Optimal Trade Policies and Free Trade Agreements in a Vertically Related Industry

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Abstract

This paper examines effects of a formation of a free trade agreement between countries with vertical production and trade relationship under imperfect competition in a three-country model. When a country exporting an intermediate good signs a bilateral free trade agreement with a country that exports a final good using the imported intermediate good, the volume of trade between the non-member country also exporting the final good may or may not diminish, depending on the number of final-good firms in each country. Although welfare in the signatory country exporting the final good improves, other countries may or may not be better off. Nevertheless, in the presence of income redistribution between the signatory countries, the FTA formation may be strictly Pareto improving. We also discuss the possibility of multilateral trade liberalization followed by the two-country FTA, by comparing welfare levels under two-country FTA with those under three-country free trade.

Keywords: Free trade agreement; Vertically related industry; Welfare; Global free trade
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1 Introduction

During this decade, the world economy has been experienced an unprecedented expansion of preferential trade agreements (PTAs). Following the fashion, Asia, Mideast and Africa, which have been recognized as blank sections of PTAs in the world, are now driving forward the formation of PTAs. For instance, among the East Asian nations, Singapore and Thailand are active in concluding agreements with Western countries as well as Asian nations. Japan has long been reluctant to move into action, but changes the policy in the new millennium, signing free trade agreements with Singapore, Mexico and Malaysia, reaching a broad agreement on the contract with Philippine and Thailand, and opening negotiations with Indonesia and Chile.

There also have been extensive studies on the economic impacts of PTAs. For example, Baldwin and Venebles (1995) give a full account of survey from early studies to newer and more sophisticated researches. Recent researches look at rationality and optimality of PTAs, by assuming imperfect competition and examining oligopolistic trade models. Among others, Freund (2000b), Mukunoki (2004), Saggi and Yildiz (2006) and Yi (1996, 2000) consider endogenous determination of optimal external tariffs.

In contrast to the above studies, which focus on trade in final goods, we explicitly consider international trade with an intermediate good. More specifically, we examine effects of a formation of a free trade agreement between countries with vertical production and trade relationship by using a simple three-country model of international trade under imperfect competition. We follow the studies on strategic trade policies with vertically related markets examined by Bernhofen (1997), Ishikawa and Spencer (1999) and Chang and Sugeta (2004).

We focus attention on vertical trade structure for the following reason. In East Asia, one of the regions in the world that are rapidly promoting the formation of PTAs, trade in intermediate and capital goods are remarkably increasing. A typical trade pattern in this region has been that ASEAN countries import intermediate goods from Japan, assemble final goods and export them to Japan and Western countries. Although two-way export in intermediate goods rather than one-sided import from Japan is expanding, Japan still keeps a high share in production and export of intermediates, especially those of electronic materials, in the region.[1] The East Asia region would

[1] For example, over 60% of the world production of silicon wafers, photomasks and photoresists, which are central materials in producing semiconductors, is contributed by Japanese firms, and materials for the production of liquid crystal display (LCD) such as deflector plates and color filters are supplied almost exclusively by Japanese manufacturers.

occupy more important position in the world's trading system in the future because of the recent high development performance of China, and hence the formation of PTAs in this region would be one of the critical issues in the world economy. Taking the actual trade pattern in this region into consideration, models with vertical specialization patterns are required. In other words, the existing literature on the effects of bilateral or regional trade agreements and consistency of such agreements with multilateral trade liberalization focuses on trade in final goods, and questions concerning preferential trade agreements in the presence of vertical trade structure are still open, despite the importance of vertical production and trade structure in actual trade transactions. We believe that this paper will open up researches on such issues.

In this paper, we develop a model in which a final good is produced under international oligopoly, an intermediate good employed in the final-good sector is supplied under monopoly, and the country where the monopoly firm locates is the sole consumer country of the final good. By these assumptions we highlight the trade and welfare consequences of a free trade agreement (FTA) between countries with definite trade patterns because the model characterizes trade between a country exporting the intermediate good and countries exporting the final good. In the context of trade agreements involving East Asian countries, the model can describe the Japan-Korea Free Trade Agreement, negotiations of which were begun in December 2003. The country exporting the intermediate good can be interpreted as Japan, and the country exporting the final good can be regarded as South Korea. At the present writing, the negotiations have been suspended since 2004. Although the principal factor responsible for this suspension is assumed to be due to handling of agricultural products, it does not seem to be unconnected with South Korea's existing trade deficit with Japan because of large imports of materials from Japan for the expanding domestic production of semiconductors and LCDs in South Korea. It is no doubt that the conclusion of the Japan-Korea FTA affects production and trade structures not only in both countries but also in other countries such as China and Taiwan.

The model is characterized as a three-stage game. In the first stage, the government in each country determines the trade policy. In the absence of an FTA, each country chooses the tariff rate so that the national welfare is maximized. If the country that exports the intermediate good and imports the final good signs a bilateral FTA with a country that has the opposite trade pattern, that country sets the optimal external tariff applied to the imports from another country. In the second stage, taking the trade policy as given, the intermediate-good monopolist sets the price. In the third stage, taking the trade policy and the prices of the intermediate good as given, the final-good

producers in each country play a Cournot game and determine output levels.

We begin with how a bilateral free trade agreement affects the optimal external tariffs and trade volumes in comparison with a pre-FTA situation. Of particular interest is whether an FTA accelerates trade within the member countries and whether it reduces trade between member and non-member countries. In addition, we examine effects of FTA on welfare in each country and the world as a whole. The examination of welfare effects is also useful in assessing whether each country has an incentive to make an agreement.

We show that a free trade agreement between the country exporting the intermediate good and one country exporting the final good unambiguously reduce the external tariff rate. This is what Bagwell and Staiger (1999) call the "tariff complementarity" effect.[2] The tariff rate imposed by the non-member country, by contrast, may or may not be reduced, depending on the numbers of the final-good firms in each country. While the FTA unambiguously expands trade between the member countries, trade between the non-member country may be reduced because the non-member country may increase the tariff. Nevertheless, the tariff complementarity effect is strong enough to achieve the expansion of the world production and trade.

The number of final-good firms also plays a role in welfare effects of the FTA. Contrary to the existing oligopolistic trade models that focus on trade in final goods, the formation of the FTA may not be beneficial to all member countries. More specifically, while welfare in the signatory country exporting the final good improves, the other signatory, i.e., the country exporting the intermediate good may be worse off after the FTA formation. Nevertheless, the sum of welfare of the signatories improves, implying that the FTA is strictly Pareto improving for these countries in the presence of income redistribution between them. In addition, the non-member country may also be better off. In such a case, the formation of FTA brings about a strictly Pareto improvement in the world economy.

We further discuss the possibility of multilateral trade liberalization followed by the two-country FTA, by comparing welfare levels under two-country FTA with those under three-country free trade. One of the issues on PTAs that attract trade economists' interest is whether forming PTAs in series becomes a "building block" or a "stumbling block" to multilateral trade liberalization (Bhagwati, 1991). Models in which each country's decision to form FTAs is endogenously determined are examined by Freund

[2] The tariff complementarity effect is demonstrated by Kennan and Riezman(1990), Kose and Riezman(2000), Bond, Riezman and Syropoulos(2004) in competitive trade models, and by Yi(2000), Ornelas(2005), Saggi(2006) in oligopolistic models.

