}{2(2+3\gamma)}(c_{ij} + c_{iC}) - \frac{(1+2\gamma)}{(2+3\gamma)}c_{ik}\right]. \tag{8b}$$

Substituting equations (8a) into equation (4) yields the maximized profit of inside and outside firms:

$$\Pi_k = \sum_{i=A,B}\left\{\frac{1+\gamma}{(1-\gamma)(1+2\gamma)}\left[\frac{(1-\gamma)}{2}\alpha + \frac{\gamma(1+\gamma)}{2(2+3\gamma)}(c_{ij} + c_{iC}) - \frac{1+2\gamma}{2+3\gamma}c_{ik}\right]^2\right\}. \tag{9}$$

We assume that policy makers in member countries can observe the production behaviors of their firms. We proceed to the first stage to examine how the potential member countries determine optimal tariffs that maximize their respective social welfare. We then calculate reduced-form solutions for prices, outputs, consumer surplus, producer surplus, tariff revenue, and social welfare, followed by an analysis on welfare implications of forming a PTA.

3. Three Alternative Trade Regimes

3.1 Pre-PTA

Prior to the formation of a PTA, country $i(=A,B)$ imposes specific tariffs on all final goods entering into its market. Since good $j(=A,B,\, j \neq i)$ and good C imported to country i are taken to have the same degree of product similarity, tariffs on the two goods are identical. For the pre-FTA case, denote the same tariff rate that country i imposes on good j and good C as $\overline{t_i}$ (Brander and Spencer, 1984). That is,

$$\overline{c_{ij}} = \overline{\tau_i} = \overline{c_{iC}} = \overline{t_i}\ . \tag{10}$$

Substituting equations (8) and (10) into equations (3) (4) and (5), we have consumer surplus, producer surplus and tariff revenue as functions of $\overline{t_i}$ for country i. Substituting the resulting equations (in terms of tariff rates) into equation (6) yields country i's pre-FTA welfare:

$$\overline{W}_i = -\frac{1+\gamma}{2(1+2\gamma)}\left[\frac{6+14\gamma-\gamma^2-12\gamma^3+\gamma^4}{(2+3\gamma)^2(1-\gamma)}\overline{t}_i^{\,2} - \frac{2+3\gamma-\gamma^2}{2+3\gamma}\alpha\overline{t}_i - \frac{5+\gamma}{4}\alpha^2\right] + f(\overline{t}_j), \qquad (11)$$

where

$$f(\overline{t}_j) = \frac{1+\gamma}{1+2\gamma}\left[\frac{1-\gamma}{4}\alpha^2 - \frac{1+\gamma-\gamma^2}{2+3\gamma}\alpha\,\overline{t}_j + \frac{(1+\gamma-\gamma^2)^2}{(2+3\gamma)^2(1-\gamma)}\overline{t}_j^{\,2}\right].$$

It is easy to verify that $\frac{\partial(\overline{W}_i)^2}{\partial^2\overline{t}_i} < 0,$ which indicates that social welfare function is strictly concave on $\overline{t}_i$. Using the FOC, $\frac{\partial\overline{W}_i}{\partial t_i} = 0,$ we solve for the pre-FTA optimal tariff:

$$\overline{t}_i = \frac{4+8\gamma-5\gamma^2-10\gamma^3+3\gamma^4}{2(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)}\alpha, \qquad (12)$$

and it is positive when $0<\gamma<1$. The maximum level of social welfare for country i without any type of PTA is:

$$\overline{W}_i = \frac{118+664\gamma+1124\gamma^2-25\gamma^3-1656\gamma^4-828\gamma^5+706\gamma^6+381\gamma^7-100\gamma^8}{4(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2. \qquad (13)$$

Substituting equation (10) into equations (8b), using $\overline{t}_i$ in equation (12), we have equilibrium outputs of inside and outside firms without any PTA[18]. Substituting the resulting equilibrium outputs into equations (3) and (5), we calculate the pre-FTA levels of consumer surplus and tariff revenue in member country i:

$$\overline{S}_i = \frac{(1+\gamma)^2(34+164\gamma+205\gamma^2-107\gamma^3-299\gamma^4-13\gamma^5 112\gamma^6)}{4(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2; \qquad (14)$$

$$\overline{R}_i = \frac{16+84\gamma+116\gamma^2-77\gamma^3-262\gamma^4-60\gamma^5+154\gamma^6+53\gamma^7-24\gamma^8}{2(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2. \qquad (15)$$

Based on $\overline{t}_i$ in equation (12), substituting equation (10) into equations (9) yields the pre-FTA levels of profits for the firms:

$$\overline{\Pi}_i = \frac{52+264\gamma+325\gamma^2-338\gamma^3-824\gamma^4+10\gamma^5+611\gamma^6+64\gamma^7-164\gamma^8}{4(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2; \qquad (16a)$$

[18] These equilibrium results are positive when $0<\gamma<1$.

$$\bar{\Pi}_C = \frac{(1-\gamma^2)(4+9\gamma-\gamma^2-8\gamma^3)^2}{2(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2. \quad (17b)$$

Substituting equation (13) and equation (17b) into equation (7), we have the pre-PTA level of world welfare:

$$\bar{W}_G = \frac{134+736\gamma+1181\gamma^2-179\gamma^3-1872\gamma^4-730\gamma^5+913\gamma^6+365\gamma^7-164\gamma^8}{2(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2. \quad (18)$$

In what follows, we will use the pre-PTA welfare as the benchmark to determine the conditions under which the potential member countries *A* and *B* choose to form an FTA or a CU.

3.2 FTA with Effective ROO

In an FTA with effective ROO, member countries independently set external tariffs on their imports from outside of the region. With no restrictions of ROO and in the absence of transport costs, a member country with a lower tariff on a product will benefit from the re-exportation of the product to other members (Grossman and Helpman, 1995; Richardson, 1995; Krishna, 2006). To eliminate re-exportation or trade deflection, member countries of an FTA agree that products cannot get duty-free access to other countries within the FTA unless their productions satisfy the preferential ROO.[19]

Under an FTA, trade in final goods between the member countries is tariff-free. Denote the FTA tariff rate imposed on good C by country $i(=A,B)$ as t_i^{FTA}. Based on the analytical framework in Section 2, we have

$$\tau_i^{FTA} = 0 \text{ and } c_{iC}^{FTA} = t_i^{FTA}. \quad (19)$$

Given the preferential ROO provisions, the cost of exporting one unit of final good from one member to another member increases. Denote the ROO-induced extra cost as $\delta(>0)$, we have

$$c_{ij}^{FTA} = \delta. \quad (20)$$

In analyzing firm behavior in an FTA with ROO, Ju and Krishna (2002, 2005) show the

[19] There are different criteria for ROO in terms of (i) regional content requirements, (ii) a change in tariff heading, (iii) particular processes that should be performed within an FTA; and (iv) a substantial transformation of a product. See, e.g., Thoening and Verdier (2004), Cadot, Estavadeoral, Suwa-Eisenmann, and Verdier. (2006), and Krishina (2006). The North American Free Trade Agreement (NAFTA), the European Union (EU), and the ASEAN Free Trade Area agreement (AFTA) all contain ROO provisions which provide preferential treatment for member countries.

possibility of regime switches because final-good exporters within the FTA may or may not comply with ROO. When ROO requirements are restrictive, inside firms may switch to pay tariffs for their exports instead of complying with ROO. In this case no firms comply with the ROO and FTA is fundamentally ineffective. To induce inside firms to comply with ROO, we consider the condition that the specific tariff rate, t_i^{FTA}, is set higher than the ROO-induced extra cost,

$$t_i^{FTA} > \delta. \tag{21}$$

Equation (21) can be referred to as the ROO-complying condition for an effective FTA.

Based on equations (19) and (20), substituting equation (8) into equations (3), (4) and (5) yields the FTA levels of consumer surplus, producer surplus and tariff revenue for each member. These functions are directly related to t_i^{FTA} and δ. We then substitute the resulting functions into (6) to determine each member's social welfare, denoted as $W_i^{FTA}(t_i^{FTA}, \delta)$.

Unless the formation of an FTA is based on noneconomic or political objectives, it is plausible to assume that FTA partners are willing to sign in ROO provisions that improve their social welfare. Each potential member country chooses to join an FTA with ROO when its welfare, $W_i^{FTA}(t_i^{FTA}, \delta)$, is higher than the pre-PTA welfare $\overline{W}_i$,

$$W_i^{FTA}(t_i^{FTA}, \delta) > \overline{W}_i. \tag{22}$$

Equation (22) can be referred to as the welfare-improving condition of forming an FTA with ROO ($\delta > 0$).

The next step is to determine the range of the ROO-induced extra cost that guarantees welfare gains from trade for all the participating members. Also, we wish to determine the responses of the member countries in setting their external tariff rates. The problem facing each member country is to choose t_i^{FTA} that maximizes $W_i^{FTA}(t_i^{FTA}, \delta)$, subject to the ROO-complying condition (see equation (21)), and the welfare-improving condition (see equation (22)). The optimal tariff rate set by each member country is

$$t_i^{FTA} = \frac{2+\gamma-3\gamma^2}{6+9\gamma-\gamma^2}\alpha + \frac{\gamma(4+11\gamma+6\gamma^2-\gamma^3)}{12+36\gamma+19\gamma^2-12\gamma^3+\gamma^4}\delta. \tag{23}$$

It follows from equation (23) that t_i^{FTA} increases as δ increases. Furthermore, t_i^{FTA} is strictly less than $\overline{t}_i$. The latter result is consistent with the requirement as specified by the

Article XXIV of GATT that an external tariff should not be set above the pre-FTA level.

Note that the solution to the constrained welfare optimization problem exists only when ROO satisfy the restriction that $\delta < \hat{\delta}$,[20] where $\hat{\delta}$ is the critical value of the ROO-induced extra cost below which there is a welfare improvement for each FTA member. When ROO are too restrictive in that $\delta \geq \hat{\delta}$, the formation of an FTA is totally ineffective.

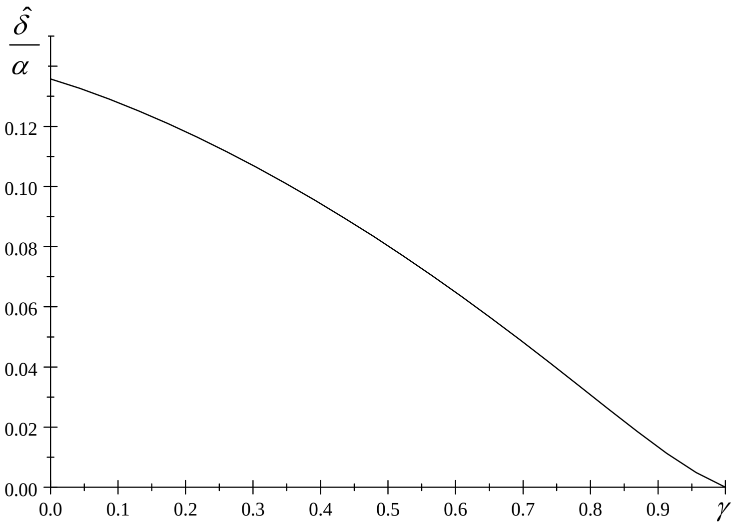

Figure 1. *The relationship between* $\frac{\hat{\delta}}{\alpha}$ *and* γ

How does the intensity of product market competition affect the maximum extent of ROO requirements? To answer the question, we use Figure 1 to illustrate the relationship between $\hat{\delta}$ and γ. Other things being equal, the critical value of the ROO-induced extra cost, $\hat{\delta}$, decreases as γ increases. The economic implication is interesting. When the substitutability between any two of final goods increases (or when the intensity of the final-good market competition is higher) in an FTA country, ROO requirements should be set less restrictively. For the case in which the ROO-induced extra cost is small enough, $\delta < \hat{\delta}$, potential firms find it welfare-improving to join an FTA.

Next, we wish to examine economic effects of changes in ROO-induced extra costs in an

[20] See A-1 in the Appendix for $\hat{\delta}(\gamma)$.

FTA. Using the optimal tariff rate t_i^{FTA} in equation (23), we calculate market equilibrium price of each final good, consumer surplus, profits of inside and outside firms, tariff revenue, each FTA country's welfare, as well as world welfare (see Appendix A-2 for detailed derivations). With the ROO restriction that $0 < \delta < \hat{\delta}$, we have the following comparative-static results:

$$\frac{\partial p_{ik}^{FTA}}{\partial \delta} > 0; \quad \frac{\partial S_i^{FTA}}{\partial \delta} < 0; \quad \frac{\partial \Pi_i^{FTA}}{\partial \delta} < 0; \quad \frac{\partial \Pi_C^{FTA}}{\partial \delta} < 0;$$

$$\frac{\partial R_i^{FTA}}{\partial \delta} > 0; \quad \frac{\partial W_i^{FTA}}{\partial \delta} < 0; \text{ and } \frac{\partial W_G^{FTA}}{\partial \delta} < 0. \tag{24}$$

The implications of the results are presented as follows. In an FTA, the equilibrium market prices of final goods are lower when ROO are less restrictive, other things being equal. Consumers in an FTA benefit from the lower prices for their consumption of the cheaper final goods. But producers in FTA countries and in the non-member country are worse off. With less restrictive ROO, the optimal external tariff becomes lower and the equilibrium amounts of the final good imported from the non-member country increase. It comes as no surprise that for a decrease in the ROO-induced extra cost, the increase in the sum of consumer and producer surplus dominates the decrease in tariff revenue for each FTA country. Consequently, social welfare is higher when ROO become less restrictive. Under the same condition, world welfare unambiguously increases. These findings further imply that with less restrictive ROO, both FTA members and the non-member are better off.

The findings of the analysis permit us to establish the first proposition:

ROPOSITION 1. *In the three-country model of trade under differentiated oligopoly, only when the ROO requirements are not too restrictive will the formation of an FTA with effective ROO be welfare-improving to each member country. The critical value of the ROO-induced extra cost, under which member countries are better off from FTA formation, decreases when the degree of substitutability of the final goods (or the intensity of product market competition) increases. Other things being equal, consumer surplus, producer surplus, and social welfare in each FTA member are greater when ROO become less restrictive. This condition also makes the non-member country and the three-country world better off.*

3.3 The formation of a CU

In a CU, member countries jointly set a common external tariff on their imports entering into the block. Denoting t^{CU} as each CU member's tariff rate on good C, we have $t_A^{CU} = t_B^{CU} = t^{CU}$. Member countries trade with each other duty-free so that extra cost c_{ij} is zero. In other words, we have

$$\tau_i^{CU} = c_{ij}^{CU} = 0 \quad c_{iC}^{CU} = t_i^{CU} = t^{CU}. \tag{25}$$

Based on equation (25), substituting equation (8) into equations (3), (4), and (5), we have consumer surplus, producer surplus, and tariff revenue as functions of t^{CU} for each member. Substituting the resulting equations into equation (6) yields the optimal level of social welfare for each CU member:

$$W_i^{CU} = -\frac{(1+\gamma)(12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4)}{8(2+3\gamma)^2(1+\gamma-2\gamma^2)}(t^{CU})^2 + \frac{2+7\gamma+6\gamma^2+\gamma^3}{4(2+7\gamma+6\gamma^2)}\alpha t^{CU} + \frac{7+6\gamma-\gamma^2}{8(1+2\gamma)}\alpha^2. \tag{26}$$

Similar to the case of forming an FTA, each potential member country has an incentive to join a CU if there is an improvement in social welfare:

$$W_i^{CU} > \overline{W}_i. \tag{27}$$

We further take into account the GATT requirement that the common external tariff set by a CU be no greater than the pre-FTA tariff for the non-member:

$$t^{CU} \le \overline{t}_i. \tag{28}$$

Maximizing W_i^{CU} in equation (26) subject to the welfare-improving condition, equation (27) and the GATT/WTO requirement (see equation (28)), we solve for the CU's optimal common external tariff:

$$t^{CU} = \begin{cases} \dfrac{4+8\gamma-5\gamma^2-10\gamma^3+3\gamma^4}{2(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)}\alpha = \overline{t}_i, & \text{if } 0 < \gamma \le 0.59575; \\ \dfrac{4+12\gamma+\gamma^2-14\gamma^3-3\gamma^4}{12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4}\alpha < \overline{t}_i, & \text{if } 0.59575 < \gamma < 1. \end{cases} \tag{29}$$

The result in (29) indicates that the substitutability of final goods plays an important role in affecting the level of the common external tariff. We thus have

PROPOSITION 2: *In the case of forming a CU, member countries lower their common external tariffs on final-good imports relative to their pre-PTA tariffs, provided that the degree of the substitutability of final goods is "sufficiently high"* $(0.59575 < \gamma < 1)$. *When the substitutability of final goods is critically low* $(0 < \gamma \le 0.59575)$, *each CU member keeps its* *external tariff at its pre-PTA level under the GATT/WTO requirement for tariffs on non-member countries.*

Based on t^{CU} in equation (29), substituting equation (25) into equation (7), (8), and (9) yields consumer surplus, tariff revenue for member country i and non-member countries producer surplus for all inside and outside firms in a CU. Substituting resulting each CU member country's consumer surplus, producer surplus and tariff revenue into equation (10), we can derive welfare for each CU member. Taking the sum of member countries' welfare and non-member country's producer surplus, we calculate social welfare for the three-country world (see Appendix A-3 for detailed derivations).

Our next step is to compare differences between an FTA and a CU, using the case without preferential trading agreements as the reference base.

4. Comparing the Alternative Trade Regimes

In evaluating and comparing the different trade regimes, we play attention to their effects on external tariffs, the non-member country, producer surplus and consumer surplus in each member country, as well as world welfare.

4.1 Effects on External Tariffs

From equations (12), (23) and (29), it is straightforward to show that

$$\frac{\partial \overline{t}}{\partial \gamma} < 0, \ \frac{\partial t_i^{FTA}}{\partial \gamma} < 0, \text{ and } \frac{\partial t^{CU}}{\partial \gamma} < 0, \tag{30}$$

which means the optimal tariffs for three regimes (without any PTA, an FTA with effective ROO and CU) decrease with the degree of the substitutability of the final goods, γ. This result indicates that when final goods are more similar or when the market competition among the goods is more severe, the optimal external tariffs are lower, regardless of the type of the trade regimes.

From equation (23), we see that each FTA member's external tariff rate, t_i^{FTA}, increases as the ROO-induced extra cost, δ, increases. For $0 < \delta < \hat{\delta}$, over which there is a welfare improvement, we have $t_i^{FTA}\big|_{\delta=0} < t_i^{FTA}\big|_{0<\delta<\hat{\delta}} < t_i^{FTA}\big|_{\delta=\hat{\delta}}$. Figure 2 presents the upper and lower limits of tariffs in the three alternative trade regimes. For a given value of $\gamma (0 < \gamma < 1)$, the FTA optimal tariff rate is lower than the CU optimal tariff, since the upper limit of the former is less than the latter. This implies that reductions in external tariffs are greater under an FTA with effective ROO than under a CU.

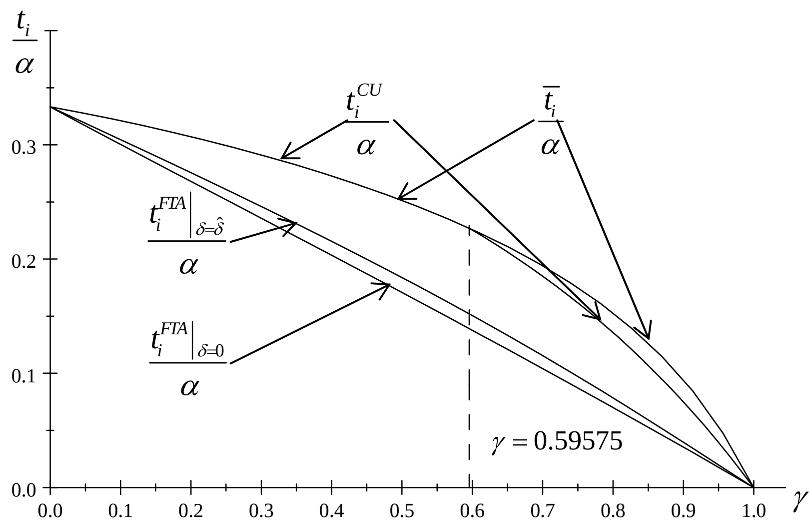

Figure 2. *The relationship between external* $\frac{t_i}{\alpha}$ *and* γ

Based on the above analysis, we have

PROPOSITION 3. *The higher the degree of substitutability between any two differentiated final goods, the lower the optimal external tariffs under each trade regime (a pre-PTA, an FTA, or a CU one). Moreover, reductions in optimal external tariffs are greater under an FTA than under a CU, despite that FTA members independently set tariffs high enough to induce their exporting firms to comply with ROO requirements.*

4.2 Effects on the Non-Member Country

Next, we discuss what effects the formation of a PTA has on a non-member. Rewriting equation (8) gives the equilibrium outputs of country *C* for three alternative regimes as:

$$q_{iC} = \frac{(1+\gamma)}{(1-\gamma)(1+2\gamma)}\left[\frac{(1-\gamma)}{2}\alpha - \frac{(1-\gamma-\gamma^2)}{(2+3\gamma)}c_{iC} - \frac{\gamma(1+\gamma)}{2(2+3\gamma)}\left(c_{iC}-c_{ij}\right)\right]. \tag{31}$$

This output function is decreasing in c_{iC}, which is firm *C*'s unit cost of exporting its final good to country i, and is also decreasing in $(c_{iC}-c_{ij})$, which is unit cost difference in exporting their final goods to country i between firm C and firm j.

According to the ROO-complying condition in equation (21) and the reduction in tariffs that $t_i^{FTA} < \overline{t}_i$, we have $c_{iC}^{FTA} < \overline{c}_{iC}$ and $(c_{iC}^{FTA} - c_{ij}^{FTA}) > (\overline{c}_{iC} - \overline{c}_{ij})$. From equations (10), (12), (19), (20) and (23), it is straightforward to prove that $q_{iC}^{FTA} > \overline{q}_{iC}$ for $0 < \delta < \hat{\delta}$. This is because the tariff deduction effect resulting from FTA formation dominates the effect of an increase in unit cost difference between firm C and firm j.

From equations (10), (12), (25) and (29), a comparison in extra costs before and after forming a CU reveals that $c_{iC}^{CU} < \overline{c}_{iC}$ and $(c_{iC}^{CU} - c_{ij}^{CU}) > (\overline{c}_{iC} - \overline{c}_{ij})$. It is also straightforward to verify that $\overline{q}_{iC} > q_{iC}^{CU}$. This is because the effect of an increase in the cost difference between exports from member country and nonmember country dominates the tariff deduction effect under the CU.

From Proposition 3, we know that $t_i^{FTA} < t^{CU}$ and $t_i^{FTA} - \delta < t^{CU}$ which, according to equations (19), (20) and (25) imply that $c_{iC}^{FTA} < c_{iC}^{CU}$ and $(c_{iC}^{FTA} - c_{ij}^{FTA}) < (c_{iC}^{CU} - c_{ij}^{CU})$. Firm C's unit cost of exporting its final good to country i in an FTA is less than that in a CU. Also, the difference in unit cost between firm C and firm j in exporting their final goods to country i in an FTA is lower than that in a CU. This explains why $q_{iC}^{FTA} > q_{iC}^{CU}$.

Based on the above analysis, we thus have $q_{iC}^{FTA} > \overline{q}_{iC} > q_{iC}^{CU}$. Since the outside firm makes more profits as the volume of its final good exports increases, as shown in equation (9), we have $\pi_{iC}^{FTA} > \overline{\pi}_{iC} > \pi_{iC}^{CU}$.

PROPOSITION 4. *Due to (i) greater reductions in external tariffs in an FTA than in a CU and (ii) the ROO-induced extra cost for exporting firms inside the FTA, a non-member country is relatively better off under the FTA. CU member countries may lower their common external tariffs, but a non-member country is hurt by the trade block because the member countries have an advantage in trading their final goods duty-free.*

4.3 Effects on the Firm in Each Member Country

Rewriting equation (8) gives the equilibrium sales of country i to its domestic market and the market in country j for three alternative trade regimes as follows:

$$q_{iC} = \frac{(1+\gamma)}{(1-\gamma)(1+2\gamma)}\left[\frac{(1-\gamma)}{2}\alpha + \frac{\gamma(1+\gamma)}{2(2+3\gamma)}(c_{iC}+c_{ij})\right];$$

$$q_{ij} = \frac{(1+\gamma)}{(1-\gamma)(1+2\gamma)}\left[\frac{(1-\gamma)}{2}\alpha - \frac{(1-\gamma-\gamma^2)}{(2+3\gamma)}c_{ij} - \frac{\gamma(1+\gamma)}{2(2+3\gamma)}(c_{ij}-c_{iC})\right]. \tag{32}$$

Each country i's domestic sale, q_{ii}, is an increasing function of $(c_{iC}+c_{ij})$, which is the sum of the extra cost to firm C in exporting one unit of final good to country i and the extra cost to firm j in exporting one unit of final good to country i.

Based on the optimal tariffs for the three alternative regimes (see equations (12), (23) and (29)), it is straightforward to prove that $(\delta + t_i^{FTA}) < t^{CU} < 2\overline{t}_i$, which indicates

$$(c_{ij}^{FTA} + c_{iC}^{FTA}) < (c_{ij}^{CU} + c_{iC}^{CU}) < (\overline{c}_{ij} + \overline{c}_{iC}).$$

It follows that

$$q_{ii}^{FTA} < q_{ii}^{CU} < \overline{q}_{ii}, \tag{33}$$

which indicates that either forming an FTA or a CU makes each inside firm worse off in its own domestic market since the domestic sale decreases.

Meanwhile, firm i's export of its final good is a decreasing function of c_{ij} and $(c_{ij}-c_{iC})$. Using Proposition 3 and the ROO-complying condition, we can verify that $0 < \delta < \overline{t}_i$ and $-t^{CU} < \delta - t_i^{FTA} < 0,$ which indicates

$$c_{ij}^{CU} < c_{ij}^{FTA} < \overline{c}_{ij} \text{ and } (c_{ij}^{CU} - c_{iC}^{CU}) < (c_{ij}^{FTA} - c_{iC}^{FTA}) < (\overline{c}_{ij} - \overline{c}_{iC}).$$

It follows that

$$\overline{q}_{ij} < q_{ij}^{FTA} < q_{ij}^{CU}, \tag{34}$$

which indicates that either forming an FTA or a CU makes each inside firm better off since the quantity of the final food exports increases.

From equations (33) and (34), we find that the CU levels of domestic sale and export are higher than those under an FTA, which implies that $\Pi_i^{CU} > \Pi_i^{FTA}$. We thus can infer that firms in member countries have greater incentives to support the formation of a CU than an FTA with ROOs.

However, whether firms producing within a PTA will be better off in an FTA or in a CU cannot be determined unambiguously. By comparing producer surplus for three alternative regimes as shown in equation (16a), (27a), (a4) and (a.6), we find that for each member country producer surplus under a CU is greater than those under the cases of an FTA and a pre-PTA. Nevertheless, the relationship in producer surplus for the later two cases (PTA and pre-PTA) depends crucially on the degree of substitutability and the ROO-induced extra cost in an FTA. Specifically,

$\Pi_i^{FTA} > \overline{\Pi}_i$ if (i) $\gamma < 0.70493$ or (ii) $0.70493 < \gamma < 0.76143$ and $0 < \delta < \delta^{\Pi}$;

$\overline{\Pi}_i > \Pi_i^{FTA}$ if (i) $\gamma < 0.76143$ or (ii) $0.70493 < \gamma < 0.76143$ and $\delta^{\Pi} < \delta < \hat{\delta}$,

where δ^{Π} makes $\Pi_i^{FTA} = \overline{\Pi}_i$, and $0 < \delta^{\Pi} < \hat{\delta}$.

PROPOSITION 5. *In the three-country model of international oligopoly, firms producing within a trade block are better in a CU than either in an FTA with ROO or in the case without a PTA. When the degree of substitutability of final goods is small, forming an FTA with effective ROO may make member countries better off.*

4.4 Effects on Consumer Surplus of Each Member Country

Next, we discuss how PTA formation affects consumers within a block. We show in equation (a.2) in appendix A-2 that consumer surplus in each member country under an FTA, S_i^{FTA}, decreases as the ROO-induced extra cost, $\delta, 0 < \delta < \hat{\delta}$, increases. It follows that

$$S_i^{FTA}\big|_{\delta=\hat{\delta}} < S_i^{FTA}\big|_{0<\delta<\hat{\delta}} < S_i^{FTA}\big|_{\delta=0}.$$

Figure 3 illustrates the upper and lower limits of consumer surplus for each member country under an FTA, under a CU, S_i^{CU}, and without any PTA, $\overline{S}_i$.

Based on the results in Figure 3, we have

PROPOSITION 6. *In the three-country model of trade under differentiated oligopoly, either forming an FTA or forming a CU makes consumers in member countries better off. The ranking of consumer surplus between an FTA and a CU depends crucially on the ROO-induced extra cost in the FTA and the degree of substitutability of the final goods. Specifically,*

$S_i^{FTA} > S_i^{CU}$ if (i) $0.65871 < \gamma < 1$ or (ii) $0 < \gamma < 0.65871$ and $0 < \delta < \delta^S$;

$S_i^{CU} > S_i^{FTA}$ if (ii) $0 < \gamma < 0.65871$ and $\delta^S < \delta < \hat{\delta}$;

where δ^S makes $S_i^{FTA} = S_i^{CU}$.

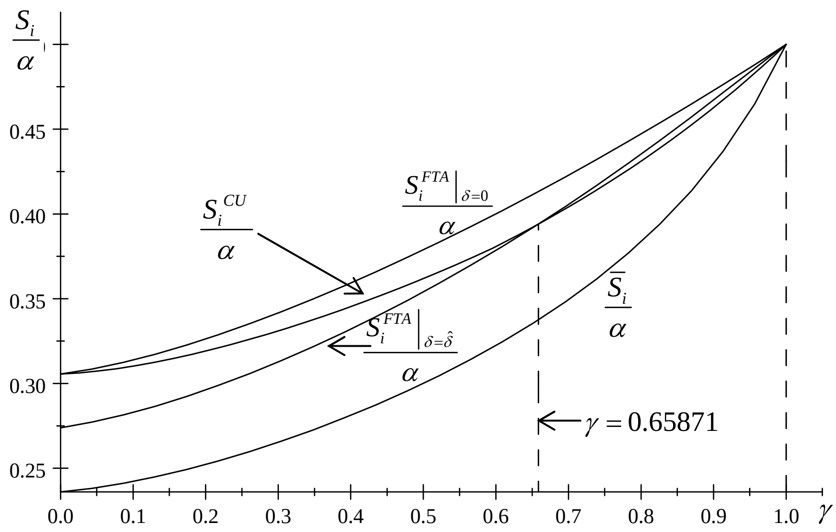

Figure 3. *The relationship between external* $\frac{S_i}{\alpha}$ *and* γ

4.5 Effects on Social welfare of Each Member Country

Under the assumption that the objectives of member countries to join a PTA are to improve their social welfare, we have that $W_i^{CU} > \bar{W}_i$ and $W_i^{FTA} > \bar{W}_i$ when an FTA or a CU exists. As proved in Appendix A-3, we also find that $W_i^{CU} > W_i^{FTA}$ for any given γ, where $0 < \gamma < 1$. This leads to

PROPOSITION 7. *In the three-country model of trade under oligopoly, forming a CU results in a greater improvement in social welfare than forming an FTA with effective ROO.*

Proposition 7 implies that member countries are better off in CUs than in FTAs, regardless of whether ROO requirements are restrictive or not. This finding is consistent with Mukunoki (2004) that welfare gain from trade to each member is the highest in customs union. Relative to the pre-RTA equilibrium, an FTA with ROO is welfare-deteriorating for member countries when ROO content requirements are “significantly restrictive.” This result stands in contrast with Mukunoki (2004) that the formation of preferential trade agreements is always welfare-improving to member countries.

4.6 *Effects on World Welfare*

Finally, we examine differences between an FTA and a CU in affecting world welfare.

Based on our model, world welfare is measured by the sum of FTA countries' social welfare and a non-member exporting country's producer surplus. From Proposition 4 and Proposition 7, we know that $\pi_{iC}^{FTA} > \overline{\pi}_{iC} > \pi_{iC}^{CU}$ and $W_i^{CU} > W_i^{FTA} > \overline{W}_i$. It follows straightforwardly that world welfare increases under an FTA. But whether world welfare is higher under a CU than under the case without any PTA cannot be determined unambiguously. Nor can we draw unambiguous conclusions about the ranking of world welfare between an FTA and a CU.

From equation (24), world welfare under an FTA is a decreasing function of the ROO-induced extra cost δ, where $0 < \delta < \hat{\delta}$. Also, we have

$$W_G^{FTA}\Big|_{\delta=\hat{\delta}} < W_G^{FTA}\Big|_{0<\delta<\hat{\delta}} < W_G^{FTA}\Big|_{\delta=0} .$$

Figure 4 illustrates that world welfare under a CU is greater than that without a PTA. Given that $\overline{\pi}_{iC} > \pi_{iC}^{CU}$ and $W_i^{CU} > \overline{W}_i$, we can infer that welfare gains for member countries exceed the loss of producer surplus for the non-member country in a CU.