(2000c), Furusawa and Konishi (2005), Ornelas (2005) and Saggi (2006). In particular, Furusawa and Konishi (2005) show that the network of bilateral FTAs can achieve global free trade is when transfers between FTA signatories are allowed. In the present paper, we draw a similar conclusion from different and simpler model, i.e., international income transfers can achieve a movement from bilateral FTA to the global free trade. We also discuss whether each country chooses the global free trade by way of bilateral FTA formation, which we call a "gradual liberalization", or the global free trade without such a step, which we call a "radical liberalization", and show that it depends on the number of final-good firms in each country.[3]

The rest of the paper is organized as follows. Section 2 sets up the model and derives subgame-perfect equilibria under pre-FTA (tariff war) situation, under bilateral FTA between a country exporting the final good and a country exporting the intermediate good, and under global free trade, respectively. In Section 3, we compare tariff rates, output levels and trade volume, and welfare under the bilateral FTA with the pre-FTA equilibrium. Section 4 considers global free trade, and compares the outcomes with those under the tariff war and the bilateral free trade. Section 5 concludes the paper.

2 The Model

We consider an imperfectly competitive trade model in which a final good and an intermediate good are traded between three countries (country A, B and C) in addition to a numeraire good that balances trade. The final good market is oligopolistic; there are m firms in country A and n firms in B and C, respectively, producing the final good. The intermediate good is produced by a monopolistic firm located in country A and used as an input of producing the final good. Consumption of the final good only takes place in country A. From these assumptions it follows that country A exports the intermediate good to and imports the final good from country B and C, as illustrated by Figure 1.

[3] The existing literature has mixed results. Using a two-period model with sunk costs, Freund (2000a) shows that world welfare is greater if global free trade is achieved after a bilateral trade agreement than if it is achieved immediately. By contrast, Krishna (1998) examines a political economy model to show that multilateral liberalization that would have been politically feasible in the absence of preferential arrangements could be rendered infeasible by a preferential arrangement. The similar conclusion is derived from a model with welfare-maximizing governments by Saggi and Yildiz (2006).

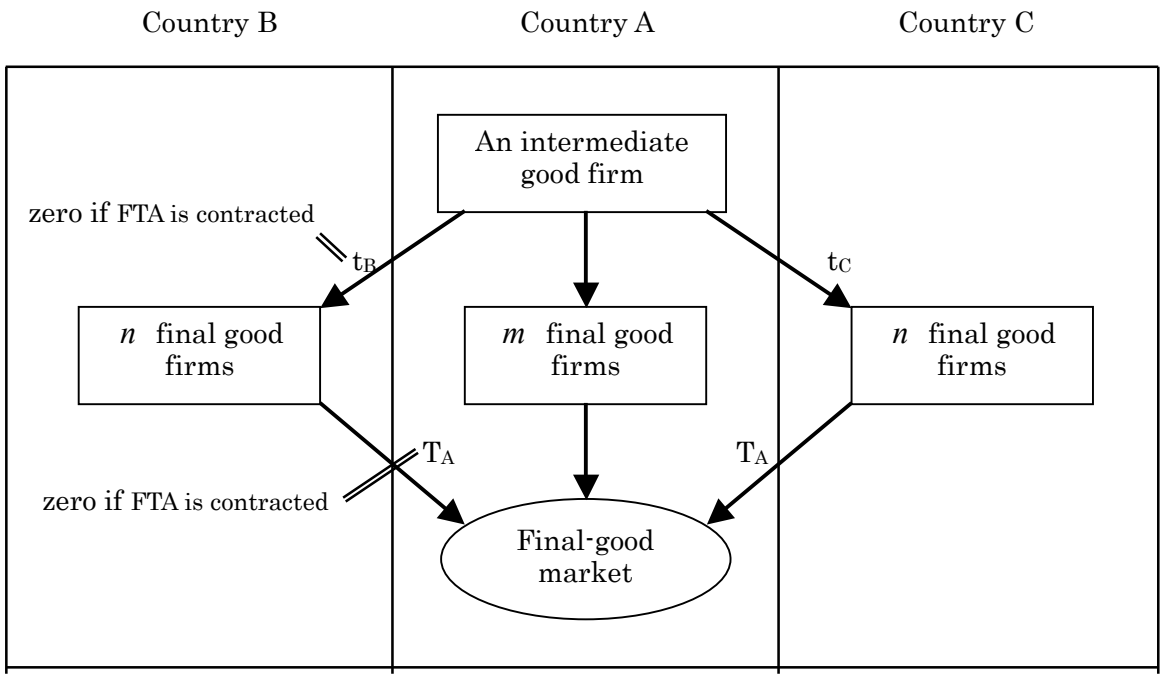

Figure 1: Market structure

International trade may be subject to commercial policy. Let us denote the tariff rate on the final good imposed by the government in country A by T_A, the tariff rate on the intermediate good imposed by the government in country B and C, respectively, by t_B and t_C. The model then involves three stages of action. In the first stage, the governments determine the tariff rates. In the second stage, the intermediate-good monopolist located in country A sets the price of the intermediate good. In the third stage, the final-good firms play a Cournot game to choose output. In the following analysis, we solve the model backwards.

Let us begin with the third stage game. We assume a linear demand curve for the final output; the inverse demand function is given by $p(Y) = \alpha - \beta Y$, where α and β are positive constants and Y equals to the total output in the world, i.e., $Y = \sum_m y_A + \sum_n y_B + \sum_n y_C$, and y_i signifies output of each final-good firm in country i $(i = A, B, C)$. In addition, we assume that production of one unit of the final good requires one unit of the intermediate input. Let us denote the price of the intermediate good that country A's final-good producers faces by r_A. Then, profit of each final-good producer in country A is given by $\pi_A = p(Y)y_A - r_A x_A = [p(Y) - r_A]y_A$. Profits of

country B's and C's representative producers are analogously defined, with the tariff imposed by country A's government in mind, as $\pi_B = p(Y)y_B - T_A y_B - r_B x_B = [p(Y) - r_B - T_A]y_B$ and $\pi_C = p(Y)y_C - T_A y_C - r_C x_C = [p(Y) - r_C - T_A]y_C$, respectively. Assuming interior Cournot-Nash equilibrium with positive outputs (we check up under what condition the positive output levels are achieved in the analysis below), the equilibrium output levels of representative firms are derived as follows:

$$(1) \qquad y_A = \frac{\alpha - (2n+1)r_A + n(r_B + r_C + 2T_A)}{(m+2n+1)\beta},$$

$$(2) \qquad y_B = \frac{\alpha - (m+n+1)r_B + mr_A + nr_C - (m+1)T_A}{(m+2n+1)\beta},$$

$$(3) \qquad y_C = \frac{\alpha - (m+n+1)r_C + mr_A + nr_B - (m+1)T_A}{(m+2n+1)\beta}.$$

The total output of the final good in the world is then derived as

$$(4) \qquad Y = \sum_m y_A + \sum_n y_B + \sum_n y_C = \frac{(m+2n)\alpha - mr_A - n(r_B + r_C + 2T_A)}{(m+2n+1)\beta}.$$

Note that eq.(4) also signifies the supply of the intermediate good since we assume unit input-output coefficient.