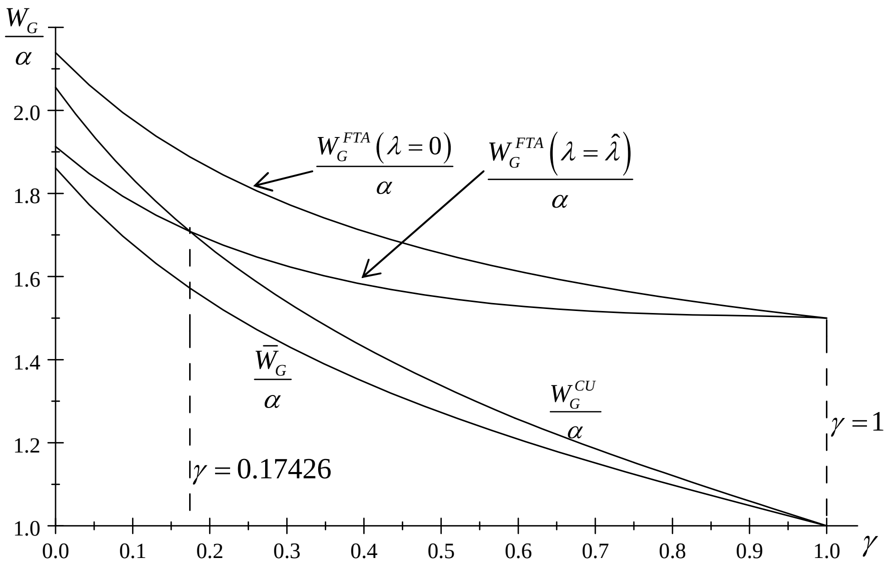

Figure 4. *The relationship between* $\frac{W_G}{\alpha}$ *and* γ

Based on the above analysis and the results in Figure 4, we have

PROPOSITION 8. *In the three-country model of trade under oligopoly, world welfare is greater in a PTA (FTA with effective ROO or CU), relative to the pre-PTA regime. But the comparison in world welfare between an FTA and a CU depends crucially on the ROO-induced extra cost in an FTA and the degree of the substitutability of final goods. Specifically,*

$W_G^{FTA} > W_G^{CU}$ *if (i)* $0.17426 < \gamma < 1$ *or (ii)* $0 < \gamma < 0.17426$ *and* $0 < \delta < \delta^{W_G}$;

$W_G^{CU} > W_G^{FTA}$ *if* $0 < \gamma < 0.17426$ *and* $\delta^{W_G} < \delta < \hat{\delta}$;

where δ^{W_G} *makes* $W_G^{CU} = W_G^{FTA}$ *for* $0 < \gamma < 0.17426$.

Although there is an improvement in global welfare from forming a PTA (either FTA or CU), we cannot draw an unambiguous conclusion concerning whether one trade regime dominates the other. Preferential ROO requirements and the degree of competition in the final good markets are among the key factors in determining whether or not FTAs are preferred to CUs. Specifically, for the case in which ROO requirements are not too restrictive or the intensity of market competition in final goods is high, global welfare is relatively higher under an FTA than under a CU.

5. Concluding Remarks

The rapid proliferation of preferential trade agreements, especially in the last two decades, has prompted economists to look into their welfare implications. This paper extends the existing literature on PTAs under imperfect competition by analyzing and comparing the economic incentives of forming an FTA or a CU. Unlike much of the literature, we explicitly take into account preferential ROO requirements in an FTA. This consideration is relevant given that final-good exporters within an FTA may choose not to comply with ROO when ROO-induced extra cost (say, due to an increase in the price of an FTA-made input) exceeds a specific tariff on the exports of final goods (Ju and Krishna, 2002, 2005).

We find that whether all the participating countries are better off under an FTA depends on whether or not ROO requirements are overly restrictive. Despite the possibility of positive welfare gains from trade for an FTA with effective ROO, member countries and their final-good producers are better off in a CU than in an FTA. Nevertheless, consumers in member countries may be better off in an FTA than in a CU. Because of greater reductions in external tariffs by member countries in an FTA than in a CU, a non-member country is better off under the FTA. For the case in which ROO requirements are not too restrictive or the intensity of product market competition is significantly high, both consumer surplus in the member countries and world welfare are relatively higher under an FTA than under a CU.

Appendix

A-1: *The critical level of the ROO-induced extra cost*

We calculate $\hat{\delta}$ as follows:

$$\hat{\delta} = \alpha \frac{E_1(E_2 - \frac{\sqrt{E_3}}{E_4})}{2E_5}$$

where

$$E_1 = 4 + 8\gamma - 5\gamma^2 - 10\gamma^3 + 3\gamma^4,$$

$$E_2 = 108 + 648\gamma + 1335\gamma^2 + 892\gamma^3 - 298\gamma^4 - 372\gamma^5 + 55\gamma^6,$$

$$\begin{aligned} E_3 = {} & 347328 + 5754240\gamma + 41808960\gamma^2 + 172161504\gamma^3 + 426963132\gamma^4 + 592415928\gamma^5 \\ & + 222511266\gamma^6 - 674120034\gamma^7 - 1126030229\gamma^8 - 372175775\gamma^9 + 674575709\gamma^{10} \\ & + 665952923\gamma^{11} - 33930431\gamma^{12} - 270875746\gamma^{13} - 52988020\gamma^{14} + 44739088\gamma^{15} \\ & + 4924869\gamma^{16} - 4759687\gamma^{17} + 849773\gamma^{18} - 66265\gamma^{19} + 2011\gamma^{20}, \end{aligned}$$

$$E_4 = 6 + 14\gamma - \gamma^2 - 12\gamma^3 + \gamma^4,$$

$$E_5 = 144 + 1296\gamma + 4536\gamma^2 + 7296\gamma^3 + 4047\gamma^4 - 2069\gamma^5 - 1551\gamma^6 + 2066\gamma^7 + 993\gamma^8 - 445\gamma^9 + 39\gamma^{10}.$$

A-2: *Reduced-form solutions for the case of an FTA*

Using the optimal tariff rate t_i^{FTA} in equation (23), we calculate the post-FTA level of social welfare for each member as

$$W_i^{FTA} = \Theta^W \delta^2 - \Psi^W \alpha\delta + \Omega^W \alpha^2, \qquad \text{(a.1)}$$

where

$$\Theta^W = \frac{144 + 1440\gamma + 5832\gamma^2 + 11832\gamma^3 + 11343\gamma^4 + 1978\gamma^5 - 3620\gamma^6 + 515\gamma^7 + 3059\gamma^8 + 548\gamma^9 - 406\gamma^{10} + 39\gamma^{11}}{(1+\gamma-2\gamma^2)(24+108\gamma+146\gamma^2+33\gamma^3-34\gamma^4+3\gamma^5)^2},$$

$$\Psi^W = \frac{108 + 756\gamma + 1983\gamma^2 + 2227\gamma^3 + 594\gamma^4 - 670\gamma^5 - 317\gamma^6 + 55\gamma^7}{(6+9\gamma-\gamma^2)^2(4+20\gamma+31\gamma^2+11\gamma^3-6\gamma^4)},$$

$$\Omega^W = \frac{3(22+86\gamma+97\gamma^2+12\gamma^3-21\gamma^4)}{2(1+2\gamma)(6+9\gamma-\gamma^2)^2},$$

noting that these coefficients are all positive.

Substituting equations (19) and (20) into equation (8b), using t_i^{FTA} in equation (23), we have equilibrium outputs of inside and outside firms after forming an FTA with effective ROO. We then use the resulting equilibrium outputs and equations (3) and (5) to calculate consumer surplus and tariff revenue for each FTA member country:

$$S_i^{FTA} = \Theta^S \delta^2 - \Psi^S \alpha\delta + \Omega^S \alpha^2, \qquad \text{(a.2)}$$

$$R_i^{FTA} = \Theta^R \delta^2 + \Psi^R \alpha\delta + \Omega^R \alpha^2.$$

where

$$\Theta^S = \frac{(1+\gamma)^2(144+1152\gamma+3460\gamma^2+4356\gamma^3+726\gamma^4-3184\gamma^5-2121\gamma^6+131\gamma^7+191\gamma^8-23\gamma^9)}{2(1+\gamma-2\gamma^2)(24+108\gamma+146\gamma^2+33\gamma^3-34\gamma^4+3\gamma^5)^2},$$

$$\Psi^S = \frac{(1+\gamma)^2(36+224\gamma+509\gamma^2+484\gamma^3+130\gamma^4-37\gamma^5)}{(6+21\gamma+17\gamma^2-2\gamma^3)(24+108\gamma+146\gamma^2+33\gamma^3-34\gamma^4+3\gamma^5)},$$

$$\Omega^S = \frac{(1+\gamma)^2(22+70\gamma+55\gamma^2)}{72+360\gamma+570\gamma^2+240\gamma^3-70\gamma^4+4\gamma^5},$$

$$\Theta^R = \frac{\gamma^2(1+\gamma)^3(4+11\gamma+6\gamma^2-\gamma^3)}{(12+36\gamma+19\gamma^2-12\gamma^3+\gamma^4)(12+48\gamma+37\gamma^2-50\gamma^3-53\gamma^4+6\gamma^5)},$$

$$\Psi^R = \frac{\gamma(1+\gamma)^2(10+31\gamma+21\gamma^2-4\gamma^3)}{72+468\gamma+1074\gamma^2+915\gamma^3+5\gamma^4-221\gamma^5+41\gamma^6-2\gamma^7},$$

$$\Omega^R = \frac{(1-\gamma^2)(2+3\gamma^2)}{36+180\gamma+285\gamma^2+120\gamma^3-35\gamma^4+2\gamma^5}.$$

Based on t_i^{FTA} in equation (23), we substitute equations (19) and (20) into equation (9) to derive profits of inside and outside firms:

$$\Pi_i^{FTA} = \Theta^{\Pi} \delta^2 - \Psi^{\Pi} \alpha\delta - \Omega^{\Pi} \alpha^2,$$

$$\Pi_C^{FTA} = \Theta^{\Pi_C} \delta^2 - \Psi^{\Pi_C} \alpha\delta + \Omega^{\Pi_C} \alpha^2, \qquad \text{(a.3)}$$

where

$$\Theta^{\Pi} = \frac{(1+\gamma)(144+1296\gamma+4512\gamma^2+7116\gamma^3+3509\gamma^4-2866\gamma^5-2116\gamma^6+1964\gamma^7+1069\gamma^8-422\gamma^9+34\gamma^{10})}{(1+-2\gamma^2\gamma)(24+108\gamma+146\gamma^2+33\gamma^3-34\gamma^4+3\gamma^5)^2},$$

$$\Psi^{\Pi} = \frac{72+480\gamma+1122\gamma^2+840\gamma^3-596\gamma^4-1144\gamma^5-342\gamma^6+80\gamma^7}{144+1152\gamma+3552\gamma^2+5052\gamma^3+2755\gamma^4-427\gamma^5-581\gamma^6+119\gamma^7-6\gamma^8},$$

$$\Omega^{\Pi} = \frac{-2(1-\gamma^2)(3+5\gamma)^2}{36+180\gamma+285\gamma^2+120\gamma^3-35\gamma^4+2\gamma^5},$$

$$\Theta^{\Pi_C} = \frac{(1+\gamma)^2(144+1152\gamma+3460\gamma^2+4356\gamma^3+726\gamma^4-3184\gamma^5-2121\gamma^6+131\gamma^7+191\gamma^8-23\gamma^9)}{2(1+\gamma-2\gamma^2)(24+108\gamma+146\gamma^2+33\gamma^3-34\gamma^4+3\gamma^5)^2},$$

$$\Psi^{\Pi_C} = \frac{(1+\gamma)^2(36+224\gamma+509\gamma^2+484\gamma^3+130\gamma^4-37\gamma^5)}{144+1152\gamma+3552\gamma^2+5052\gamma^3+2755\gamma^4-427\gamma^5-581\gamma^6+119\gamma^7-6\gamma^8},$$

$$\Omega^{\Pi_C} = \frac{(1+\gamma)^2(22+70\gamma+55\gamma^2)}{72+360\gamma+570\gamma^2+240\gamma^3-70\gamma^4+4\gamma^5}.$$

Finally, substituting equations (a.1) and (a.3) into equation (7), we derive the post-FTA level of world welfare:

$$W_G^{FTA} = \Theta^{W_G}\delta^2 - \Psi^{W_G}\alpha\delta + \Omega^{W_G}\alpha^2,$$

where $\Theta^{W_G} = 2\Theta^W + \Theta^{\Pi_C}$; $\Psi^{W_G} = 2\Psi^W + \Psi^{\Pi_C}$; and $\Omega^{W_G} = 2\Omega^W + \Omega^{\Pi_C}$.

A-3: *Reduced-form solutions for the case of a CU*

Depending on the value of γ, we have two possible cases:

Case 1: $0 < \gamma \leq 0.59575$

$$S_i^{CU} = \frac{(1+\gamma)^2(352+1664\gamma+1928\gamma^2-1440\gamma^3-3117\gamma^4+228\gamma^5+1274\gamma^6-124\gamma^7+3\gamma^8)}{32(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2;$$

$$R_i^{CU} = \frac{(4+8\gamma-5\gamma^2-10\gamma^3+3\gamma^4)(8+24\gamma+9\gamma^2-25\gamma^3-17\gamma^4+\gamma^5)}{8(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2;$$

$$\Pi_i^{CU} = \frac{(12+18\gamma-27\gamma^2-25\gamma^3+23\gamma^4-\gamma^5)(12+42\gamma+33\gamma^2-19\gamma^3-21\gamma^4+\gamma^5)}{8(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2; \qquad \text{(a.4)}$$

$$\Pi_C^{CU} = \frac{(1-\gamma)^3(1+\gamma)(8+24\gamma+17\gamma^2-\gamma^3)^2}{8(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2;$$

$$W_i^{CU} = \frac{1056 + 5888\gamma + 9672\gamma^2 - 1104\gamma^3 - 15221\gamma^4 - 6442\gamma^5 + 7201\gamma^6 + 3124\gamma^7 - 1171\gamma^8 + 70\gamma^9 - \gamma^{10}}{32(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2; \tag{a.5}$$

$$W_G^{CU} = \frac{1184 + 6400\gamma + 9832\gamma^2 - 2640\gamma^3 - 16531\gamma^4 - 4850\gamma^5 + 8843\gamma^6 + 2484\gamma^7 - 1789\gamma^8 + 142\gamma^9 - 3\gamma^{10}}{16(1+2\gamma)(6+14\gamma-\gamma^2-12\gamma^3+\gamma^4)^2}\alpha^2.$$

Case 2: $0.59575 < \gamma < 1$

$$S_i^{CU} = \frac{(1+\gamma)^2(88+528\gamma+1062\gamma^2+618\gamma^3-367\gamma^4-296\gamma^5+95\gamma^6)}{2(1+2\gamma)(12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4)^2}\alpha^2;$$

$$R_i^{CU} = \frac{(4+12\gamma+\gamma^2-14\gamma^3-3\gamma^4)(4+14\gamma+11\gamma^2-6\gamma^3-7\gamma^4)}{(12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4)(12+60\gamma+89\gamma^2+18\gamma^3-33\gamma^4-2\gamma^5)}\alpha^2;$$

$$\Pi_i^{CU} = \frac{2(6+13\gamma-7\gamma^2-17\gamma^3+5\gamma^4)(6+25\gamma+31\gamma^2+7\gamma^3-5\gamma^4)}{(12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4)(12+60\gamma+89\gamma^2+18\gamma^3-33\gamma^4-2\gamma^5)}\alpha^2; \tag{a.6}$$

$$\Pi_C^{CU} = \frac{2(1-\gamma^2)(4+10\gamma+\gamma^2-7\gamma^3)^2}{(1+2\gamma)(12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4)^2}\alpha^2;$$

$$W_i^{CU} = \frac{22+86\gamma+87\gamma^2-14\gamma^3-37\gamma^4}{2(12+60\gamma+89\gamma^2+18\gamma^3-33\gamma^4-2\gamma^5)}\alpha^2; \tag{a.7}$$

$$W_G^{CU} = \frac{296+1984\gamma+4698\gamma^2+3842\gamma^3-1361\gamma^4-3004\gamma^5-116\gamma^6+634\gamma^7-61\gamma^8}{(1+2\gamma)(12+36\gamma+17\gamma^2-16\gamma^3-\gamma^4)^2}\alpha^2.$$

A-4: *Welfare comparison between an FTA and a CU*

For the case of an FTA, we have from equation (a.1) that

$$\frac{\partial W_i^{FTA}}{\partial \delta} < 0. \tag{a.8}$$

For $0 < \delta < \hat{\delta}$, $W_i^{FTA}\big|_{0<\delta<\hat{\delta}} < W_i^{FTA}\big|_{\delta=0}$ where

$$W_i^{FTA}\big|_{\delta=0} = \frac{3(22+86\gamma+97\gamma^2+12\gamma^3-21\gamma^4)}{2(1+2\gamma)(6+9\gamma-\gamma^2)^2}\alpha^2. \tag{a.9}$$

For comparing the case of a CU to that of an FTA, we have from equations (a.5) and (a.9) that

$$W_i^{CU} > W_i^{FTA}\big|_{\delta=0} \text{ when } 0 < \gamma \le 0.59575. \tag{a.10}$$

It follows from equations (a.8) and (a.10) that $W_i^{CU} > W_i^{FTA}\big|_{0<\delta<\hat{\delta}}$ for $0 < \gamma \le 0.59575$.

But when $0.59575 < \gamma < 1,$ we from equations (a.7) and (a.9) that

$$W_i^{CU} > W_i^{FTA}\big|_{\delta=0} . \qquad \text{(a.11)}$$

It follows from equations (a.8) and (a.11) that $W_i^{CU} > W_i^{FTA}\big|_{0<\delta<\hat{\delta}}$ for $0.59575 < \gamma < 1$.

We therefore conclude that social welfare is higher under a CU than under an FTA since $SW_i^{CU} > SW_i^{FTA}$ when $0 < \gamma < 1$ and $0 < \delta < \hat{\delta}$.

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Essay Three

Free Trade Areas, Rules of Origin, and Optimal Tariff Reductions under International Oligopoly: A Welfare Analysis

1. Introduction

Despite a dramatic proliferation of regional trade agreements in recent decades (World Bank, 2005), there have been considerable concerns about the use of Rules of Origin (ROO) in Free Trade Areas/Arrangements (FTAs) as trade barriers or hidden protections (Krueger, 1993; Krishna and Krueger, 1995, Krishna, 2006). Specifically, the important and challenging questions posed to economists concern whether ROO provisions in FTAs are "welfare improving" and increase total trade (i.e., trade creation), and whether the extra trade arises at the expense of non-member countries (i.e., trade diversion).[21]

Countries that establish an FTA eliminate tariffs and quotas on goods traded among them, but they do not have a harmonization of trade policies toward non-members. Without ROO in an FTA, however, a member with a lower tariff on a product will benefit from re-exporting the product to other members. Grossman and Helpman (1995) examine, among other things, the effects of FTA with ROO that prevent re-exportation from a lower tariff member to a higher tariff member. Richardson (1995) shows explicitly that there is no Nash equilibrium in setting external tariffs, because all members of an FTA compete to set the lowest tariff with respect to non-members. One important implication of the studies is that for preventing trade deflection, FTA members sign in ROO under which products cannot get *duty-free* access to a partner's market unless their productions contain a minimum extent of intermediate inputs originated from the region.[22] Falvey and Reed (1998) indicate that ROO may be used strategically as policy instruments due to the potential arbitrariness in categorizing the geographical sources of goods produced not in a single location. Falvey and Reed (2002) further show that producers may modify their production processes and input mix in response to content requirements in ROO. In analyzing firm behavior in an FTA with ROO, Ju and Krishna (2002, 2005) show the possibility of regime switches because competing exporters within the FTA may or may not choose to comply with ROO. There is compliance when external tariffs exceed the increased input costs under binding ROO. But when ROO are overly restrictive, exporters of a member country may

[21] The notions of trade creation and trade diversion are due to the seminal work of Viner (1950).

[22] There are several different criteria for ROO provisions in terms of (i) domestic or regional content requirements, (ii) a change in tariff heading, (iii) particular processes that should be performed within an FTA; and (iv) a substantial transformation of a product See, e.g., Krueger (1993), Thoening and Verdier (2004), Cadot, Estavadeoral, Suwa-Eisenmann, and Verdier (2006), and Krishina (2006). The North American Free Trade Agreement (NAFTA), the European Union, and the ASEAN Free Trade Area agreement (AFTA), for example, all contain certain criteria of the ROO provisions which provide preferential treatment for member countries.

simply pay tariffs for their products to be sold to other countries in the FTA. From the social welfare perspective of forming regional trade agreements, Panagariya and Krishna (2002) point out that ROO are required to support the welfare-enhancing FTAs. In her interesting and systematic review, Krishna (2006) further calls for more studies on the economics of ROO in FTAs where markets are characterized by imperfect competition.

There are several important questions that have not yet been systematically examined in the literature on FTAs with preferential ROO. Given that ROO constitute an indispensible component of an FTA and have the potential to be improperly used as barriers to trade, what are countries have economic incentives to join an FTA with ROO? Is there a maximum limit of regional content requirements over which there are welfare gains from trade for all participating members? What are economic variables that determine the extent to which content requirements are capable of inducing voluntary compliance with ROO? Stated alternatively, what are conditions under which there is a successful FTA formation with effective ROO input restrictions without having the possibilities of regime switches? Answers to these questions have policy implications for how potential member countries determine their external tariffs in response to FTA formation and how the optimal tariffs effectively entice firms producing within an FTA to meet ROO. More importantly, government policy makers may wish to know the economic determinants of an acceptable (or enforceable) range of the content ratio.

Based on a stylized three-country model of trade under imperfect competition, this paper attempts to answer the afore-mentioned questions. Assuming that welfare improvement as the common goal of potential member countries in forming an FTA, we find that FTA formation depends on a set of economic variables. These variables include the value of the content ratio, the price difference between a regional input and a cheaper input imported from outside the FTA, the size of the market for the final good in each member country, as well as the structure of the oligopolistic final-good market (in terms of the number of firms producing inside and outside the FTA). We find that each member country's social welfare as a function of the ROO content ratio is *strictly convex*. Although there does not exist a unique optimal solution, the model allows us to identify the maximum extent of ROO input restrictions that potentially participating countries have an economic incentive to accept.[23] This "participation constraint" analysis constitutes the

[23] Unless the establishment of an FTA is politically motivated, which is beyond the scope the present paper, it is plausible to assume that social welfare improvement is the goal of becoming an FTA member. Grossman and

first stage of the three-stage game at which potential member countries decides on establishing a welfare-improving FTA with effective ROO. At the second stage of the game, given an acceptable content ratio, FTA members decide on external tariffs that maximize respective social welfare subject to the condition that their exporting firms comply with ROO. At the third and last stage of the game, given the content ratio and the optimal tariffs, all firms inside and outside the FTA determine output levels that maximize their respective profits. We analyze what effects FTA with effective ROO may have on the production decisions of the inside and outside firms. We further examine the resulting effects on consumer surplus, producer surplus, and social welfare of each member country.

The other key findings of the paper are as follows. First, potential member countries find it optimal to reduce their external tariffs when forming an FTA with ROO. This implies that external tariffs and ROO are *strategic substitutes* in terms of FTA formation. Interestingly, the post-FTA external tariffs increase with the content ratio in order to effectively induce the final-good exporters within the FTA to comply with ROO. The two policy instruments to a certain degree become *strategic complements* in terms of ROO compliance. Second, potential member countries' decisions on FTA formation and external tariff reductions cannot be isolated from their decisions on the implementation of effectively enforceable ROO content requirements. Third, in terms of the final-good trade among FTA members, ROO apparently place restrictions on the final-good exporters located inside the FTA because they are required to use regional intermediate input. But the resulting tariff reductions benefit the final-good exporters outside of the FTA. As indicated by Krishna (2006), relatively higher input costs associated with preferential ROO provisions "look like tariffs on imported intermediate inputs" within an FTA. In contrast to the standard argument in the literature, we find that ROO content restrictions may not have a negative trade-diverting effect on trade in the intermediate input (by exporting firms outside the FTA). Thus, the ambiguous trade-diverting effect on the intermediate-input trade and the positive trade-creating effect on the final-good trade should be taken into account simultaneously when evaluating whether regional trading arrangements exclude non-members

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Helpman (1995) examine the political viability of FTAs when two countries negotiate a free-trade agreement. Based on a political-economy framework, in which industrial interest groups attempt to influence their government, the authors show that a free-trade agreement with ROO can be an equilibrium outcome. For further contributions on FTA formation and interest group politics see, e.g., Krishina (1998), Maggi and Rodríguez-Clare (1998), Mitra (2002) and Ornelas (2005). Duttagupta and Panagariya (2007) further show that preferential trading under ROO can enhance the political viability of FTAs.

from the FTA markets on net. We also find that FTA formation with effective ROO input restrictions makes exporters within the FTA worse off. But consumers in each FTA country are better off. Our simple model has policy implications for FTA members in determining a welfare-enhancing content ratio and optimal external tariffs that eliminate the noncompliance problems with ROO. The model may also help explain economic conditions that foster or hinder the proliferation of regional trade agreements under international oligopoly.

The analysis of FTAs with ROO under oligopoly in this paper complements the contributions by Ju and Krishna (2002, 2005) in examining the complying and non-complying decisions of final-good exporters under regional content regulations. The authors assume that the final-good market is perfectly competitive. Our paper also complements a recent contribution by Ishikawa, Mizoguchi, and Mukunoki (2007). The authors develop a model that examines the welfare effects of FTA with ROO when the final-good producers engage in Bertrand price competition. In our model of Cournot quantity competition in which ROO content restrictions are explicitly spelled out, we further investigate the following: (i) The maximum extent of ROO that generates a welfare improvement for FTA formation; (ii) FTA members' optimal decisions on external tariffs that effectively induce their firms to comply with ROO; and (iii) The potentially important economic factors that affect the incentives for establishing a welfare-enhancing FTA with enforceable ROO, especially the role played by the structure of the oligopolistic final-good market.

The remainder of the paper is organized as follows. In Section 2, we present an analytical framework of international oligopoly to examine the trade regimes before and after the establishment of an FTA, using the pre-FTA equilibrium as the reference base. We analyze the production decisions of the firms inside and outside the FTA for the two alternative regimes. In Section 3, we determine optimal external tariffs for FTA members subject to the constraints that their firms meet ROO. In Section 4, we discuss how the economic incentive of forming an FTA is affected by the structure of the final-good market. We then analyze the range of the content ratio that improves welfare for each FTA member. In Section 5, given the range of the welfare-improving content ratio, we discuss what effects FTA formation and changes in the content ratio have on trade in the final good, on trade in the intermediate input, as well as on consumer and producer surplus in each FTA member. Section 6 contains concluding remarks.

2. The Model Set-Up

2.1 Basic Assumptions and Regional Content Requirements in ROO

To analyze the welfare implications of FTA formation with effective ROO, we employ a simple setting in which there are three countries: A, B, and C.[24] Countries A and B, which are taken to be symmetric in a region, consider the formation of an FTA. Country C represents a country outside of the region. In either country A or B, there are m firms producing a homogeneous final good q by the use of an intermediate input x. To focus primarily on the final-good markets within an FTA, we assume that input markets in countries A and B are characterized by perfect competition.

The price of the regional input in countries A and B is assumed to be higher than that of an intermediate input in country C, with the price difference being equal to $h(>0)$.[25] Denoting country C's input price as h_o, the regional input price is then given as $h_o + h$. We assume that input market in country C (i.e., the rest of the world) is perfectly competitive. Also, in country C there are n firms producing the homogeneous final good q for export to countries A and B.

Prior to the formation of an FTA, countries A and B engage in a two-way trade in the final good, with each country imposing a specific tariff on the good imported from the other country (Brander and Spencer, 1984). Firms located in both countries A and B purchase their intermediate inputs from country C since $h > 0$. After an FTA is formed, trade in the final good q between countries A and B is tariff-free if their exporting firms use a certain proportion of their intermediate inputs originated from the region as specified in ROO provisions. For an inside firm in country $i\ (= A, B)$ that meets ROO, its input component of the final good q to be exported to county $j\ (= A, B, \neq i)$ must satisfy the following condition:

$$\frac{x_{i,r}}{x_{i,r} + x_{i,r}^C} \geq \lambda, \qquad (1)$$

[24] Although the set-up and assumptions may differ, the use of a three-country model to analyze issues on FTA with ROO can be found in several recent studies such as Anson, Cadot, Estevadeordal, de Melo, Suwa-Eisenmann, and Tumurchudur (2005), Ju and Krishna (2005), and Ishikawa, Mizoguchi, and Mukunoki (2007). FTAs may be an arrangement of two or more countries. But the prevailing FTAs are signed between two countries (World Bank, 2005).

[25] The assumption of symmetry between countries A and B implies that the prices of the regional inputs in the two countries are identical.

where λ represents the content ratio $(0 < \lambda \leq 1)$, and $x_{i,r}$ and $x_{i,r}^{C}$ are the amounts of the intermediate inputs that country i's r^{th} firm purchases from the region and country C, respectively.

We adopt the simple production technology for all firms that one unit of input is required to produce one unit of the final good. That is, $q = x$. Since the regional input price is strictly higher than the imported input price, all the inside firms use the least proportion of their inputs from the region that satisfies the content restrictions as specified in equation (1). In this case, if the r^{th} inside firm in country i complies with ROO, its input cost in exporting one unit of the final good to country j becomes $c_{i,r}(\lambda) = \lambda h + h_o$. For analytical simplicity, the price of the imported input is normalized to zero, i.e., $h_o = 0$. It follows that

$$c_{i,r}(\lambda) = \lambda h, \tag{2}$$

which reflects ROO-induced input cost increase for all the inside firms.

Denote $q_{i,r}^{i}$ and $q_{j,r}^{i}$ as the quantities of final good that the r^{th} $(=1,...,m)$ firm in country i $(= A, B)$ sells to its domestic market and to country j $(= A, B, \neq i)$, respectively. Also, let $q_{i,k}^{C}$ represent the quantity of final good that the k^{th} $(=1,...,n)$ firm in country C exports to country i. Denoting Q_i as the overall consumption of the final good in country i, we have $Q_i = \sum_{r=1}^{m} q_{i,r}^{i} + \sum_{s=1}^{m} q_{i,s}^{j} + \sum_{k=1}^{n} q_{i,k}^{C}$, where $\sum_{r=1}^{m} q_{i,r}^{i}$ is the amount purchased from the domestic firms, $\sum_{s=1}^{m} q_{i,s}^{j}$ is the amount imported from a member country, and $\sum_{k=1}^{n} q_{i,k}^{C}$ is the amount imported from outside the FTA. The (inverse) market demand for the final good in country i is taken to be linear:

$$p_i = \alpha - \beta Q_i, \tag{3}$$

where $\alpha > 0$ and $\beta > 0$. The parameter α can be used to reflect the size of the final-good market in a potential member country. We also assume that all the inside and outside firms adopt a Cournot strategy in their production decisions.

Despite the formation of an FTA between countries A and B, final-good exporters within the FTA may or may not choose to comply with ROO (Ju and Krishna, 2005). Whether an inside firm in country *j* decides to meet ROO depends crucially on (i) import tariff set by the member country *i*, t_i, and (ii) the ROO-induced input cost increase, λh, in the exportation of the final good.[26] For each unit of the final good to be exported by a firm in country j to the market in country i within the FTA, if the specific tariff exceeds the input cost increase such that

$$t_i > \lambda h, \tag{4}$$

it is to the benefit of the firm to comply with ROO. Thus, for the efficacy of the ROO provisions, member countries should set their external tariff rates above the ROO-induced input cost increase (λh). Equations (4) thus define the ROO-complying condition under which each inside firm is induced to meet ROO. Accordingly, profit functions of the r^{th} firm in country i for the two alternative trade regimes are as follows:[27]

(i) $\pi_{i,r} = p_i q^i_{i,r} + (p_j - \lambda h) q^i_{j,r}$ after forming an FTA with effective ROO; (5a)

(ii) $\pi_{i,r} = p_i q^i_{i,r} + (p_j - t_j) q^i_{j,r}$ prior to the FTA formation. (5b)

In the above two equations, the first term is profit from domestic sales while the second term is export profit from serving the market in a potential member country. Note that ROO are applicable to exporters within the FTA. As such, the production of the final good $(q^i_{i,r})$ by each inside firm for sales in its domestic market is *not* subject to the ROO content requirements in equation (1).

As for the profit function of the k^{th} firm in country C, it is given as

$$\pi_k{}^C = (p_A - t_A) q^C_{A,k} + (p_B - t_B) q^C_{B,k}, \tag{6}$$

In what follows, we first examine the post-FTA regime with effective ROO in a three-stage Nash game of trade under oligopoly. In stage one both countries *A* and *B* identify the acceptable range of a welfare-improving content ratio. In stage two the FTA countries independently and simultaneously determine optimal external tariffs that maximize their individual welfare subject to the ROO-complying condition (see equation (4)), given a content ratio. In stage three each inside firm determines the amounts of the final good for domestic sales

[26] The result of a higher input cost is in accordance with Krishina (2006, p. 21) who indicates that "RoO can also "provide an incentive for regional producers to buy intermediate goods from regional sources, even if their prices are higher than those of the identical import from outside the FTA, in order to make their product originate in the FTA and qualify for preferential treatment."

[27] As in Ju and Krishna (2002, 2005), Mukunoki (2004), and Ishikawa, Mizoguchi, and Mukunoki (2007), we assume that transportation costs are relatively small or zero and hence can be ignored for analytical simplicity.

and for export to a member country's market in order to maximize its own profit, given the content ratio and tariffs. Also, each outside firm decides on its final-good exports to the FTA markets.