In the second stage, the intermediate-good monopolist determine prices r_A, r_B and r_C to maximize its profit $\pi_I = m(r_A - k)x_A + n(r_B - k - t_B)x_B + n(r_C - k - t_C)x_C$, taking the Cournot-Nash equilibrium outputs given by eqs.(1), (2) and (3) into consideration, where k is the marginal production cost, which is assumed to be constant and less than α, and x_i denotes the supply of intermediate good to each firm in country i ($i = A, B, C$). The following Lemma lays out the monopolist's optimal pricing strategy:

Lemma 1

(i) If the governments choose non-zero tariffs, the intermediate-good firm finds it optimal to adopt a price discrimination strategy in which the prices are set as follows:

$$(5) \qquad r_A = \frac{\alpha + k}{2}, \quad r_B = \frac{\alpha + k - T_A + t_B}{2}, \quad r_C = \frac{\alpha + k - T_A + t_C}{2}.$$

(ii) If mutual free trade is achieved between country A and B, but not C, the intermediate-good firm sets the prices as follows:

$$(6) \qquad r_A = r_B = \frac{\alpha + k}{2}, \quad r_C = \frac{\alpha + k - T_A + t_C}{2}.$$

(iii) If mutual free trade is achieved between both country A and B and country A and C,

the intermediate-good firm adopts uniform pricing:

(7) $$r_A = r_B = r_C = \frac{\alpha + k}{2}.$$

(Proof) Under price discrimination, the optimal prices for the intermediate-good monopolist are derived as ones given by eq.(5). Let us denote the profit of the monopolist in this case by π_I^{dis}. If the monopolist choose uniform pricing only to the final-good producers in country A and B, the prices are derived as

$$r_A = r_B = \frac{(m+n)(\alpha+k) - n(T_A - t_B)}{2(m+n)}, \quad r_C = \frac{\alpha + k - T_A + t_C}{2}.$$

Let us denote the profit of the monopolist in this case by π_I^{ABuni}. If the monopolist choose uniform pricing to all final-good firms, the uniform price is derived as

$$r_A = r_B = r_C = \frac{(m+2n)(\alpha+k) - n(2T_A - t_B - t_C)}{2(m+2n)}.$$

Let us denote the profit of the monopolist in this case by π_I^{uni}. Comparing the profits, it follows that

$$\pi_I^{\text{dis}} - \pi_I^{\text{ABuni}} = \frac{mn(T_A - t_B)^2}{4(m+n)\beta} \geq 0 \quad \text{and} \quad \pi_I^{\text{ABuni}} - \pi_I^{\text{uni}} = \frac{[m(T_A - t_C) + n(t_B - t_C)]^2 n}{4(m+n)(m+2n)\beta} \geq 0.$$

Then we have the statements in the Lemma. Q.E.D.

Before deriving the tariff rates determined by the governments in the first stage, let us define economic welfare in each country. Country A's welfare consists of the sum of profits of the final-good producers, monopoly profit of the intermediate-good firm, tariff revenue, and consumer's surplus:

(8) $$\begin{aligned} W_A &= m\pi_A + \pi_I + T_A(ny_B + ny_C) + \int_0^Y p(z)dz - p(Y)Y \\ &= m[p(Y) - r_A]y_A + m(r_A - k)y_A + n(r_B - k - t_B)y_B + n(r_C - k - t_C)y_C \\ &\quad + T_A(ny_B + ny_C) + \int_0^Y p(z)dz - p(Y)Y. \end{aligned}$$

Since country B and C do not consume the final good and do not produce the intermediate good, their welfare consist of the sum of profits of the final-good firms and tariff revenue:

(9) $$W_B = n\pi_B + nt_B x_B = n[p(Y) - r_B - T_A]y_B + nt_B y_B,$$

(10) $$W_C = n\pi_C + nt_C x_C = n[p(Y) - r_C - T_A]y_C + nt_C y_C.$$

2.1 Pre-FTA Outcome

We begin with the determination of tariff rates in the absence of free trade agreements. We characterize this pre-FTA situation as a tariff war between the three countries. That is, each country's government sets its tariff rate in order to maximize the national welfare, taking the other countries' tariff rates as given, and the Nash equilibrium of this tariff game is the pre-FTA outcome.

By Lemma 1 (i), the intermediate-good monopolist adopts the price discrimination strategy. Substituting the set of optimal intermediate-good prices (5) into eqs.(1), (2) and (3) and then the obtained set of equilibrium outputs (y_A, y_B, y_C) into eq.(8), we obtain country A's welfare as a function of tariff rates. Analogous calculation derives country B's and C's welfare. The Nash equilibrium tariffs are derived as follows:

$$(11) \qquad T_A = \frac{[m(m+1)-2n(n+1)](\alpha-k)}{2[(m+1)^3+(m+1)(2m+3)n+n^2]},$$

$$(12) \qquad t_B = t_C = \frac{(m+2)n(\alpha-k)}{2[(m+1)^3+(m+1)(2m+3)n+n^2]}.$$

From eqs.(10) and (11), we have:

Lemma 2

In the absence of free trade agreements, the optimal policy for country A is an import tariff (subsidy) on the final good if and only if $m(m+1) > 2n(n+1)$ *(*$m(m+1) < 2n(n+1)$*). The optimal policy for importing countries of the intermediate good (i.e., country B and C) is always a tariff.*

Whether country A's government choose tariff or subsidy depends on the number of final-good firms in each country. In particular, tariff policy is not optimal for country A unless the number of firms in that country (m) is large enough in comparison with those in other countries (n). Intuitively, this result is explained as follows. Differentiating W_A with respect to T_A and evaluating it at $T_A = 0$, it follows that

$$(13) \qquad \left.\frac{\partial W_A}{\partial T_A}\right|_{T_A=0} = \frac{\partial[m\pi_A]}{\partial T_A} + \frac{\partial \pi_I}{\partial T_A} + (ny_B + ny_C) - \frac{\partial p}{\partial T_A}Y,$$

where

$$\frac{\partial[m\pi_A]}{\partial T_A} = \frac{2n}{m+2n+1}my_A > 0, \quad \frac{\partial \pi_I}{\partial T_A} = -ny_B - ny_C < 0, \quad \frac{\partial p}{\partial T_A}Y = -\frac{n}{m+2n+1}Y < 0.$$

A small increase in T_A from the free trade situation increases the tariff revenue (the third term in the right-hand side of eq.(13)). However, it decreases the profit of the intermediate-good monopolist and completely offsets the increase in the tariff revenue. The optimal policy is therefore determined by whether the positive effect on the sum of profits of the final-good producers in country A outweighs the negative effect on consumer's surplus (the last term in the RHS of eq.(13)). Let us further examine the sign of $\partial W_A / \partial T_A\big|_{T_A=0}$. When $T_A = 0$, eqs. (1), (4) and (5) imply that the per-firm output of the final good in country A and the total output are given by

$$y_A = \frac{\alpha - k + nt_B + nt_C}{2(m+2n+1)\beta}, \quad Y = \frac{(m+2n)(\alpha-k) - nt_B - nt_C}{2(m+2n+1)\beta}.$$

In addition, from the first-order conditions for welfare maximization in country B and C, the tariff rates in these countries are derived as

$$t_B = t_C = \frac{n(\alpha-k)}{(m+1)^2 + 4(m+1)n + 2n^2}$$

when $T_A = 0$. Substituting these expressions into eq.(13), we have

$$\left.\frac{\partial W_A}{\partial T_A}\right|_{T_A=0} = \frac{2n}{m+2n+1} m y_A - \frac{n}{m+2n+1} Y = \frac{n\left[m(m+1) - 2n(n+1)\right](\alpha-k)}{2\left[(m+1)^2 + 4(m+1)n + 2n^2\right](m+2n+1)\beta},$$

the sign of which is positive (negative) and hence the government in country A has an incentive to impose tariff (to subsidize) if and only if $m(m+1) - 2n(n+1) > 0$ ($m(m+1) - 2n(n+1) < 0$).

Substitution of the Nash equilibrium tariff rates (10) and (11) yields the per-firm output levels of the final good in each country:

$$(14) \qquad y_A^{\text{Pre}} = \frac{[m^2 + (n+2)m - n^2 + n + 1](\alpha-k)}{2[(m+1)^3 + (m+1)(2m+3)n + n^2]\beta},$$

$$(15) \qquad y_B^{\text{Pre}} = y_C^{\text{Pre}} = \frac{(m+2)(m+n+1)(\alpha-k)}{4[(m+1)^3 + (m+1)(2m+3)n + n^2]\beta}.$$

From eq.(14), country A's final output per firm is positive if and only if $m^2 + (n+2)m - n^2 + n + 1 > 0$.

Lemma 3

In the absence of free trade agreements, the final-good output in country A is positive if import tariff is adopted in that country, i.e., if $m(m+1) > 2n(n+1)$.

(Proof) Substituting eq.(5) into eq.(1), we have

$$y_A = \frac{\alpha - k + n(2T_A + t_B + t_C)}{2(m+2n+1)\beta}.$$

Hence, it follows that $y_A > 0$ if $T_A \geq 0$. Q.E.D.

From eqs. (14) and (15), the total output of the final good, which also equals to that of the intermediate good, is derived as

$$(16) \qquad Y^{\text{Pre}} = \frac{[(m+1)^2(m+2n)+2n^2](\alpha-k)}{2[(m+1)^3+(m+1)(2m+3)n+n^2]\beta}.$$

Making use of eqs. (5), (11), (12), (14), (15) and (16), the welfare levels (8), (9) and (10) are derived, under pre-FTA situation, as

$$(17) \qquad W_A^{\text{Pre}} = \frac{M_1(\alpha-k)^2}{8[(m+1)^3+(m+1)(2m+3)n+n^2]^2\beta},$$

where $M_1 \equiv (m+1)^4(3m+4)m + (m+1)^2(12m^3+35m^2+28m+4)n$
$+4(m+1)(3m^3+12m^2+13m+3)n^2 + (13m^2+28m+12)n^3 + 4n^4 > 0,$

$$(18) \qquad W_B^{\text{Pre}} = W_C^{\text{Pre}} = \frac{(m+2)^2(m+n+1)(m+3n+1)n(\alpha-k)^2}{16[(m+1)^3+(m+1)(2m+3)n+n^2]^2\beta}.$$

2.2. FTA between Country A and B

Next we consider a situation in which country A makes a free-trade agreement with country B but still imposes tariff on imports from country C. Let us denote this tariff rate by T, and country C's tariff rate on imports of the intermediate good from country A by t. There are no tariffs on trade between country A and B. We assume that the government in country A determines T in order to maximize the national welfare, taking the tariff rate determined by country C as given, and vice versa.

The intermediate-good monopolist adopts the pricing strategy given by By Lemma 1 (ii). Substituting the set of optimal intermediate-good prices (6) into eqs.(1), (2) and (3) and then the obtained set of equilibrium outputs (y_A, y_B, y_C) into eq.(8), we obtain country A's welfare as a function of tariff rates. Analogous calculation derives country C's welfare. The Nash equilibrium tariffs are derived as follows:

(19) $$T = \frac{[m(m+1) - n(3n+2)](\alpha - k)}{(m+n+1)[2(m+1)^2 + (6m+7)n + 6n^2]},$$

(20) $$t = \frac{(m+3n+2)n(\alpha - k)}{(m+n+1)[2(m+1)^2 + (6m+7)n + 6n^2]}.$$

From eqs.(19), it follows that the optimal policy for country A is an import tariff (subsidy) on the final good if and only if $m(m+1) > n(3n+2)$ ($m(m+1) < n(3n+2)$). The intuition is similar to that of Lemma 2 in the pre-FTA situation. Moreover, we have the following Lemma:

Lemma 4

If $m(m+1) \geq n(3n+2)$ holds, the optimal policy for country A is not an import subsidy under both pre-FTA situation and the case where country A and B form a free-trade agreement.

(Proof) As shown in Lemma 2, the optimal policy for country A is an import tariff if and only if $m(m+1) > 2n(n+1)$. Since $n(3n+2) - 2n(n+1) = n^2 > 0$, the condition $m(m+1) > 2n(n+1)$ is always satisfied when $m(m+1) \geq n(3n+2)$. Q.E.D.

Putting Lemma 3 and 4 together, we can state that the output of each final-good producer in country A if $m(m+1) \geq n(3n+2)$ holds. In the following analysis, we assume that this condition is met.

Substitution of the Nash equilibrium tariff rates (19) and (20) yields the per-firm output levels of the final good in each country:

(21) $$y_A^* = y_B^* = \frac{(2m+3n+2)(\alpha - k)}{2[2(m+1)^2 + (6m+7)n + 6n^2]\beta},$$

(22) $$y_C^* = \frac{(m+3n+2)(\alpha - k)}{2[2(m+1)^2 + (6m+7)n + 6n^2]\beta},$$

and we obtain the total output of the final good, which also equals to that of the intermediate good:

(23) $$Y^* = \frac{[m^2 + m(3n+1) + (3n+2)n](\alpha - k)}{[2(m+1)^2 + (6m+7)n + 6n^2]\beta}.$$

The welfare level in each country under the FTA outcome is then derived as follows:

$$(24)\qquad W_A^* = \frac{M_2(\alpha-k)^2}{4(m+n+1)[2(m+1)^2+(6m+7)n+6n^2]^2\beta},$$

where $M_2 \equiv 2m(m+1)^3(3m+4)+(m+1)(42m^3+105m^2+72m+8)n$
$+(126m^3+329m^2+254m+48)n^2+6(33m^2+56m+19)n^3$
$+18(9m+7)n^4+54n^5>0,$

$$(25)\qquad W_B^* = \frac{(2m+3n+2)^2 n(\alpha-k)^2}{4[2(m+1)^2+(6m+7)n+6n^2]^2\beta},$$

$$(26)\qquad W_C^* = \frac{(m+3n+1)(m+3n+2)^2 n(\alpha-k)^2}{4(m+n+1)[2(m+1)^2+(6m+7)n+6n^2]^2\beta}.$$

3 Effects of FTA

In this section we examine the effects of FTA between country A and B by comparing the pre-FTA outcome with the outcome under FTA between A and B.

3.1. Tariff Rates

We begin with the comparison of tariff rates which the governments determine noncooperatively. Comparing country A's Nash equilibrium tariffs (11) and (19), we have $T_A > T$. This is because subtracting the numerator of T from that of T_A equals to $n^2(\alpha-k)>0$ and subtracting the denominator of T from that of T_A yields $-n[m(4m+7)+12mn+6n^2+11n+3]<0$.

Comparison of country C's Nash equilibrium tariffs is as follows. From eq.(12) and eq.(20), we have

$$(27)\qquad t_c - t = \frac{[(5m+4)n+6(m+1)n^2-m(m+1)(2m+1)]n^2(\alpha-k)}{2(m+n+1)[(m+1)^3+(m+1)(2m+3)n+n^2][2(m+1)^2+(6m+7)n+6n^2]}.$$

Hence, it follows that $t_c > (<) t$ if and only if $(5m+4)n+6(m+1)n^2 > (<) m(m+1)(2m+1)$.

As discussed in the previous section, we assume $m(m+1) \geq n(3n+2)$ so that the country A's tariff rates under both pre-FTA situation and FTA between country A and B are not negative. We now examine the compatibility of this condition with $(5m+4)n+6(m+1)n^2 > (<) m(m+1)(2m+1)$. In Figure 2, we draw two curves indicating the relationship between m and n that satisfies $T=0$ and $t_c = t$, respectively. It is readily shown that the $T=0$ curve lies above the $t_c = t$ curve. Since

we assume $m(m+1) \geq n(3n+2)$, we concentrate attention on the area on and below the $T=0$ curve. If (m,n) is in the scanty area between $T=0$ curve and $t_c = t$ curve (e.g., $m=2$ and $n=1$), it follows that $t_c > t$. Otherwise, $T>0$ implies $t_c < t$.