We then examine the pre-FTA regime, the equilibrium of which is used as the benchmark to evaluate the FTA equilibrium with effective ROO. For the pre-FTA regime, there involves a two-stage Nash game of trade under oligopoly. In stage one both countries A and B independently and simultaneously determine optimal tariff rates that maximize their respective social welfare. In stage two, all the firms in the three-country world independently and simultaneously decide on their outputs that maximize individual profits, given the optimal tariffs.

2.2 Nash Equilibrium Outputs of the Inside and Outside Firms

As standard in game theory, we use backward induction to solve for the sub-game perfect Nash equilibrium of the two alternative trade regimes as follows:

(i) Post-FTA with effective ROO

For the post-FTA regime, we first determine the quantities of the final good produced by the inside and outside firms (under the conditions that the content ratio and optimal tariffs are given). The problem facing an inside firm in member country $i(=A,B)$ is to determine the quantities of the final good to be sold in its domestic market and in the member county $j\ (=A,B,\neq i)$, $\{q_{i,r}^{i}, q_{j,r}^{i}\}$, that maximize the firm's profit function in (5a), subject to the ROO content requirements in equation (1) and the market demand in equation (4). The first-order conditions (FOCs) are given, respectively, as

$$\alpha-\beta(\sum_{r=1}^{m}q_{i,r}^{i}+\sum_{s=1}^{m}q_{i,s}^{j}+\sum_{k=1}^{n}q_{i,k}^{C})-\beta q_{i,r}^{i}=0; \tag{7a}$$

$$\alpha-\beta(\sum_{r=1}^{m}q_{i,r}^{i}+\sum_{s=1}^{m}q_{i,s}^{j}+\sum_{k=1}^{n}q_{i,k}^{C})-\lambda h-\beta q_{j,r}^{i}=0. \tag{7b}$$

The assumption of symmetry implies that the quantities of the final good produced by m firms in country i for their domestic market are identical. That is, $q_{i,r}^{i}=q_{i}^{i}$ for $r=1,...,m.$ Similarly, for the final good exported to the other member country's market, we have $q_{i,s}^{j}=q_{i}^{j}$ for $s=1,...,m.$

The objective of the k^{th}, $(k=1,...,n),$ outside firm in country C is to determine the quantities of the final good, $\{q^C_{A,k}, q^C_{B,k}\}$, to be exported to the FTA markets that maximize the firm's profit π^C in equation (6) subject to the market demand in equation (4). The FOCs are given, respectively, as

$$\alpha - \beta(\sum_{r=1}^{m} q^i_{i,r} + \sum_{s=1}^{m} q^j_{i,s} + \sum_{k=1}^{n} q^C_{i,k}) - t_A - \beta q^C_{A,k} = 0; \tag{8a}$$

$$\alpha - \beta(\sum_{r=1}^{m} q^i_{i,r} + \sum_{s=1}^{m} q^j_{i,s} + \sum_{k=1}^{n} q^C_{i,k}) - t_B - \beta q^C_{B,k} = 0. \tag{8b}$$

The assumption of symmetry of firms in country C implies that $q^C_{i,k} = q^C_i$ for $k = 1,...,n.$ Using the FOCs in equations (7) and (8), we solve for the Nash equilibrium levels of the final good produced by the inside and outside firms are:

$$\tilde{q}^i_i = \frac{\alpha + nt_i + m\lambda h}{\beta(1+2m+n)};\ \tilde{q}^j_i = \frac{\alpha + nt_i - (1+m+n)\lambda h}{\beta(1+2m+n)};\ \tilde{q}^C_i = \frac{\alpha - (1+2m)t_i + m\lambda h}{\beta(1+2m+n)}. \tag{9(a-c)}$$

The equilibrium price and consumption of the final good in each member country are:

$$\tilde{p}_i = \frac{\alpha + nt_i + m\lambda h}{1+2m+n};\quad \tilde{Q}_i = \frac{\alpha(2m+n) - nt_i - m\lambda h}{\beta(1+2m+n)}. \tag{10(a-b)}$$

(ii) Pre-FTA

Next, we discuss the benchmark case of the Pre-FTA regime for the three-country world. In this case, the final-good producers in countries A and B purchase their intermediate inputs from country C because of a relatively lower input price there. Under the same assumptions of a linear demand and constant marginal costs, we calculate the Nash equilibrium levels of the final good produced by the firms in the three countries as follows:

$$\overline{q}^i_i = \frac{\alpha + (m+n)t_i}{\beta(1+2m+n)};\ \overline{q}^j_i = \frac{\alpha - (m+1)t_i}{\beta(1+2m+n)};\ \overline{q}^C_i = \frac{\alpha - (1+m)t_i}{\beta(1+2m+n)}; \tag{11(a-c)}$$

The equilibrium price and total consumption of the final good in countries A and B are:

$$\overline{p}_i = \frac{\alpha + (m+n)t_i}{1+2m+n};\ \overline{Q}_i = \frac{\alpha(2m+n) - (m+n)t_i}{\beta(1+2m+n)}. \tag{12(a-b)}$$

3. Optimal External Tariffs (Subject to Full Compliance with ROO)

We now proceed to the second stage of the game at which potential member countries independently determine their optimal external tariffs on final-good imports for the two alternative regimes. We assume that each of the countries adopts a Cournot strategy in choosing an external tariff rate that maximizes its own social welfare. Using the equilibrium external tariffs, we then derive the condition under which firms producing within the FTA choose to meet ROO. As in the trade literature, we define social welfare as the sum of consumer surplus, producer surplus, and tariff revenue.

(i) Post-FTA

We first calculate the optimal external tariff set by the government of each FTA member. Under the assumption that market demand is linear (see equation (4)), post-FTA consumer surplus in member country $i(=A,B)$ is:

$$\tilde{S}_i = \frac{(\alpha - \tilde{p}_i)\tilde{Q}_i}{2} = \frac{(\alpha - \tilde{p}_i)^2}{2\beta}, \tag{13}$$

where the Nash equilibrium price of the final good is given in (10(a)). A member country's producer surplus is the sum of firm profits from its domestic market and from exports. Using the profit function of each inside firm in equation (5a), country i's post-FTA producer surplus is:

$$\tilde{\Pi}_i = m\tilde{\pi}_i = m[\tilde{p}_i\tilde{q}_i^i + (\tilde{p}_j - \lambda h)\tilde{q}_j^i] = m\beta[(\tilde{q}_i^i)^2 + (\tilde{q}_j^i)^2], \tag{14}$$

where $\tilde{q}_i^i$ and $\tilde{q}_j^i$ are the firm's domestic sales and exports of the final good as given in equations (9a) and (9b). In the presence of FTA formation with effective ROO, each member country charges a specific tariff only on the final-good imports from country *C*. Country *i*'s tariff revenue then is:

$$\tilde{R}_i = t_i(n\tilde{q}_i^C). \tag{15}$$

It follows from equations (13)-(15) that each member country's social welfare is given as follows:

$$\tilde{W}_i = \frac{(\alpha - \tilde{p}_i)^2}{2\beta} + m\beta[(\tilde{q}_i^i)^2 + (\tilde{q}_j^i)^2] + t_i n\tilde{q}_i^C. \tag{16}$$

Note that when the input cost increase (λh) is strictly less than the specific tariff (t_i), all the inside firms find it beneficial to comply with ROO. To make the ROO enforceable, each member country's government sets its tariff at a level higher than the input cost increase. The objective of member country i is to choose its optimal tariff that maximizes $\tilde{W}_i$ in equation (16) subject to the constraint that inside firms comply with the ROO (i.e., $t_i > \lambda h$ in equation (4)).

Depending on the value of λ, we have two possible solutions as illustrated in Lemma 1.

LEMMA 1. *In the three-country model of trade under oligopoly, the optimal external tariffs* $(\tilde{t}_i)$ *for FTA members to induce full compliance with ROO depends crucially on the value of the content ratio. There are two possibilities:*

(i) $\tilde{t}_i = \dfrac{\alpha(1+2m)+m(2+4m+n)\lambda h}{(1+2m)(2+4m+n)}$ *when* $0 < \lambda < \hat{\lambda}$,

where $\hat{\lambda} = \dfrac{(2m+1)}{(m+1)(4m+n+2)}\dfrac{\alpha}{h}$; (17)

(ii) $\tilde{t}_i = \lambda h + \zeta_i$ when $\hat{\lambda} \le \lambda \le \dfrac{\alpha}{(m+1)h}$,

where ζ_i *is a positive infinitesimal number.*[28]

(18)

PROOF: See Appendix A-1. ■

It is straightforward to verify from equations (17) and (18) that $\tilde{t}_i > \lambda h$ and $\partial \tilde{t}_i / \partial \lambda > 0$. We thus have Lemma 2:

LEMMA 2: *Over the effectively enforceable range of the ROO content requirements in an FTA, the optimal external tariffs and the content ratio are positively related.*

The finding in Lemma 2 has an interesting policy implication. External tariffs and regional input restrictions are fundamentally strategic complements, viewed from the perspective of effectively inducing firms producing within the FTA to comply with ROO.

(ii) Pre-FTA

Prior to the FTA formation, a potential member country's external tariff applies to all imports of the final good, regardless of where they are imported. Under the same demand

[28] We rule out the case that $\lambda > \alpha / [(m+1)h]$ because the quantities of the final good produced by the outside firms in country *C* are negative. Also, when the content ratio is "significantly high," there does not exist an interior solution for the optimal tariff.

condition (see equation (4)), country i's consumer surplus is given as $\overline{S}_i = (\alpha - \overline{p}_i)^2 / 2\beta$, where $i = A, B$ and $\overline{p}_i$ is the pre-FTA market price of the final good (see question 12(a)). Producer surplus, which is the sum of firm profits from the domestic market and the market in a member country, is $\overline{\Pi}_i = m\beta[(\overline{q}_i^i)^2 + (\overline{q}_j^i)^2]$, where $\overline{q}_i^i$ and $\overline{q}_j^i$ are given in equations 11(a) and 11(b). As for the total tariff revenue collected by i, it is the sum of tariff incomes from country j and country C. That is, $\overline{R}_i = t_i(m\overline{q}_i^j + n\overline{q}_i^C)$, where $\overline{q}_i^j$ and $\overline{q}_i^C$ are the quantities of the final-good imports as given in equations 11(b) and 11(c).

It follows that the pre-FTA welfare for a potential member country i is:

$$\overline{W}_i = \frac{(\alpha - \overline{p}_i)^2}{2\alpha} + m\beta[(\overline{q}_i^i)^2 + (\overline{q}_j^i)^2] + t_i(n\overline{q}_i^C + m\overline{q}_i^j), \tag{19}$$

Setting the first-order derivative of $\overline{W}_i$ with respect to t_i to zero, we solve for country i's pre-FTA optimal tariff:

$$\overline{t}_i = \frac{\alpha(2m+1)}{2m^2 + 5m + n + 2}. \tag{20}$$

The strict concavity of $\overline{W}_i$ on t_i implies that the interior solution for the pre-FTA tariff is unique.

Based on the pre-FTA welfare and tariff, our next step is to analyze the welfare implications of an FTA over the enforceable range of the content ratio.

4. The Maximum Extent of the Welfare-Enhancing ROO in an FTA

Unless the formation of an FTA is based on noneconomic or political objectives, it is plausible to assume that FTA partners are willing to sign in ROO provisions that are capable of improving their social welfare. Given that ROO are imperative in an FTA and may constitute as protective devices, the issue then is the maximum extent of regional content requirements that guarantees welfare gains from trade for all the participating members. To deal with this issue, we evaluate the post-FTA welfare for each member, using its pre-FTA welfare as the reference base. We then derive the conditions under which there are gains from trade for the FTA, as well as voluntary compliance with ROO input restrictions.

Recall Lemma 1 that for $0 < \lambda \le \alpha / [(m+1)h]$, the ROO-complying condition (i.e., equation (4)) can be satisfied when the optimal external tariff is $\tilde{t}_i$ (see equation (17)). To calculate each member country's post-FTA welfare, we first substitute $\tilde{t}_i$ into the output and price equations in (9) and (10), and then substitute the resulting equilibrium outputs and price into $\tilde{W}_i$ in equation (16) to obtain

$$\tilde{W}_i = \begin{cases} \dfrac{\alpha^2(16m^2+8mn+16m+n^2+2n)}{2\beta(4m+n+2)^2} - \dfrac{8\alpha m(m+1)\lambda h}{2\beta(2m+1)(4m+n+2)} \\ +\dfrac{m(4m^2+5m+2)\lambda^2 h^2}{2\beta(2m+1)^2} \text{ if } 0<\lambda<\hat{\lambda}; \\ \\ \dfrac{\alpha^2(4m^2+4mn+4m+n^2)}{2\beta(2m+n+1)^2} + \dfrac{2\alpha(n-2m)(m+1)\lambda h}{2\beta(2m+n+1)^2} \\ +\dfrac{(4m^3+5m-4mn+2m-n^2-2n)\lambda^2 h^2}{2\beta(2m+n+1)^2} + \eta_i \text{ if } \hat{\lambda} \le \lambda \le \dfrac{\alpha}{(m+1)h}; \end{cases} \tag{21}$$

where η_i is an infinitesimal number since

$$\eta_i = 2n\varsigma_i[(1+m)\alpha + (m+1)(4m+n+2)h\lambda] + n\varsigma_i^2(2m+1)(4m+n+2)$$
$$-4mn\varsigma_j(\alpha - h\lambda - mh\lambda) - 2mn^2\varsigma_j^2.$$

Next, we calculate the pre-FTA welfare for each potential member country. We first substitute $\bar{t}$ in equation (20) back into the output and price equations in (11) and (12), and then substitute the resulting equilibrium outputs and price into $\bar{W}_i$ in equation (19) to obtain

$$\bar{W}_i = \frac{\alpha^2(4m^4+20m^3+4m^2n+29m^2+10mn+12m+n^2+2n)}{2\beta(2m^2+5m+n+2)^2}. \tag{22}$$

In what follows, we compare $\tilde{W}_i$ with $\bar{W}_i$ in order to determine the conditions under which there is a welfare improvement for FTA with effective ROO.

One question we need to answer is: Is there a welfare gain to each FTA member when the content ratio λ is set at a value that satisfies the following condition: $\hat{\lambda} \le \lambda \le \alpha/[(m+1)h]$? The answer is negative because in this case each member's post-FTA welfare is strictly lower than its pre-FTA level.[29] We therefore rule out this case and consider the range of the content ratio: $0<\lambda<\hat{\lambda}$. Interestingly, the welfare function in (21) is strictly convex on λ as illustrated by the following second-order derivative:

[29] See Appendix A-2 for detailed derivations.

$$\frac{\partial^2 \tilde{W}_i}{\partial \lambda^2} = \frac{m(4m^2+5m+2)h^2}{\beta(2m+1)^2} > 0.$$

To calculate the critical value of the content ratio that a potentially participating country finds it indifferent between forming or not forming an FTA with ROO, we solve $\tilde{W}_i = \overline{W}_i$ and obtain the following solution:

$$\lambda_L^W = \frac{(2m+1)[4(m+1)(2m^2+5m+n+2)-\sqrt{\Omega}]}{(5m+4m^2+2)(18m+4n+2m^2n+9mn+24m^2+8m^3+n^2+4)}\frac{\alpha}{h}, \tag{23a}$$

where

$$\begin{aligned}\Omega = (&2108m+16n+10mn^2+125m^2n+112m^3n+68m^4n+16m^5n+10m^2n^2 \\ &+8m^3n^2+74mn+282m^2+368m^3+272m^4+4n^2+128m^5+32m^6+16) > 0.\end{aligned} \tag{23b}$$

It is easy to very that λ_L^W is strictly less than $\hat{\lambda}$, which implies that λ_L^W is the maximum limit of the welfare-improving content ratio. Moreover, we have

$$\frac{\partial \tilde{W}_i}{\partial \lambda} < 0 \text{ for } \lambda < \lambda_L^W < \hat{\lambda}. \tag{23c}$$

Given the strict convexity of the welfare function, we establish the first proposition as follows:

PROPOSITION 1: *In the three-country model of international oligopoly, each member country's post-FTA welfare is strictly greater than its pre-FTA welfare, i.e.,* $\tilde{W}_i > \overline{W}_i$, *when the ROO content ratio falls into the effectively enforceable region:* $\lambda < \lambda_L^W < \hat{\lambda}$. *There are three possibilities:*

(i) If $\lambda_L^W > 1$, *the range of the welfare-improving content ratio is* $(0,1]$;

(ii) If $0 < \lambda_L^W < 1$, *the range of the welfare-improving content ratio is* $(0, \lambda_L^W)$ *and this range increases as* α/h *increases;*

(iii) But if $\lambda_L^W < 0$, *there exists no content ratio that improves social welfare.*

PROOF: See Appendix A-3. ■

The maximum limit of the welfare-improving contain ratio in an FTA under international oligopoly has not been identified in the existing literature. Furthermore, λ_L^W in equation (23a) indicates an interesting relationship between the structure of the oligopolistic final-good market in each member country (in terms of m and n) and the formation of a welfare-improving FTA with ROO. Figure 1 illustrates a graphical interpretation of the relationship. The L-shape curve satisfies the condition that $4(m+1)(2m^2+5m+n+2)=\sqrt{\Omega}$. For (m,n) such that $4(m+1)(2m^2+5m+n+2)>\sqrt{\Omega}$, we have $\lambda_L^W>0$ in Area I which is lying below the curve. Area I thus shows the structure of the final-good market that is consistent with both the ROO-complying condition and the welfare-improving condition for the FTA members. This analysis allows us to establish

PROPOSITION 2. *If the structure of the final-good market, captured by* (m,n)*, is such that*

$$4(m+1)(2m^2+5m+n+2)\le\sqrt{\Omega}, \qquad (24)$$

where Ω *is given in equation (23b), the welfare-improving condition is violated because* $\lambda_L^W<0$*. In this case, FTA formation with ROO is welfare deteriorating. But if the market structure is such that*

$$4(m+1)(2m^2+5m+n+2)>\sqrt{\Omega}, \qquad (25)$$

the welfare-improving condition is satisfied because $\lambda_L^W>0$*. In this case, FTA formation with ROO is welfare improving. Nevertheless, due to the strict convexity of the welfare function on* $\lambda\in(0,\min(1,\lambda_L^W))$*, each member country's post-FTA welfare increases as the content ratio decreases. That is,* $\partial\tilde{W}_i/\partial\lambda<0$ for $\lambda<\lambda_L^W<\hat{\lambda}$.