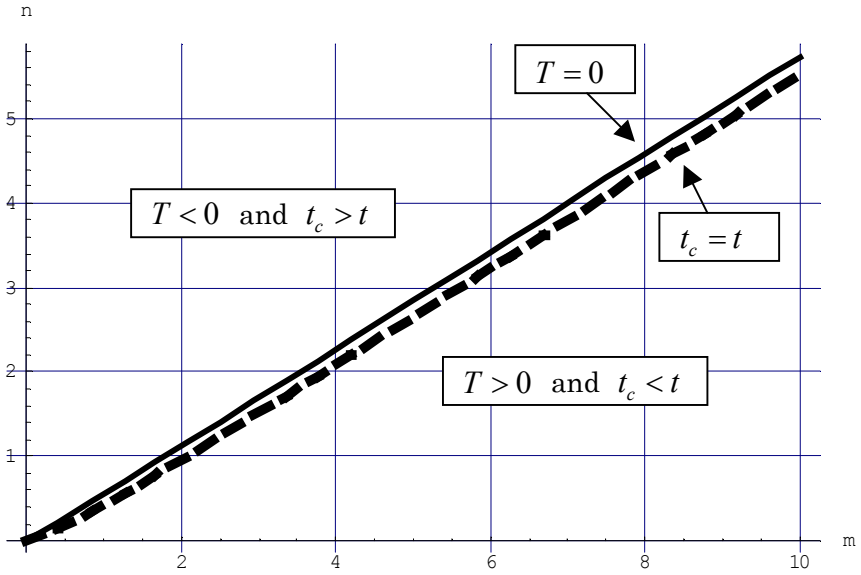

Figure 2: Comparison of Nash equilibrium tariff rates in country C

To sum up, we have the following Proposition:

Proposition 1

Suppose that $m(m+1) \geq n(3n+2)$ *holds. In comparison with the pre-FTA situation, FTA between country A and B (i) lowers the Nash equilibrium tariff rate in country A and (ii) lowers the Nash equilibrium tariff rate in Country C only if* $(5m+4)n + 6(m+1)n^2 > m(m+1)(2m+1) \geq (2m+1)n(3n+2)$ *and otherwise raises it.*

Proposition 1 has the following policy implications. First, FTA between country A and B also promotes a reduction of tariffs on imports from the non-member country. Therefore, "tariff complementarity" exists in the present model. Secondly, as shown in Figure 2, it is not easy to find the combination of firm numbers (m,n) such that $t_c > t$ holds, and in many cases the government of the non-member country has an incentive to choose more protectionist policy.

3.2. Output Levels

Next we examine how output levels and trade volumes change due to the formation of FTA. By direct calculation, we obtain the following Proposition (see Appendix A.1 for details):

Proposition 2

Suppose that $m(m+1) \geq n(3n+2)$ *holds. In comparison with the pre-FTA situation, FTA between country A and B (i) decreases the final-good output per firm in country A, (ii) increases the final-good output per firm in country B, (iii) increases (decreases) the final-good output per firm in country C if and only if* $t_C < t$ ($t_C > t$), *(iv) increases the total output of the final-good in the world and hence the intermediate-good output, and (v) increases the trade volume.*

From (i) and (ii) of Proposition 2, we see that the FTA between country A, which has a comparative advantage in the intermediate good, and country B, which has a comparative advantage in the final good, makes the international specialization between these countries more efficient. This production efficiency also increases the worldwide output.

As for the production in country C, Proposition 2 (iii) indicates that whether or not it increases depends on the tariff rate imposed by country C's government on the import of the intermediate good. Intuitively, if country C's government raises the tariff rate, the intermediate-good monopolist sets higher price on the sales to firms in country C, which increases the production costs of those firms. At the same time, the government in country A unambiguously reduces the tariff rate, which directly decreases the production costs of the final-good firms in country C, and this direct effect outweighs the indirect price effect. Therefore, the output of each final-good firm in country C increases with a rise in the tariff level that country C's government imposes on the imported intermediate good. In light of Proposition 1 (ii), the possibility of $y_C^{\mathrm{Pre}} > y_C^*$ cannot be ruled out, but in many cases it holds that $y_C^{\mathrm{Pre}} < y_C^*$, the final-good output per firm in the non-member country increases in response to the formation of the FTA.

Proposition 2 also illustrates the effects of FTA on trade volume. From (ii) and (v) of Proposition 2, it holds that the FTA promotes international trade between all countries as well as between country A and B. In addition, Proposition 2 (iii) shows that the trade volume between country A and C may increase, although in the limited case where $(5m+4)n + 6(m+1)n^2 > m(m+1)(2m+1) \geq (2m+1)n(3n+2)$ is satisfied.

3.3. Welfare

In this subsection we discuss whether the governments in country A and B have an incentive to make a free-trade agreement by comparing the welfare levels of these countries under FTA with the pre-FTA welfare. We also examine the effect of the FTA on country C's welfare.

We begin with the analysis by assuming the simplest case, $n=1$. Then, in light of Lemma 4, we assume $m \geq 2$. Under these assumptions, it follows that

$$(28) \qquad W_A^{\mathrm{Pre}} - W_A^* = \frac{M_3(\alpha-k)^2}{8(m+2)(2m^2+10m+15)^2(m^3+5m^2+8m+5)^2\beta},$$

$$\text{where} \quad M_3 \equiv 2m^9+20m^8+33m^7-438m^6-3111m^5 - 9896m^4-18215m^3-20010m^2-12200m-3100,$$

$$(29) \qquad W_B^{\mathrm{Pre}} - W_B^* = \frac{M_4(\alpha-k)^2}{16(2m^2+10m+15)^2(m^3+5m^2+8m+5)^2\beta},$$

$$\text{where} \quad M_4 \equiv -12m^8-160m^7-852m^6-2156m^5 - 1771m^4+3890m^3+11820m^2+12200m+4700,$$

$$(30) \qquad W_C^{\mathrm{Pre}} - W_C^* = \frac{M_5(\alpha-k)^2}{16(2m^2+10m+15)^2(m^3+5m^2+8m+5)^2(m+2)\beta},$$

$$\text{where} \quad M_5 \equiv (m+4)(10m-3m^2-2m^3+10)(190m+129m^2+38m^3+4m^4+110),$$

$$(31) \qquad \sum_{i=A,B} W_i^{\mathrm{Pre}} - \sum_{i=A,B} W_i^* = \frac{M_6(\alpha-k)^2}{16(m+2)(2m^2+10m+15)^2(m^3+5m^2+8m+5)^2\beta},$$

$$\text{where} \quad M_6 \equiv -8m^9-144m^8-1106m^7-4736m^6-12305m^5 - 19444m^4-16830m^3-4180m^2+4700m+3200.$$

From the above expressions, we obtain the following proposition (see Appendix A.2 for proof):

Proposition 3

Suppose $n=1$ and $m \geq 2$. In comparison with the pre-FTA situation, FTA between country A and B (i) improves country A's welfare only if $2 \leq m \leq 5$ and otherwise deteriorates it, (ii) always improves country B's welfare, (iii) deteriorates country C's welfare only if $m=2$ and otherwise improves it, and (iv) unambiguously improves the

sum of welfare in country A and B.

Proposition 3 has the following policy implications. First, the formation of FTA is not always beneficial to country A, which imports the final good in exchange for exporting the intermediate good. Consumers gain from more consumption and lower price, but producers of the final good suffers from a decrease in profits, and the government loses tariff revenue.[4] Only if there are few final-good firms in country A, the positive effect of FTA on consumer's surplus outweighs the negative effects on firms' profits and tariff revenue.

Secondly, FTA is certainly beneficial to country B and the member countries as a whole. This means that even if the FTA decreases country A's welfare, income transfer from country B to A can compensate the welfare loss.

Finally, the FTA between country A and B is harmful to the non-member country C in a very limited case.[5] In connection with the second point, we can say that in the presence of income redistribution between the member countries, the formation of FTA between country A and B is strictly Pareto-improving if $m \geq 3$. It seems that the classical theorem on preferential trade agreements by Ohyama (1972) and Kemp and Wan (1976) reappears. However, notice that Proposition 1 and 2 imply that the export from country C strictly reduces after the FTA if $m \geq 3$. Therefore, even if the condition which is required in the Ohyama-Kemp-Wan theorem that trade volume between member countries and non-members remains unchanged is not satisfied, the formation of FTA can achieve the strict Pareto improvement.