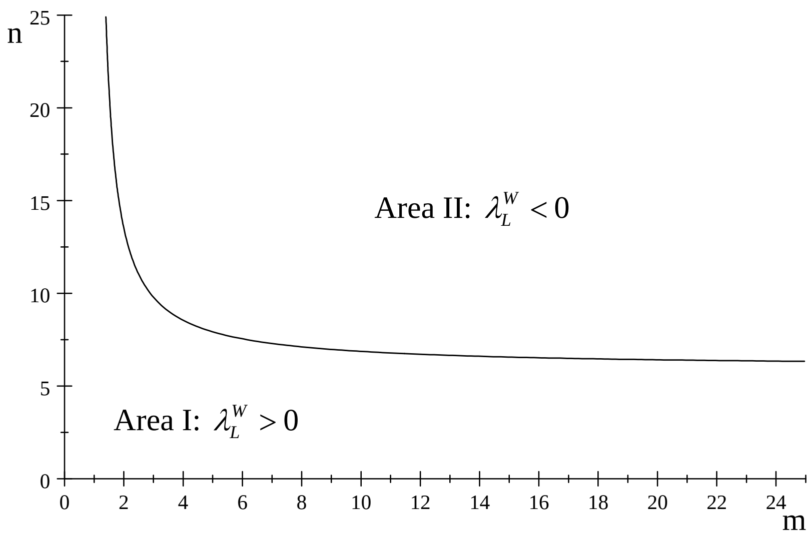

Figure 1. *Market structure of the final good and the welfare-improving content ratio*

The findings in Proposition 1 imply that an FTA with ROO is always welfare enhancing for the special case where $m = n = 1$, an assumption frequently adopted in models of strategic trade policies under imperfect competition. Our analysis further implies that different market structures of final goods play a role in affecting whether there is a welfare improvement from trade for FTA with ROO.

5. Economic Implications of the Model

5.1 Economic Effects of FTA Formation

Having identified the maximum limit of content requirements that not only induces final-good producers to meet ROO but also generates welfare gains for all participating countries, we proceed to analyze economic implications of forming an FTA.

First, FTA formation with ROO apparently affects the optimal decisions of member countries on their external tariffs to non-member countries. A comparison between $\tilde{t}_i$ in (17) and $\overline{t_i}$ in (20) reveals that[30]

$$\tilde{t}_i < \overline{t_i} \text{ for } 0 < \lambda < \lambda_L^W < \hat{\lambda}. \tag{26}$$

This indicates that, for any welfare-improving content ratio that induces ROO compliance, the post-FTA external tariffs are lower than the pre-FTA external tariffs. Interestingly, the extent to which the external tariffs are reduced, defined as $\Delta t_i = \overline{t_i} - \tilde{t}_i$, depends crucially on the value of the content ratio, the increase in production costs of using the FTA-made input under ROO, and the size of the final-good market in each member country. Form equations (17) and (20), it follows that

$$\frac{\partial(\Delta t_i)}{\partial \lambda} < 0, \ \frac{\partial(\Delta t_i)}{\partial h} < 0, \text{ and } \frac{\partial(\Delta t_i)}{\partial \alpha} > 0. \tag{27}$$

The results in equations (26) and (27) lead to the following proposition:

PROPOSITION 3. *In the three-country model of trade under imperfect competition,*

[30] See Appendix A-4 for detailed derivations.

(i) After the formation of an FTA with ROO, each member country lowers its external tariff on the final-good imports, as compared its pre-FTA tariff. For a full compliance with ROO, the post-FTA external tariff remains to be higher than the increase in the unit cost of using the FTA-made input.

(ii) Other thing being equal, the resulting reduction in the external tariff is greater as the content ratio decreases over its welfare-improving range. Moreover, the lower the ROO-induced input cost increase or the larger the market size of the final good in each member country, the greater the reduction in the external tariff.

The findings in Proposition 3 have policy implications. The post-FTA tariffs are systematically lower than the pre-FTA tariffs in response to the FTA formation. Additionally, there is voluntary compliance with FTA content regulations because the ROO-induced input cost increase is strictly lower than the post-FTA tariff. Our analysis thus rules out the possibilities of regime switches in an FTA with ROO as discussed by Ju and Krishna (2002, 2005).

Next, we examine what effects FTA formation have on the production decisions of all the inside and outside firms, total consumption and market price of the final good, consumer surplus, producer surplus, as well as the aggregate volumes of trade in both the final good and the intermediate input. By substituting the optimal external tariff $\tilde{t}_i$ (under the condition that $0 < \lambda < \lambda_L^W$) from (17) into equations (9), (10), (13) and (14), we obtain the sub-game perfect Nash equilibrium quantities of the final good produced by the inside and outside firms as follows:

$$\tilde{q}_i^i = \frac{2\alpha}{\beta(2+4m+n)} + \frac{m\lambda h}{\beta(1+2m)};\ \tilde{q}_i^j = \frac{2\alpha}{\beta(2+4m+n)} - \frac{(m+1)\lambda h}{\beta(1+2m)};\ \tilde{q}_i^c = \frac{\alpha}{\beta(2+4m+n)}. \quad (28a)$$

The equilibrium price and consumption of the final good in each member country are:

$$\tilde{p}_i = \frac{2\alpha}{2+4m+n} + \frac{m\lambda h}{1+2m} \text{ and } \tilde{Q}_i = \frac{(4m+n)\alpha}{\beta(4m+n+2)} - \frac{m\lambda h}{\beta(2m+1)}; \quad (28b)$$

and the consumer and producer surplus are:

$$\tilde{S}_i = \frac{\left[(2m+1)(4m+n)\alpha - (2+4m+n)m\lambda h\right]^2}{2\beta(2m+1)^2(4m+n+2)^2}; \quad (28c)$$

$$\tilde{\Pi}_i = \frac{m}{\beta}\left[\frac{8\alpha^2}{(4m+n+2)^2} - \frac{4\alpha\lambda h}{(2m+1)(4m+n+2)} + \frac{(2m^2+2m+1)\lambda^2 h^2}{(2m+1)^2}\right]. \tag{28d}$$

Despite the binding ROO in an FTA, the final good ($\tilde{q}_i^i$) produced by an inside firm for its own domestic market is *not* subject to the regional content requirements. As the imported intermediate input is relatively cheaper, this part of the final-good production for own domestic consumption uses entirely the imported input from country *C*. In producing the final good ($\tilde{q}_j^i$) for export to another member country within the FTA, an inside firm that complies with ROO uses $\lambda\tilde{q}_j^i$ amount of the more expensive FTA-made input and $(1-\lambda)\tilde{q}_j^i$ amount of the imported input. As a result, the total amount of the intermediate input imported by all the inside firms is given as

$$\tilde{X} = 2m\left[\tilde{q}_i^i + (1-\lambda)\tilde{q}_j^i\right] = \frac{8m\alpha}{\beta(4m+n+2)} - \left[\frac{4\alpha}{\beta(4m+n+2)} + \frac{2h}{\beta(2m+1)}\right]m\lambda + \frac{2mh}{\beta}\lambda^2. \tag{29}$$

For calculating the equilibrium solution to the pre-FTA regime, which serves as the benchmark case, we substitute the optimal tariff $\bar{t}_i$ from (20) into equations (11) and (12) to derive the following:

$$\bar{q}_i^i = \frac{2\alpha(m+1)}{\beta(2m^2+5m+n+2)};\ \ \bar{q}_i^j = \frac{\alpha}{\beta(2m^2+5m+n+2)};\ \ \bar{q}_i^C = \frac{\alpha}{\beta(2m^2+5m+n+2)};$$

$$\bar{p}_i = \frac{2\alpha(m+1)}{2m^2+5m+n+2};\ \ \bar{Q}_i = \frac{\alpha(2m^2+3m+n)}{\beta(2m^2+5m+n+2)};$$

Consumer and producer surplus of country $i (i = A, B)$ are

$$\bar{S}_i = \frac{\alpha^2(2m^2+3m+n)^2}{2\beta(2m^2+5m+n+2)^2};\ \ \bar{\Pi}_i = \frac{\alpha^2 m(4m^2+8m+5)}{\beta(2m^2+5m+n+2)^2}. \tag{30}$$

In the pre-FTA equilibrium, the final-good firms in countries *A* and *B* import their inputs completely from country *C* due to a relatively lower price there. That is,

$$\bar{X} = 2m(\bar{q}_i^i + \bar{q}_i^j) = \frac{2m(2m+3)\alpha}{\beta(2m^2+5m+n+2)}. \tag{31}$$

It comes as no surprise that each inside firm sells less of the final good to its own domestic market after the FTA is formed. That is,

$$\tilde{q}_i^i < \overline{q}_i^i .$$

As shown in Appendix A-5, we have

PROPOSITION 4. *After the formation of an FTA with effective ROO, the equilibrium quantity of the final good sold by an inside firm to its domestic market decreases and the final good's equilibrium price decreases. Each inside firm's profit from serving its own domestic market decreases. Because the final good's market price decreases, total consumption of the good in each member country increases. Consequently, consumers within the FTA are better off.*

Furthermore, we show in Appendix A-6 that

$$\tilde{q}_i^j > \overline{q}_i^j ,\ \ \tilde{q}_i^C > \overline{q}_i^C ,\ \text{and}\ \tilde{\pi}_C > \overline{\pi}_C . \tag{32}$$

Thus, each firm in a member country increases its final-good exports to another country within the FTA. Also, each firm producing outside the FTA increases its final-good exports to the FTA markets and hence its export profit increases. These results lead to the following proposition:

PROPOSITION 5. *After the formation of an FTA with effective ROO, two-way trade in the final good between the FTA members increases. Exports into the FTA of the final good from a non-member country also increase. As a consequence, the total volume of the final-good trade for all the exporting firms inside and outside the FTA unambiguously increases. Moreover, there is an increase in the profits of the outside firms that export the final good to the FTA markets.*

Although a successful FTA may has a positive trade-creating effect within its region, a considerable concern is that there may involve a negative trade-diverting effect from the more efficient outside firms to the less efficient inside firms. In our model, the negative effect of trade diversion occurs not in the final-good sector. Outside firms are able to increase their final-good exports to the FTA markets due to tariff reductions induced by the FTA formation. The question then is the potential negative effect on trade in the intermediate input. To answer this question, we compare $\tilde{X}$ in equation (29) to $\overline{X}$ in equation (31) for $0 < \lambda < \lambda_L^W$. As shown in Appendix A-7, we find that

$$\tilde{X} < \overline{X} \ \text{if}\ \ (4m + n - 2mn + 2) < 0. \tag{33}$$

If $(4m + n - 2mn + 2) > 0,$ however, the effect of FTA formation with ROO on the intermediate-input trade is indeterminate. This effect is shown to depend on the size and structure of the final-good market, as well as the increase in production cost of using a more expensive regional input. We thus have

PROPOSITION 6. *(i) FTA formation with effective ROO lowers the total volume of the intermediate-input trade when the structure of the oligopolistic final-good market is such that* $(4m+n-2mn+2)<0.$ *(ii) But when* $(4m+n-2mn+2)>0,$ *the formation of an FTA with effective ROO has an ambiguous effect on trade in the intermediate input.*

As we have analyzed above, after establishing an FTA with effective ROO, each firm's profit is lower in its own domestic market but is higher from serving the market in a member country. The issue then is how the FTA affects the profitability of the inside firms. For any content ratio that satisfies $0<\lambda<\hat{\lambda},$ we show in Appendix A-8 that $\tilde{\pi}_i < \overline{\pi}_i$. We therefore have

PROPOSITION 7. *FTA formation with effective ROO makes the firms producing within the FTA worse off. Nevertheless, each member country's producer surplus increases as the content ratio decreases, ceteris paribus.*

The finding in Proposition 7 stands in contrast with the result shown by Ju and Krishna (2005) that firms producing within an FTA gains from the FTA with ROO. The difference lies in the assumptions. In the three-country model of Ju and Krishna (2005), the potential member countries do not engage in trade prior to the establishment of an FTA. The FTA allows market access since firms producing within the region are able to sell their final goods to the markets in member countries. The other difference is that Ju and Krishna analyze the small-country case in which all markets are perfectly competitive. In the three-country model we consider, the potential member countries engage in two-way trade with import tariffs priori to establishing an FTA. There is a duty-free access when firms producing within the FTA meet ROO. Also, we assume that the final-good markets are characterized by international oligopoly.

The finding of Proposition 7 is consistent with an interesting result in Ishikawa, Mizoguchi, and Mukunoki (2007), although the underlying reasons differ. In their price-competition model of differentiated goods produced by an inside firm and an outside firm, the authors show the possibility that the inside firm complies with ROO but loses from the ROO. This outcome arises because, when complying with ROO, the inside firm loses its market power in practicing price discrimination across the final-good markets. In our three-country model of international oligopoly with a homogeneous final good, inside firms lose because external tariff reductions cause by the FTA formation significantly lower the good's market price.

5.2 The Comparative Statics of the Content Ratio

Finally, we examine economic effects of changes in the content ratio. We have from equations (28a)-(28d) the following derivatives (see Appendix A-9):

$$\frac{\partial \tilde{q}_i^i}{\partial \lambda} > 0, \ \frac{\partial \tilde{q}_i^j}{\partial \lambda} < 0, \ \frac{\partial \tilde{q}_i^C}{\partial \lambda} = 0, \ \frac{\partial \tilde{Q}_i}{\partial \lambda} < 0, \ \frac{\partial \tilde{p}_i}{\partial \lambda} > 0, \ \frac{\partial \tilde{S}_i}{\partial \lambda} < 0, \ \frac{\partial \tilde{\Pi}_i}{\partial \lambda} < 0, \text{ and } \frac{\partial \tilde{X}}{\partial \lambda} < 0,$$

where the content ratio satisfies the welfare-improving condition, $0 < \lambda < \lambda_L^W$. It follows that a decrease in the content ratio lowers the domestic sales of the final good by each inside firm, but increases its final-good exports to the market in a member country. Interestingly, exports of the final good from country *C* to the FTA are independent of the content ratio. This can be explained by the strategic complementarily between the optimal external tariff and the welfare-improving content ratio. A reduction in external tariffs induced by FTA formation has a positive effect on the exports of the final good by the firms producing outside the FTA. This positive effect is offset by the implementation of ROO content requirements, which has a negative effect on the final-good exports of the outside firms.

Under the FTA with effective ROO, each inside firm incurs a higher input cost of serving the final-good market in a member country in order to be qualified for duty-free treatment. Each inside firm's per-unit profit from exports and how this profit is affected by a change in the content ratio are calculated as follows:

$$\tilde{p}_i - \lambda h = \frac{2\alpha}{2+4m+n} - \frac{(m+1)\lambda h}{1+2m} \text{ and } \frac{\partial(\tilde{p}_i - \lambda h)}{\partial \lambda} < 0.$$

With a less stringent content ratio, each inside firm's per-unit profit from exporting the final good to a member's market increases. Given that the profitability of the final-good exports is negatively related to the content ratio, the firms producing within the FTA increase their final-good exports as the content ratio decreases. This explains why $\partial \tilde{q}_i^j / \partial \lambda < 0$. We also find that the increase in the final-good exports by all the inside firms within the FTA exceeds the decrease in their domestic sales. Since the final-good imports from outside of the FTA are not affected by a change in the content ratio, the final good's market price unambiguously decreases. This explains why $\partial \tilde{p}_i / \partial \lambda > 0$. As a consequence, consumers in the FTA benefit from a less stringent

ROO.