Are the statements in Proposition 3 robust? We discuss it by examining cases for $n \geq 2$. Table 1 summarizes the result for $n = 2,3,4,5,6$. It demonstrates that, for each n, the formation of FTA improves country A's welfare only when m is not so large and for larger values for m the FTA is harmful to country A. It also shows that the FTA between country A and B may reduce welfare of the non-member country C, but the case is only when m is small (within the compass of $T \geq 0$) for each n, and there are values for n such that the FTA strictly improves country C's welfare for all m satisfying $T \geq 0$. Although comparisons of country B's welfare and the sum of welfare of member countries are not scheduled in Table 1, we calculate them to obtain the result

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[4] Notice that the formation of FTA does not decrease the monopoly profit of the intermediate-good producer.

[5] In light of eq.(30), it is clear that the FTA between country A and B improves (deteriorates) country C's welfare if and only if $t_C < t$ ($t_C > t$). In other words, the non-member country becomes better off from an FTA if that country increases the tariff and hence the domestic firms increase their outputs.

on the side of Proposition 3; i.e., the FTA improves country B's welfare and the sum of welfare of member countries for all m satisfying $T \geq 0$.

n \ m	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
2	$W_A^{\mathrm{Pre}} < W_A^*$							$W_A^{\mathrm{Pre}} > W_A^*$																							
3	—			$W_A^{\mathrm{Pre}} < W_A^*$								$W_A^{\mathrm{Pre}} > W_A^*$																			
4	—					$W_A^{\mathrm{Pre}} < W_A^*$												$W_A^{\mathrm{Pre}} > W_A^*$													
5	—							$W_A^{\mathrm{Pre}} < W_A^*$																$W_A^{\mathrm{Pre}} > W_A^*$							
6	—											$W_A^{\mathrm{Pre}} < W_A^*$																$W_A^{\mathrm{Pre}} > W_A^*$			

(i) Welfare in country A

n \ m	4	5	6	7	8	9	10	11	12	13	14
2	$W_C^{\mathrm{Pre}} < W_C^*$										
3	—			$W_C^{\mathrm{Pre}} < W_C^*$							
4	—			$W_C^{\mathrm{Pre}} > W_C^*$	$W_C^{\mathrm{Pre}} < W_C^*$						
5	—					$W_C^{\mathrm{Pre}} > W_C^*$	$W_C^{\mathrm{Pre}} < W_C^*$				
6	—							$W_C^{\mathrm{Pre}} < W_C^*$			

(ii) Welfare in country C

Table 1: Comparison of welfare between pre-FTA and FTA solutions

4 Global Free Trade

In this section, we consider free trade between country A, B and C, and compare the levels of final-good output, volume of trade, and welfare with those under pre-FTA and FTA between country A and B. Since we consider trade between three countries, this situation can be interpreted as global free trade. Alternatively, such a situation can be interpreted as the coexistence of two FTAs, i.e., country A makes an FTA with country C

independently of the FTA between country B. Nevertheless, we use the term "global free trade" in order to address whether the multilateral trade liberalization should be achieved gradually or radically (see Section 4.3).

By Lemma 1 (iii), the intermediate-good monopolist adopts uniform pricing and the intermediate-good prices are given by eq.(7). Substituting $T_A = t_B = t_C = 0$ and eq.(7) into eqs.(1), (2), (3), we obtain the final-good output levels per firm under free trade:

$$(32) \qquad y_A^{**} = y_B^{**} = y_C^{**} = \frac{\alpha - k}{2(m+2n+1)\beta},$$

and the total output of the final good is derived as follows:

$$(33) \qquad Y^{**} = \frac{(m+2n)(\alpha - k)}{2(m+2n+1)\beta}.$$

The welfare level in each country is then obtained as

$$(34) \qquad W_A^{**} = \frac{[3m^2 + 4(m+n)(3n+1)](\alpha - k)^2}{8(m+2n+1)^2\beta},$$

$$(35) \qquad W_B^{**} = W_C^{**} = \frac{n(\alpha - k)^2}{4(m+2n+1)^2\beta}.$$

4.1. Trade Volume

Comparison of output per firm in each country, total output and trade volume in each country yields

$$(36) \qquad y_A^{*} - y_A^{**} = y_B^{*} - y_B^{**} = \frac{mn(\alpha - k)}{2(m+2n+1)[2(m+1)^2 + (6m+7)n + 6n^2]\beta} > 0,$$

$$(37) \qquad y_C^{*} - y_C^{**} = -\frac{m(m+n+1)(\alpha - k)}{2(m+2n+1)[2(m+1)^2 + (6m+7)n + 6n^2]\beta} < 0,$$

$$(38) \qquad Y^{*} - Y^{**} = -\frac{mn(\alpha - k)}{2(m+2n+1)[2(m+1)^2 + (6m+7)n + 6n^2]\beta} < 0,$$

$$(39) \qquad n(y_B^{*} + y_C^{*}) - n(y_B^{**} + y_C^{**}) = -\frac{m(m+1)n(\alpha - k)}{2(m+2n+1)[2(m+1)^2 + (6m+7)n + 6n^2]\beta} < 0.$$

It directly follows from the above expressions that:

Proposition 4

In comparison with the case in which country A and B form a free trade agreement, global free trade with country C (i) decreases the final-good output per firm in country A and B, and (ii) increases the final-good output per firm in country C, the total output of the final-good in the world and hence the intermediate-good output, and the trade

volume.

4.2. Welfare

A particular interest is whether participation of country C into the FTA formed by country A and B is beneficial to each country. Hence, we compare the welfare levels under free trade with those under FTA between country A and B. Comparison of eqs.(34) and (35) with eqs. (24), (25) and (26), it follows that

$$(40)\qquad W_A^* - W_A^{**} = \frac{M_7(\alpha-k)^2}{8(m+n+1)(m+2n+1)^2[2(m+1)^2+(6m+7)n+6n^2]^2\beta},$$

where
$$\begin{aligned} M_7 \equiv -n[&-2m^5+2m^4(n-3)+m^3(56n^2+27n-6)\\ &+m^2(188n^3+227n^2+65n-2)\\ &+4mn(2n+1)(3n+2)(11n+7)+4n(6n^2+7n+2)^2], \end{aligned}$$

$$(41)\qquad W_B^* - W_B^{**} = \frac{mn^2[4(m+1)^2+(13m+14)n+12n^2](\alpha-k)^2}{4(m+2n+1)^2[2(m+1)^2+(6m+7)n+6n^2]^2\beta} > 0,$$

$$(42)\qquad W_C^* - W_C^{**} = \frac{M_8(\alpha-k)^2}{4(m+n+1)(m+2n+1)^2[2(m+1)^2+(6m+7)n+6n^2]^2\beta},$$

where
$$\begin{aligned} M_8 \equiv n[&-m(m+1)^3(3m+4)-(m+1)^2(3m+4)(5m-2)n\\ &-(m+1)(17m^2-24m-56)n^2\\ &+(39m^2+174m+146)n^3+12(9m+14)n^4+72n^5], \end{aligned}$$

$$(43)\qquad \sum_{i=A,B,C} W_i^* - \sum_{i=A,B,C} W_i^{**}$$
$$= -\frac{mn[4(m+1)^2(m+2)+(20m^2+55m+36)n+4(9m+13)n^2+24n^3](\alpha-k)^2}{8(m+2n+1)^2[2(m+1)^2+(6m+7)n+6n^2]^2\beta} < 0.$$

Since the sign of eq.(42) is ambiguous, country C does not necessarily have an incentive to choose free trade.

Although the signs of eq.(40) and eq.(42) are ambiguous, we obtain the following Proposition from eqs.(41) and (43):

Proposition 5

In comparison with the case in which country A and B make a free trade agreement, global free trade with country C (i) reduces welfare in country B, and (ii) increases the world welfare.