Because an inside firm's per-unit profit from its domestic market decreases when the content ratio decreases, the firm sells less of the final good to its own market, $\partial \tilde{q}_i^i / \partial \lambda > 0$. Although a decrease in the content ratio negatively affects each member's domestic sales, this negative effect is dominated by the increase in the two-way trade of the final good within the FTA. As the final good's equilibrium price decreases, each inside firm's profit unambiguously decreases. This explains why $\partial \tilde{\Pi}_i / \partial \lambda < 0$.

It comes as not a surprise that when ROO become less restrictive, the total volume of the final-good trade within the FTA increases. In this case, imports into the FTA of the intermediate unambiguously increases. This explains why $\partial \tilde{X} / \partial \lambda < 0$.

6. Concluding Remarks

It has been widely recognized in the literature that preferential ROO constitute an indispensible part of FTAs for preventing trade deflection and have the potential to be strategically used as protectionist barriers to trade. Nevertheless, relatively little or no research has been conducted to identify explicitly the socially acceptable/enforceable range of ROO content requirements over which there are welfare gains from trade for FTA formation under imperfect competition.[31] This paper presents a three-country, partial equilibrium model of trade under oligopoly to analyze the welfare implications of forming an FTA with effectively enforceable ROO. Specifically, we derive the conditions under which the inside firms obey ROO content requirements and receive duty-free treatment for their exports to member countries

[31] In the theoretical literature on free trade areas/arrangements and strategic trade policies, the welfare effects of ROO content provisions has frequently been ignored due to the complexity of the issues involved. There are some exceptions, including the contributions mentioned in the introduction section of this paper. Another notable exception is the book edited by Cadot et. al. (2006), which contains a collection of recent studies on issues related to ROO. Cadot et al. (2006) indicate that ROO act as trade barriers and become new policy instruments. The authors further contend that the design and implementation of ROO should occupy the central stage in negotiation and functioning of preferential trade agreements.

within an FTA. Although FTA formation benefits consumers at the expense of firms producing within the FTA, each member country's social welfare may increase, depending on a set of economic variables. These variables include the value of the content ratio, the reduction in external tariffs stemming from the FTA formation, the differences in costs between using a regional input and a cheaper input from outside the FTA, each member country's market size of a final good, as well as the structure of the oligopolistic final-good market. These economic variables also affect the maximum limit of the welfare-improving ROO content requirements. We show that potential member countries find it optimal to reduce external tariffs when forming an FTA. External tariffs and ROO are thus strategic substitutes in terms of FTA formation. But the optimal external tariffs increase with the ROO content ratio in order to induce firms producing within the FTA to meet ROO. The two policy instruments to a certain degree become strategic complements in terms of ROO compliance. The findings in our analysis contribute to the recent literature on regional trade agreements, in that it provides new insights on the endogenous determination of external tariffs that generate full compliance with ROO, on the maximum extent of the restrictive ROO content requirements, as well as on the resulting welfare consequences of FTA with effectively enforceable ROO under imperfect competition.

We further discuss issues on trade creation and trade diversion by analyzing whether FTA formation increases total trade or whether the extra trade arises at the expense of non-members. Within the enforceable range of a welfare-enhancing content ratio, the aggregate volume of the final-good exports by all the firms inside and outside the FTA increases. The FTA with effective ROO has a positive effect on the final-good trade. The trade-diverting effect thus does not occur in the final-good sector. Surprisingly, ROO may not have a diverting effect on imports into the FTA of the intermediate input by outside firms, depending upon the value of the content ratio, the increase in the cost of using a more expensive regional input, and the structure of the final-good market.

Some caveats and the potentially interesting extensions of the simple model should be mentioned. Although ROO are considered as an integral part of preferential trade agreements for member countries, their implementation involves administrative and bureaucratic costs, which are completely ignored in our model. One would expect that these costs affect the degree to which the optimal external tariffs are reduced, as well as the likelihood of establishing a successful FTA with effective ROO.[32] A possible extension is to incorporate production differentiation into the oligopolistic model to analyze how the intensity of competition in the final-good markets affects the welfare implications of FTA formation. The positive analysis of ROO in an FTA in the present paper also abstracts from the consideration of possible interactions between interest groups and government. Trade liberalization without preferential treatments may not always be politically feasible, once one looks at how active interest groups may have in lobbying government for protections. As stressed by Krugman (1993), preferential trading arrangements may have to be accepted as the second-best option to liberalize trade before moving toward the first-best economic solutions.

[32] Noting the fact that the NATFA agreement contains up to 200 pages on ROO provisions as an example, Krishna (2006) indicates that ROO might be strategically used. She further points out that documenting ROO is quite expensive for exporting firms so that they may simply pay tariffs instead of going through the more costly documentation.

Appendix

This appendix presents detailed derivations of key findings in the paper.

A-1. Proof of Lemma 1.

The constrained welfare maximization problem is rewritten as follows:

$$\max \tilde{W}_i = \frac{1}{2\beta}(\alpha - \frac{\alpha + nt_i + mh\lambda}{2m+n+1})^2 + m\beta\left[(\frac{\alpha + nt_i + mh\lambda}{\beta(1+2m+n)})^2 + (\frac{\alpha + nt_j - (1+n+m)h\lambda}{\beta(1+2m+n)})^2 \right]$$
$$+ nt_i \frac{\alpha - (1+2m)t_i + mh\lambda}{\beta(1+2m+n)}$$

subject to the constraints that the inside and outside firms produce non-negative levels of the final good. According to equations (4), 9(b) , and 9(c), these constrained conditions are:

$$\alpha + nt_i - (1+n+m)\lambda h \geq 0,\ \ \alpha - (1+2m)t_i + m\lambda h \geq 0,\ \text{and}\ t_i - k\lambda > 0.$$

The Lagrangian function is:

$$= \frac{1}{2\beta}(\alpha - \frac{\alpha + nt_i + mh\lambda}{2m+n+1})^2 + \quad \beta\left[(\frac{\alpha + nt_i + mh\lambda}{\beta(1+2m+n)})^2 + (\frac{\alpha + nt_j - (1+n+m)h\lambda}{\beta(1+2m+n)})^2 \right]$$
$$+ nt_i \frac{\alpha - (1+2m)t_i + mh\lambda}{\beta(1+2m+n)} + \mu_1[\alpha + nt - (1+n+m)\lambda h] + \mu_2[\alpha - (1+2m)t_i + m\lambda h].$$

The Kuhn-Tucker conditions are:

$$\frac{\partial \pounds}{\partial t} = \frac{n[(1+2m)\alpha - (2m+1)(4m+n+2)t_i + (2+4m+n)m\lambda h]}{\beta(2m+n+1)^2} + n\mu_1 - (1+2m)\mu_2 = 0$$
$$\mu_1[\alpha + nt_i - (1+n+m)\lambda h] = 0, \mu_1 \geq 0, \alpha + nt_i - (1+n+m)\lambda h \geq 0$$
$$\mu_2[\alpha - (1+2m)t_i + m\lambda h] = 0\ , \mu_2 \geq 0, \alpha - (1+2m)t_i + m\lambda h \geq 0$$
$$t_i - \lambda h > 0.$$

It follows that the first- and second-order derivatives of $\overline{W}_i$ with respect to t_i are given, respectively, as

$$\frac{\partial \tilde{W}_i}{\partial t_i} = \frac{n[(1+2m)\alpha - (2m+1)(4m+n+2)t_i + (2+4m+n)m\lambda h]}{\beta(2m+n+1)^2};$$
$$\frac{\partial^2 \tilde{W}_i}{\partial t_i^2} = \frac{-n(2m+1)(4m+n+2)}{\beta(2m+n+1)^2} < 0.$$

Because the objective function $\tilde{W}_i$ is strictly concave on t_i and the constrained conditions are linear, we set the derivative $\frac{\partial \tilde{W}_i}{\partial t_i}$ to zero and calculate the solution to the constrained optimization problem as

$$\tilde{t}_i = \frac{\alpha(1+2m) + m(2+4m+n)\lambda h}{(1+2m)(2+4m+n)} \quad \text{if } 0 < \lambda < \frac{(2m+1)}{(m+1)(4m+n+2)}\frac{\alpha}{h}.$$

From equation (9(c)), we find that if $\lambda > \frac{\alpha}{(m+1)h}$ each firm in country *C* chooses not to export the final good to the FTA markets. In this case, $q_{i,k}^{C}=0$. Substituting $q_{i,k}^{C}=0$ into each inside firm's profit function (see equation (5a)) and maximizing the resulting profit function subject to the restriction that $\lambda > \frac{\alpha}{(m+1)h}$ yields the firm's optimal outputs as follows:

$$q_i^i = \frac{\alpha}{\beta m} \text{ and } q_i^j = 0.$$

Since $q_{i,k}^{C}=0$ and $q_i^j=0,$ there will be no trade in the final good. We therefore rule out the case that $\lambda > \frac{\alpha}{(m+1)h}$.

If the content ratio falls into the range $\frac{(2m+1)}{(m+1)(4m+n+2)}\frac{\alpha}{h} \le \lambda \le \frac{\alpha}{(m+1)h}$, there will be no interior and unique solution for the welfare maximization problem. Due to the fact that $\frac{\partial \tilde{W}_i}{\partial t_i}\Big|_{\tilde{t}_i=\frac{\alpha(1+2m)+m(2+4m+n)\lambda h}{(1+2m)(2+4m+n)}} = 0$ and the strict concavity of $\tilde{W}_i$ on t_i, we have

$$\frac{\partial \tilde{W}_i}{\partial t_i}\Big|_{\tilde{t}_i \ge \lambda h} \le 0.$$

We cannot rule out the possibility that both of the following inequalities are satisfied:

$$\frac{(2m+1)}{(m+1)(4m+n+2)}\frac{\alpha}{h} \le \lambda \le \frac{\alpha}{(m+1)h} \text{ and } t_i > \lambda h.$$

Given the objective of obtaining an improvement in social welfare, each member country sets its external tariff at a level that is slightly greater than the ROO-induced input cost increase. That is, to induce ROO compliance, member country *i* sets its tariff rate to be $\tilde{t}_i = \lambda h + \zeta_i$, where ζ_i is an infinitesimal positive number.

A-2. Proof that $\tilde{W}_i < \overline{W}_i$ ***if*** $\hat{\lambda} \le \lambda \le \frac{\alpha}{(m+1)h}$.

Recall from Lemma 1 that $\tilde{t}_i = \lambda h + \zeta_i$ if $\frac{(2m+1)}{(m+1)(4m+n+2)}\frac{\alpha}{h} \le \lambda \le \frac{\alpha}{(m+1)h}$. Substituting $\tilde{t}_i = \lambda h + \zeta_i$ into $\tilde{W}_i$ gives each member country's post-FTA welfare when with the content ratio satisfies the above inequality condition. We find that

$$\tilde{W}_i\Big|_{\tilde{t}_i=\lambda h+\varsigma_i} = \tilde{W}_i\Big|_{\tilde{t}_i=\lambda h} + \eta_i,$$

where η_i is an infinitesimal number and

$$\eta_i = 2n\varsigma_i[(1+m)\alpha + (m+1)(4m+n+2)h\lambda] + n\varsigma_i^2(2m+1)(4m+n+2)$$
$$-4mn\varsigma_j(\alpha - h\lambda - mh\lambda) - 2mn^2\varsigma_j^2.$$

Since η_i is a very small number and can be ignored, we compare $\tilde{W}_i$ and $\overline{W}_i$ for the case when

$$\frac{(2m+1)\alpha}{(m+1)(4m+n+2)h} \le \lambda \le \frac{\alpha}{(m+1)h}.$$

Replacing λh with t_i gives

$$\tilde{W}_i \Big|_{t_i=\lambda h} = \overline{W}_i \Big|_{t_i=\lambda h} - \left(t_i n \tilde{q}_i^j\right)\Big|_{t_i=\lambda h}.$$

Because the values of t_i and $\tilde{q}_i^j$ are all positive, we have

$$\tilde{W}_i \Big|_{t_i=\lambda h} = \overline{W}_{ii} \Big|_{t_i=\lambda h} - \left(t_i n \tilde{q}_i^j\right)\Big|_{t_i=\lambda h} < \overline{W}_i \Big|_{t_i=\lambda h}.$$

Given that $\overline{W}_i$ is maximized when $\bar{t} = \dfrac{\alpha(2m+1)}{2m^2+5m+n+2}$, we have

$$\overline{W}_i \Big|_{t_i=\lambda h} < \overline{W}_i \Bigg|_{t_i=\frac{\alpha(2m+1)}{2m^2+5m+n+2}}.$$

This further implies that

$$\tilde{W}_i \Big|_{t_i=\lambda h} < \overline{W}_i \Bigg|_{t_i=\frac{\alpha(2m+1)}{2m^2+5m+n+2}}.$$

A-3. Proof of Proposition 1.

To calculate the critical level of the content ratio at which $\tilde{W}_i = \overline{W}_i$, we apply the Weda's Theorem to this equality condition, using their expressions in equations (21) and (22), to get two possible roots:

$$\lambda_L^W = \frac{(2m+1)[4(m+1)(2m^2+5m+n+2)-\sqrt{\Omega}]}{(5m+4m^2+2)(18m+4n+2m^2n+9mn+24m^2+8m^3+n^2+4)}\frac{\alpha}{h}$$

and

$$\lambda_H^W = \frac{(2m+1)[4(m+1)(2m^2+5m+n+2)+\sqrt{\Omega}]}{(5m+4m^2+2)(18m+4n+2m^2n+9mn+24m^2+8m^3+n^2+4)}\frac{\alpha}{h},$$

where $\lambda_L^W < \lambda_H^W$ and

$$\Omega = (2108m+16n+10mn^2+125m^2n+112m^3n+68m^4n+16m^5n+10m^2n^2 \\ +8m^3n^2+74mn+282m^2+368m^3+272m^4+4n^2+128m^5+32m^6+16) > 0.$$

Given the strict convexity of the welfare function, it is easy to verify that $\tilde{W}_i > \overline{W}_i$ for $\lambda < \lambda_L^W$ or $\lambda > \lambda_H^W$. The value of $\hat{\lambda}$ lies somewhere between λ_L^W and λ_H^W, i.e., $\lambda_L^W < \hat{\lambda} < \lambda_H^W$. We rule out λ_H^W because its value violates the ROO-complying condition. We thus have

$$\frac{\partial \tilde{W}_i}{\partial \lambda} < 0 \text{ for } 0 < \lambda < \lambda_L^W.$$

If $\lambda_L^W > 0$, the welfare-improving content ratio falls into the range $(0, \lambda_L^W)$. But if $\lambda_L^W < 0$, there does not exist any content ratio capable of improving social welfare.

A-4: Proof of Proposition 2.

(i) Recall that, if $0 < \lambda < \lambda_L^W$, the post-FTA optimal tariff set by member country i is

$$\tilde{t}_i = \frac{(1+2m)\alpha + (4m+n+2)m\lambda h}{(2m+1)(4m+n+2)}.$$

Taking the derivative of $\tilde{t}_i$ with respect to λ yields

$$\frac{\partial \tilde{t}_i}{\partial \lambda} = \frac{mh}{2m+1} > 0.$$

A comparison between $\overline{t_i}\big|_{\lambda=\hat{\lambda}}$ and $\tilde{t}_i$ reveals that

$${}_i\tilde{t}_i\big|_{\lambda=\hat{\lambda}} - \overline{t} = -\frac{\alpha m(2m+1)(2m+n+1)}{(m+1)(4m+n+2)(2m^2+5m+n+2)} < 0.$$

This implies that $\tilde{t}_i\big|_{\lambda=\hat{\lambda}} < \overline{t_i}$. The positive sign for the derivative $\frac{\partial \tilde{t}_i}{\partial \lambda} > 0$ indicates the optimal tariff decreases as the content ratio decreases. Given that $\lambda_L^W < \hat{\lambda}$, we conclude that

$$\tilde{t}_i(\lambda) < \tilde{t}_i\big|_{\lambda=\hat{\lambda}} \text{ for } 0 < \lambda < \lambda_L^W.$$

Since $\tilde{t}_i\big|_{\lambda=\hat{\lambda}} < \overline{t_i}$ and $\tilde{t}_i(\lambda) < \tilde{t}_i\big|_{\lambda=\hat{\lambda}}$, we have

$$\tilde{t}_i < \overline{t_i} \text{ for } 0 < \lambda < \lambda_L^W.$$

(ii) Note that the reduction in external tariffs is defined as

$$\Delta t_i = \overline{t_i} - \tilde{t}_i = \frac{(2m+1)\alpha}{2m^2+5m+n+2} - \frac{(2m+1)\alpha + (4m+n+2)m\lambda h}{(2m+1)(4m+n+2)}.$$

Taking the first-order derivatives of Δt_i with respective to α, h, and λ, respectively, we have

$$\frac{\partial(\Delta t_i)}{\partial \alpha} = \frac{m(2m+1)(2m+n+1)}{(m+1)(4m+n+2)(2m^2+5m+n+2)} > 0;$$

$$\frac{\partial(\Delta t_i)}{\partial h} = -\frac{m\lambda}{(2m+1)} < 0;$$

$$\frac{\partial(\Delta t_i)}{\partial \lambda} = -\frac{hm}{(2m+1)} < 0.$$

A-5: Proof of Proposition 4.

Recall that the sales of the final good by each inside firm to its domestic market before and after the FTA are

$$\tilde{q}_i^i = \frac{2\alpha}{\beta(4m+n+2)} + \frac{mh\lambda}{\beta(2m+1)} \text{ and } \overline{q}_i^i = \frac{2\alpha(m+1)}{\beta(2m^2+5m+n+2)}.$$

Taking the derivative of $\tilde{q}_i^i$ with respect to λ yields

$$\frac{\partial \tilde{q}_i^i}{\partial \lambda} = \frac{mh}{(1+m)\beta} > 0.$$

This indicates that the post-FTA level of the final good sold to the domestic market increases as the content ratio increases. Evaluating $\tilde{q}_i^i$ at where $\lambda = \hat{\lambda}$, we have

$$\tilde{q}_i^i\Big|_{\lambda=\hat{\lambda}} = \frac{(3m+2)\alpha}{\beta(m+1)(4m+n+2)}.$$

It follows that

$$\tilde{q}_i^i\Big|_{\lambda=\hat{\lambda}} - \overline{q}_i^i = -\frac{\alpha(2m+1)(m+n)}{\beta(m+1)(8m^3+2m^2n+24m^2+9mn+18m+n^2+4n+4)} < 0.$$

We thus have $\tilde{q}_i^i < \overline{q}_i^i$ for $0 < \lambda < \lambda_L^W < \hat{\lambda}$. Recall that the pre- and post-FTA equilibrium prices of the final good in each member country are

$$\tilde{p}_i = \frac{2\alpha}{4m+n+2} + \frac{m\lambda h}{2m+1} = \beta\tilde{q}_i^i \text{ and } \overline{p}_i = \frac{2\alpha(m+1)}{2m^2+5m+n+2} = \beta\overline{q}_i^i,$$

where $\frac{\partial\tilde{p}_i}{\partial\tilde{q}_i^i} = \frac{\partial\overline{p}_i}{\partial\overline{q}_i^i} = \beta > 0$. Since $\tilde{q}_i^i < \overline{q}_i^i$, we have $\tilde{p}_i < \overline{p}_i$ for $0 < \lambda < \lambda_L^W$. Given that total consumption in each member country is negatively related to price, we have $\tilde{Q}_i > \overline{Q}_i$ for $0 < \lambda < \lambda_L^W$. Since the post-FTA price of the final good is relatively lower and the post-FTA consumption of the good is relatively higher, each member country's consumer surplus increases. Note that each inside firm's domestic profit is the product of the final-good price and its domestic sales and that the price of the imported input from country *C* is normalized to 0. Since we have proved that $\tilde{q}_i^i < \overline{q}_i^i$ and $\tilde{p}_i < \overline{p}_i$, it is straightforward to show that $\tilde{\pi}_i^i < \overline{\pi}_i^i$.

A-6: Proof that (i) $\tilde{q}_i^j > \overline{q}_i^j$***, (ii)*** $\tilde{q}_i^C > \overline{q}_i^C$***, and (iii)*** $\tilde{\pi}_C > \overline{\pi}_C$ ***when*** $0 < \lambda < \lambda_L^W$.

(i) Recall that the pre- and post-FTA quantities of the final good exported to another member country's market are given, respectively, as

$$\tilde{q}_i^j = \frac{2\alpha}{\beta(4m+n+2)} - \frac{(m+1)\lambda h}{\beta(2m+1)} \text{ and } \overline{q}_i^j = \frac{\alpha}{\beta(2m^2+5m+n+2)}.$$

Taking the derivative of $\tilde{q}_i^j$ with respect to λ yields

$$\frac{\partial\tilde{q}_i^j}{\partial\lambda} = -\frac{(m+1)h}{\beta(2m+1)} < 0.$$

This indicates that $\tilde{q}_i^j$ increases as λ decreases. Also, we have $\tilde{q}_i^j(\lambda) \le \tilde{q}_i^j\Big|_{\lambda=0}$. A comparison between $\tilde{q}_i^j\Big|_{\lambda=0}$ and $\overline{q}_i^j$ reveals that

$$\tilde{q}_i^j\Big|_{\lambda=0} - \overline{q}_i^j = \frac{\alpha(4m^2+6m+n+2)}{\beta(4m+n+2)(2m^2+5m+n+2)} < 0.$$

We thus have $\tilde{q}_i^j\Big|_{\lambda=0} < \overline{q}_i^j$. For $0 < \lambda < \lambda_L^W$, we have $\tilde{q}_i^j(\lambda) < \overline{q}_i^j$.

(ii) Recall that the post- and pre-FTA exports of the final good by an outside firm in country *C* to the FTA markets are given, respectively, as

$$\tilde{q}_i^C = \frac{\alpha}{\beta(2+4m+n)} \text{ and } \overline{q}_i^C = \frac{\alpha}{\beta(2m^2+5m+n+2)}.$$

It is apparent that $2+4m+n < 2m^2+5m+n+2$, which implies that $\tilde{q}_i^C > \overline{q}_i^C$.

(iii) Using the post-FTA quantities of the final-good exports by each firm in country C and this outside firm's profit function in equation (6), we calculate its post-FTA profit as follows:

$$\tilde{\pi}_C = 2\beta\left[\frac{\alpha}{\beta(2+4m+n)}\right]^2 = 2\beta(\tilde{q}_i^C)^2.$$

Similarly, using the pre-FTA optimal quantities of the final-good exports by each firm in country C equation (6), we calculate the firm's pre-FTA profit:

$$\bar{\pi}_C = 2\beta\left[\frac{\alpha}{\beta(2m^2+5m+n+2)}\right]^2 = 2\beta(\bar{q}_i^C)^2.$$

Given the result in part (ii) that $\tilde{q}_i^C > \bar{q}_i^C$, we have $\tilde{\pi}_C > \bar{\pi}_C$.

A-7: Proof of Proposition 6.

(i) Recall that the post- and pre-FTA quantities of the intermediate input exported from country C to the FTA countries are given, respectively, as

$$\tilde{X} = \frac{8m\alpha}{\beta(4m+n+2)} - \left[\frac{4m\alpha}{\beta(4m+n+2)} + \frac{2mh}{\beta(2m+1)}\right]\lambda + \frac{2mh}{\beta}\lambda^2,$$

and

$$\bar{X} = \frac{2m(2m+3)\alpha}{\beta(2m^2+5m+n+2)}.$$

Taking the first- and second-order derivatives of $\tilde{X}$ with respect to λ yields

$$\frac{\partial\tilde{X}}{\partial\lambda} = -\left[\frac{4m\alpha}{\beta(4m+n+2)} + \frac{2mh}{\beta(2m+1)}\right] + \frac{4mh}{\beta}\lambda \text{ and } \frac{\partial^2\tilde{X}}{\partial\lambda^2} = \frac{4mh}{\beta}\lambda > 0,$$

Which imply that $\tilde{X}$ is strictly convex on λ. Substituting $\lambda = \hat{\lambda} = \dfrac{\alpha(1+2m)}{h(m+1)(4m+n+2)}$ into the first-order derive $\dfrac{\partial\tilde{X}}{\partial\lambda}$ yields $\dfrac{\partial\tilde{X}}{\partial\lambda}\Big|_{\lambda=\hat{\lambda}} = -\dfrac{2mh}{\beta(1+2m)} < 0.$ Thus, $\dfrac{\partial\tilde{X}}{\partial\lambda} < 0$ for $0 < \lambda < \lambda_L^W$ since $\lambda_L^W < \hat{\lambda}.$

Note that for $0 < \lambda < \lambda_L^W$, $\tilde{X}$ increases as λ decreases and $\tilde{X}\big|_{\lambda=0} > \tilde{X}$. That is,

$$\tilde{X}\big|_{\lambda=0} - \bar{X} = \frac{2m(4m+n-2mn+2)\alpha}{\beta(4m+n+2)(2m^2+5m+n+2)}.$$

When $(4m+n-2mn+2) < 0,$ we have $\tilde{X} < \bar{X}$ for $0 < \lambda < \lambda_L^W$.

(ii) We discuss the case when $(4m+n-2mn+2) > 0.$ In this case $\tilde{X} > \bar{X}\big|_{\lambda=0}$.

Subtracting $\bar{X}$ from $\tilde{X}$ yields

$$\tilde{X} - \bar{X} = \frac{2mh}{\beta}[\lambda - \frac{\alpha}{h(4m+n+2)} - \frac{1}{2(2m+1)}]^2 + \Delta'',$$

where

$$\Delta'' = \frac{2m\alpha(4m+n-2mn+2)}{\beta(8m^3+2m^2n+24m^2+9mn+18m+n^2+4n+4)} - \frac{2mh}{\beta}\left[\frac{\alpha}{h(4m+n+2)} + \frac{1}{2(2m+1)}\right]^2.$$

It is straightforward to verify that there is no solution of $\tilde{X} = \bar{X}$. Given $\tilde{X} > \bar{X}\big|_{\lambda=0}$, we have $\tilde{X} > \bar{X}$

for $0 < \lambda < \lambda_L^W$. If $\Delta'' > 0$, there are two possible roots for $\tilde{X} = \overline{X}$:

$$\lambda_L^X = \frac{\alpha}{h(4m+n+2)} + \frac{1}{2(2m+1)} - \sqrt{\frac{\beta\Delta''}{2mh}} \text{ and } \lambda_H^X = \frac{\alpha}{h(4m+n+2)} + \frac{1}{2(2m+1)} + \sqrt{\frac{\beta\Delta''}{2mh}},$$

where $\lambda_L^X < \lambda_H^X$, $\frac{\partial \tilde{X}}{\partial \lambda}\Big|_{\lambda=\lambda_L^X} < 0$ and $\frac{\partial \tilde{X}}{\partial \lambda}\Big|_{\lambda=\lambda_H^X} > 0$. Because the function $\tilde{X}$ is strictly convex on λ and $\frac{\partial \tilde{X}}{\partial \lambda}\Big|_{\lambda=\lambda_L^{SW}} < 0$, we conclude that $\lambda_H^X > \lambda_L^W$. Note that the sign of $(\lambda_L^X - \lambda_L^W)$ is ambiguous. For $0 < \lambda < \lambda_L^W$, we have two possibilities: (i) $\tilde{X} > \overline{X}$ when $\lambda < \lambda_L^X$; (ii) $\tilde{X} < \overline{X}$ when $\lambda > \lambda_L^X$.

A-8: Proof that $\tilde{\pi}_i < \overline{\pi}_i$.

Recall that each inside firm's total profit with and without the FTA are given, respectively, as

$$\tilde{\pi}_i = \frac{m}{\beta}\left[\frac{8\alpha^2}{(4m+n+2)^2} - \frac{4\alpha\lambda h}{(2m+1)(4m+n+2)} + \frac{(2m^2+2m+1)\lambda^2 h^2}{(2m+1)^2}\right]$$

and

$$\overline{\pi}_i = \frac{\alpha^2 m(4m^2+8m+5)}{\beta(2m^2+5m+n+2)^2}.$$

Taking the first- and second-order derivatives of $\overline{\pi}_i$ with respect to λ gives

$$\frac{\partial \tilde{\pi}_i}{\partial \lambda} = \frac{m}{\beta}\left[-\frac{4\alpha h}{(2m+1)(4m+n+2)} + \frac{2(2m^2+2m+1)\lambda h^2}{(2m+1)^2}\right] \text{ and}$$

$$\frac{\partial^2 \tilde{\pi}_i}{\partial \lambda^2} = \frac{m}{\beta}\left[\frac{2(2m^2+2m+1)h^2}{(2m+1)^2}\right] > 0.$$

Since $\frac{\partial^2 \tilde{\pi}_i}{\partial \lambda^2} > 0$, $\tilde{\pi}_i$ is a strictly convex on λ. Next, we calculate the critical value of the content ratio so that $\overline{\pi}_i = \tilde{\pi}_i$. There are two possible roots:

$$\lambda_L^{PS} = \frac{(2m+1)(10m+2n+4m^2+4-\sqrt{\Delta'})}{(2m+2m^2+1)(18m+4n+2m^2n+9mn+24m^2+8m^3+n^2+4)}\frac{\alpha}{h}$$

and

$$\lambda_H^{PS} = \frac{(2m+1)(10m+2n+4m^2+4+\sqrt{\Delta'})}{(2m+2m^2+1)(18m+4n+2m^2n+9mn+24m^2+8m^3+n^2+4)}\frac{\alpha}{h},$$

where $\lambda_L^{PS} < \lambda_H^{PS}$ and

$$\Delta' = (8m+4n+2mn^2+24m^2n+112m^3n+160m^4n+64m^5n+14m^2n^2+24m^3n^2$$
$$+8m^4n^2+8mn-28m^2-64m^3+32m^4+n^2+128m^5+64m^6+4) > 0.$$

It is straightforward to verify that $\lambda_L^{PS} < 0 < \hat{\lambda} < \lambda_H^{PS}$. Because $\tilde{\pi}_i$ is strictly convex on λ, we conclude that for $0 < \lambda < \lambda_L^{SW} (< \hat{\lambda})$, we have $\tilde{\pi}_i < \overline{\pi}_i$.

A-9: Proof static analysis results under FTA.

(i) For $0<\lambda<\lambda_L^W$, the equilibrium quantities, price, total consumption, and consumer surplus are given in equations (28a)-(28d). Taking the derivatives of these functions with respect of λ, we have

$$\frac{\partial \tilde{q}_i^i}{\partial \lambda}=\frac{hm}{\beta(2m+1)}>0;\quad \frac{\partial \tilde{q}_i^j}{\partial \lambda}=-\frac{(m+1)h}{\beta(2m+1)}<0;\quad \frac{\partial \tilde{q}_i^C}{\partial \lambda}=0;\quad \frac{\partial \tilde{p}_i}{\partial \lambda}=\frac{hm}{2m+1}>0;$$

$$\frac{\partial \tilde{Q}_i}{\partial \lambda}=-\frac{mh}{\beta(2m+1)}<0;$$

$$\frac{\partial \tilde{S}_i}{\partial \lambda}=-mh\left[\frac{(2m+1)(4m+n)\alpha-(2+4m+n)m\lambda h}{\beta(2m+1)^2(4m+n+2)}\right]=-\tilde{p}_i\frac{hm}{\beta(2m+1)}<0;$$

Also, taking the derivative of $\tilde{X}_i$ yields

$$\frac{\partial \tilde{X}_i}{\partial \lambda}=-\left[\frac{4m\alpha}{\beta(4m+n+2)}+\frac{2mh}{\beta(2m+1)}\right]+\frac{4mh}{\beta}\lambda,$$

which indicates that $\frac{\partial \tilde{X}_i}{\partial \lambda}$ increases with λ. Evaluating $\frac{\partial \tilde{X}_i}{\partial \lambda}$ at where $\lambda=\hat{\lambda}=\frac{\alpha(1+2m)}{h(m+1)(4m+n+2)}$, we have

$$\left.\frac{\partial \tilde{X}_i}{\partial \lambda}\right|_{\lambda=\hat{\lambda}}=-\frac{2mh}{\beta(1+2m)}<0,$$

which implies that $\frac{\partial \tilde{X}_i}{\partial \lambda}<0$ for $0<\lambda<\lambda_L^W$ and $\lambda_L^W<\hat{\lambda}$.

Also, taking the derivative of the post-FTA producer surplus $\tilde{\Pi}_i$ with respect to λ yields

$$\frac{\partial \tilde{\Pi}_i}{\partial \lambda}=\frac{4m(2m^2+2m+1)^2h^2}{\beta(2m+1)^2}\left[\lambda-\frac{2(2m+1)\alpha}{h(2m^2+2m+1)(4m+n+2)}\right],$$

which implies that $\tilde{\Pi}_i$ increases with λ. Evaluating $\frac{\partial \tilde{\Pi}_i}{\partial \lambda}$ at where $\lambda=\lambda_L^W$, we have $\left.\frac{\partial \tilde{\Pi}_i}{\partial \lambda}\right|_{\lambda=\lambda_L^{SW}}<0.$ This further implies that

$$\frac{\partial \tilde{\Pi}_i}{\partial \lambda}<0 \text{ for } 0<\lambda<\lambda_L^W.$$

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