Even if the welfare effects of global free trade on country A and C are ambiguous, we can say from Proposition 5 (ii) that the global free trade is strictly Pareto-improving in comparison with the bilateral FTA if appropriate income redistribution among the member countries is implemented. At the same time, Proposition 5 (i) states that in the absence of international income redistribution there is at least one country, namely country B, which strictly becomes worse off after global free trade.

Let us further investigate the signs of eq.(40) and eq.(42). We calculate them for $n = 1, 2, 3, 4, 5, 6$ and Table 2 summarizes the results. We obtain similar conclusion to that we made a comparison between pre-FTA situation and the two-country FTA. That is, for each n, the participation of country C in the FTA improves country A's welfare only when m is not so large and otherwise deteriorates it, and improves country C's welfare unless m is small (within the compass of $T \geq 0$) for each n.

numbers of fims	country A	country C
$n=1 \quad (m \geq 2)$	$W_A^* < W_A^{**}$ if $2 \leq m \leq 7$ $W_A^* > W_A^{**}$ if $m \geq 8$	$W_C^* < W_C^{**}$ for $\forall m \geq 2$
$n=2 \quad (m \geq 4)$	$W_A^* < W_A^{**}$ if $4 \leq m \leq 15$ $W_A^* > W_A^{**}$ if $m \geq 16$	$W_C^* < W_C^{**}$ for $\forall m \geq 4$
$n=3 \quad (m \geq 6)$	$W_A^* < W_A^{**}$ if $6 \leq m \leq 22$ $W_A^* > W_A^{**}$ if $m \geq 23$	$W_C^* < W_C^{**}$ for $\forall m \geq 6$
$n=4 \quad (m \geq 7)$	$W_A^* < W_A^{**}$ if $7 \leq m \leq 29$ $W_A^* > W_A^{**}$ if $m \geq 30$	$W_C^* > W_C^{**}$ if $m = 7$ $W_C^* < W_C^{**}$ if $m \geq 8$
$n=5 \quad (m \geq 9)$	$W_A^* < W_A^{**}$ if $9 \leq m \leq 36$ $W_A^* > W_A^{**}$ if $m \geq 37$	$W_C^* > W_C^{**}$ if $m = 9$ $W_C^* < W_C^{**}$ if $m \geq 10$
$n=6 \quad (m \geq 11)$	$W_A^* < W_A^{**}$ if $11 \leq m \leq 43$ $W_A^* > W_A^{**}$ if $m \geq 44$	$W_C^* > W_C^{**}$ if $m = 11$ $W_C^* < W_C^{**}$ if $m \geq 12$

Table 2: Comparison of welfare between FTA and free trade solutions

4.3. Gradual vs. Radical Trade Liberalization

Putting Proposition 3 and 5 together, we can state that a "gradual trade liberalization" in the sense that, after a formation of free trade agreement between

country A and B, global free trade, is strictly Pareto-improving provided international income redistribution is properly implemented. Now we would like to consider a "radical and global trade liberalization," in which these three countries make a free trade agreement without step by step procedure. Is such a radical procedure beneficial, and is it better than the gradual liberalization?

We begin with the first question, i.e., whether the radical trade liberalization improve the world welfare in comparison with the pre-FTA outcome. From eqs. (31) and (43), it follows that

$$(44)\qquad \sum_{i=A,B,C} W_i^{\mathrm{Pre}} - \sum_{i=A,B,C} W_i^{**} = \frac{-(m^2+m+mn-2n^2)M_9(\alpha-k)^2}{8(m+2n+1)^2[(m+1)^3+(m+1)(2m+3)n+n^2]^2\beta},$$

$$\text{where}\quad M_9 \equiv n[2(m+1)^3(m+2)+(m+n+1)n(8m^2+23m+16)+2n^3] > 0.$$

The sign of eq.(44) depends on the numbers of final-good firms m and n. However, since we assume $m(m+1) \geq n(3n+2)$,

$$m(m+1) \geq n(3n+2) \quad \Leftrightarrow \quad m^2+m+mn \geq 3n^2+2n+mn > 2n^2$$

holds, and hence we have $\sum_{i=A,B,C} W_i^{\mathrm{Pre}} < \sum_{i=A,B,C} W_i^{**}$.

Proposition 6

Suppose that $m(m+1) \geq n(3n+2)$ holds. Then, in comparison with the pre-FTA situation, the global free trade is strictly Pareto-improving in the presence of income redistribution between countries.

Next we discuss whether the radical trade liberalization dominates the gradual one. Comparing eq.(18) with eq.(35), we have

$$(45)\qquad W_C^{\mathrm{Pre}} - W_C^{**} = \frac{M_{10}n(\alpha-k)^2}{16(m+2n+1)^2[(m+1)^3+(m+1)(2m+3)n+n^2]^2\beta},$$

$$\begin{aligned}\text{where}\quad M_{10} \equiv\ & -m(m+1)^4(3m+4)-8(m+1)^3(m^2+m-1)n \\ & +(m+1)^2(7m^2+36m+48)n^2+4(m+1)(7m^2+24m+22)n^3 \\ & +4(3m^2+12m+11)n^4.\end{aligned}$$

Even in the light of the assumption $m(m+1) \geq n(3n+2)$, the sign of M_{10} is ambiguous. Let us suppose $n=5$ for example. Then, the condition $m(m+1) \geq n(3n+2)$ is satisfied if $m \geq 9$. In this case, it holds that $M_{10} = 927500 > 0$ if $m=9$, but $M_{10} = -1060900 < 0$ if $m=10$ and $M_{10} < 0$ for $m \geq 10$. Therefore, depending on the numbers of the final-good firms, country C may or may not have an

incentive to participate in the global free trade agreement from the pre-FTA situation. Moreover, whether country A and B prefer the radical trade liberalization to the gradual one is also dependent on the numbers of firms. Country A and B make a choice to bring country C in the free trade agreement rather than to form the FTA alone if the welfare gain under the global FTA is larger than that under the two-country FTA. However, since

$$(46)\qquad \left(\sum_{i=A,B} W^{\mathrm{Pre}} - \sum_{i=A,B} W_i^{*}\right) - \left(\sum_{i=A,B} W_i^{\mathrm{Pre}} - \sum_{i=A,B} W_i^{**}\right)$$

$$= \frac{M_{11} n(\alpha - k)^2}{8(m+n+1)(m+2n+1)^2[2(m+1)^2 + (6m+7)n + 6n^2]^2 \beta},$$

where $M_{11} \equiv -2m^5 - 6m^4(n+1) + m^3(22n^2 + 3n - 6)$

$$+ m^2(138n^3 + 157n^2 + 41n - 2)$$

$$+ 8mn(2n+1)(3n+2)(5n+3) + 4n(6n^2 + 7n + 2)^2$$

and M_{11} may take any sign, the sign of eq.(46) is in general ambiguous. If $M_{11} > 0$, eq.(46) implies $\left(\sum_{i=A,B} W_i^{**} - \sum_{i=A,B} W_i^{\mathrm{Pre}}\right) > \left(\sum_{i=A,B} W_i^{*} - \sum_{i=A,B} W_i^{\mathrm{Pre}}\right)$, that is, the FTA consisting of country A and B prefers the radical trade liberalization to the gradual liberalization. If $M_{11} < 0$, the opposite holds, i.e., the original FTA members prefers the gradual liberalization to the radical liberalization.

Let us consider a case when $n = 5$ (and hence $m \geq 9$). For country C, eq.(45) implies that $W_C^{\mathrm{Pre}} > W_C^{**}$ if $m = 9$ and $W_C^{\mathrm{Pre}} < W_C^{**}$ if $m \geq 10$. Turning to the potential FTA members (i.e., country A and B), eq.(46) implies that $M_{11} > 0$ if $9 \leq m \leq 23$ and $M_{11} < 0$ if $m \geq 24$. Therefore, if $10 \leq m \leq 23$, both $W_C^{\mathrm{Pre}} < W_C^{**}$ and $\left(\sum_{i=A,B} W_i^{**} - \sum_{i=A,B} W_i^{\mathrm{Pre}}\right) > \left(\sum_{i=A,B} W_i^{*} - \sum_{i=A,B} W_i^{\mathrm{Pre}}\right)$ hold, that is, global and radical trade liberalization is preferable for both country C and the potential FTA consisting of country A and B. However, if $m \geq 24$, such liberalization is less preferable for the potential FTA to gradual liberalization. To sum up, we can conclude that

Proposition 7

Starting from the tariff-war situation, the gradual trade liberalization may be

preferable to the global and radical trade liberalization if there are sufficiently large number of final-good firms in country A (importer of the final good) compared with those in country B and C (exporters of the final good). If the number of final-good firms in country A is not so large, the opposite holds.

5 Conclusion

Despite the importance of vertical production and trade structure in actual trade transactions, questions concerning preferential trade agreements in the presence of vertical trade structure are still open. In this paper, we attempt to fill the gap by examining effects of a formation of a free trade agreement between countries with vertical production and trade relationship under imperfect competition in a three-country model. It is shown that a bilateral free trade agreement between a country exporting an intermediate good and a country that produces a final good using the imported intermediate good and exports the final good increases the volume of trade within the FTA and the world production. The member country reduces the external tariff on the final good produced in the non-member country, and hence there is a tariff complementarity. Trade between the signatory country and the outside country may or may not diminish, depending on the number of final-good firms in each country. While welfare in the signatory country exporting the final good unambiguously improves, other countries may or may not be better off. Nevertheless, the sum of welfare of FTA members unambiguously improves. Therefore, in the presence of income redistribution between the signatory countries, the FTA formation is strictly Pareto improving for them. In addition, depending on the numbers of final-good firms, the non-member country may be better off, and hence the bilateral FTA can be Pareto improving for the world economy.

We also discussed the possibility of multilateral trade liberalization followed by the two-country FTA, by comparing welfare levels under two-country FTA with those under three-country free trade. While world welfare increases under global free trade in comparison with the bilateral FTA, the FTA member country exporting the final good becomes worse off and, welfare effects on other countries is ambiguous. This result suggests that global free trade followed by a bilateral trade liberalization is difficult to achieve without appropriate income transfers. Moreover, such a “gradual” trade liberalization may or may not be preferred to a “radical” liberalization in the sense that the countries achieve free trade without going through bilateral agreements, depending on the number of final-good firms in each country.

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Appendix

A.1 Comparison of Output Levels

From eq.(14) and eq.(21), we have

$$y_A^{\mathrm{Pre}} - y_A^* = \frac{[m(m+1)^2 + 4m(m+1)n - 2n^2(3n+2)]n(\alpha - k)}{2[(m+1)^3 + (m+1)(2m+3)n + n^2][2(m+1)^2 + (6m+7)n + 6n^2]\beta}.$$

Since

$$\begin{aligned} &m(m+1)^2 + 4m(m+1)n - 2n^2(3n+2) \\ &> 2m(m+1)n - 2n^2(3n+2) = 2n[m(m+1) - n(3n+2)], \end{aligned}$$

it holds that $y_A^{\mathrm{Pre}} > y_A^*$ under the assumption $m(m+1) > n(3n+2)$.

From eq.(15) and eq.(21), we have

$$y_B^{\mathrm{Pre}} - y_B^* = \frac{[(3m+4)n^2 + 6(m+1)n^3 - 2m(m+1)^3 - m(m+1)(6m+7)n](\alpha - k)}{4[(m+1)^3 + (m+1)(2m+3)n + n^2][2(m+1)^2 + (6m+7)n + 6n^2]\beta}.$$

Since

$$\begin{aligned} &(3m+4)n^2 + 6(m+1)n^3 - 2m(m+1)^3 - m(m+1)(6m+7)n \\ &< (4m+4)n^2 + 6(m+1)n^3 - m(m+1)(6m+6)n \\ &< 2(m+1)n[n(3n+2) - 3m(m+1)] < 2(m+1)n[n(3n+2) - m(m+1)], \end{aligned}$$

it holds that $y_B^{\mathrm{Pre}} < y_B^*$ under the assumption $m(m+1) > n(3n+2)$.

From eq.(15) and eq.(22), we have

$$y_C^{\mathrm{Pre}} - y_C^* = -\frac{[m(m+1)(2m+1) - (5m+4)n - 6(m+1)n^2]n(\alpha - k)}{4[(m+1)^3 + (m+1)(2m+3)n + n^2][2(m+1)^2 + (6m+7)n + 6n^2]\beta}.$$

In light of eq.(27), it follows that $\mathrm{sgn}[y_C^{\mathrm{Pre}} - y_C^*] = \mathrm{sgn}[t_C - t]$

From eq.(16) and eq.(23), we have

$$Y^{\text{Pre}} - Y^* = \frac{[2n^2(3n+2) - 4m(m+1)n - m(m+1)^2]n(\alpha - k)}{2[(m+1)^3 + (m+1)(2m+3)n + n^2][2(m+1)^2 + (6m+7)n + 6n^2]\beta}.$$

Since $\text{sgn}[Y^{\text{Pre}} - Y^*] = -\text{sgn}[y_A^{\text{Pre}} - y_A^*]$, it holds that $Y^{\text{Pre}} < Y^*$ under the assumption $m(m+1) > n(3n+2)$.

Finally, we obtain

$$\begin{aligned} & n(y_B^{\text{Pre}} + y_C^{\text{Pre}}) - n(y_B^* + y_C^*) \\ &= \frac{(m+1)[2n^2(3n+2) - m(m+1)^2 - 4m(m+1)n](\alpha - k)}{2[(m+1)^3 + (m+1)(2m+3)n + n^2][2(m+1)^2 + (6m+7)n + 6n^2]\beta} \\ &= \frac{m+1}{n}(Y^{\text{Pre}} - Y^*) < 0. \end{aligned}$$

A.2 Proof of Proposition 3

The values of M_3 in eq.(28) for $m = 2,3,4,5,6$ are derived as follows:

$M_3 = -528812 < 0$ if $m = 2$,
$M_3 = -2345689 < 0$ if $m = 3$,
$M_3 = -6675228 < 0$ if $m = 4$,
$M_3 = -11294975 < 0$ if $m = 5$,
$M_3 = 802820 > 0$ if $m = 6$.

In addition, since M_3 is a polynomial function with positive coefficients for higher orders of m, M_3 is increasing in m for $m \geq 7$. It therefore follows that $W_A^{\text{Pre}} < W_A^*$ if $2 \leq m \leq 5$ and $W_A^{\text{Pre}} > W_A^*$ if $m \geq 6$.

Analogously, the values of M_4 in eq.(29) and M_6 in eq.(31), respectively, for $m = 2$ are $M_4 = -67908 < 0$ and $M_6 = -1329256 < 0$. Since both M_4 and M_6 are polynomial functions with negative coefficients for higher orders of m, they are decreasing in m for $m \geq 3$. It therefore follows that $W_B^{\text{Pre}} < W_B^*$ and $\sum_{i=A,B} W_i^{\text{Pre}} < \sum_{i=A,B} W_i^*$.

The values of M_5 in eq.(30) are as follows:

$M_5 = 16488 > 0$ if $m = 2$,
$M_5 = -915817 < 0$ if $m = 3$.

M_5 is also a polynomial function with negative coefficients for higher orders of m,

meaning that it is decreasing in m and hence $W_C^{\mathrm{Pre}} < W_C^*$ holds if $m \geq 3$. Q.E.D.

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