Economic Integration and Rules of Origin
under International Oligopoly*

Jota Ishikawa[†]   Hiroshi Mukunoki   Yoshihiro Mizoguchi

Hitotsubashi University   Gakushuin University   Hitotsubashi University

August 25, 2005

Abstract

Free trade agreements (FTAs) have rules of origin (ROOs) to prevent tariff circumvention by firms of non-member countries. This paper points out that in imperfectly competitive markets, ROOs have another role overlooked in the existing literature. Instead of focusing on the impacts of ROOs in the intermediate-good markets, we draw our attention to the final-good markets to examine the effects of ROOs. We find that under some conditions, ROOs benefit both firms at the expense of consumers. Under some other conditions, ROOs benefit the firm producing outside the FTA and hurt the firm producing inside the FTA.

JEL Classification Numbers: F12, F13, F15

Keywords: rules of origin; free trade agreements; market segmentation; market integration

1 Introduction

Recently, many countries and regions have been attempting to make regional trade agreements (RTAs) in order to strengthen economic ties with specific trading partners. Typical RTAs are "customs union" (CU) and "free trade agreement"/"free trade area" (FTA). While under the CU framework, members jointly set common external tariffs, in the case of the FTA, each member has independence in choosing external tariffs. Thus, were it not for any regulation in an FTA and assuming the absence of transport costs, imports from outside of the FTA would be channeled through the member country with the lowest tariffs. The development of such tariff circumvention would have negative effects on the member countries with respectively higher tariffs, shrinking their tariff revenue. Such incentive arising from low-tariff advantage may lead to a race to the bottom in setting tariffs (see Richardson, 1995). Moreover, the firms within the countries with higher tariffs face keener competition, because the export costs of the rival firms located outside the FTA fall. Thus, it is claimed that to prevent such tariff circumvention, rules of origin (ROOs), which condition goods to be regarded as produced within the FTA so that they are traded among FTA members without tariffs, are indispensable to FTAs.[1] In fact, to our knowledge, all of the existing FTAs establish such ROOs.

ROOs are often based on percentage of value added.[2] Thus, most studies on the *role* of ROOs focus on the intermediate-good markets. In particular, many of them examine the role of ROOs through the perspective of content protection, because producers are likely to respond so as to have their products qualified for FTA preferential treatment when ROOs are employed or when ROOs become more restrictive.[3] In order to understand

---

[1] Strictly speaking, ROOs are divided into two categories: non-preferential and preferential origin rules. The former is used for statistical purposes, while the latter is used to judge whether or not advantageous tariff treatments should be provided. The preferential origin rules are divided into two more categories: rules on general preferential treatment for developing countries (i.e. ROOs for the Generalized System of Preferences (GSP)) and rules relating to RTAs.

[2] There are two other methods to determine the origin. These are based on changes in tariff heading and on technical definition, respectively. For details, see Falvey and Reed (1998) and WTO (2002). Note that some ROOs, such as those of NAFTA, combine the methods based on percentage of value added and based on changes in tariff heading.

[3] See Krishna and Krueger (1995), Krueger (1999), Rosellón (2000), Rodriguez (2001), and Ju and Krishna (2002), among others. There are studies that address more than a binary choice to meet or not meet ROOs. For example, Cadot et al. (2005) and Duttagupta and Panagariya (2003) consider the aspect of political economy in their analysis of ROOs. However, their focus is mainly on the intermediate-good markets, too.

better the nature of ROOs, it is important to broaden research by examining ROOs from a different viewpoint. The purpose of this paper is to examine other roles of ROOs by directing our attention to the final-good market rather than the intermediate-good market.

It should be emphasized that the focus of the investigation lies not in the effects of FTA formation accompanied by ROOs but rather in the effects of ROOs alone. It is important to distinguish the effects of ROOs from those of FTA formation, because FTAs are accompanied by tariff-elimination as well as ROOs. Thus, we do not explicitly model FTA formation, but rather treat FTAs as a given factor in the assumptions for our analysis. We extract the pure effects of ROOs by contrasting FTAs with and without ROOs. Although an FTA without ROOs is unrealistic, this provides a useful benchmark to isolate the direct effect of ROOs from other effects.[4]

Particularly, we point out that in imperfectly competitive markets, ROOs play an important role which has been overlooked in the existing literature. The products which satisfy ROOs are freely traded within the FTA, while the products which do not are subject to tariffs when being traded among the FTA members. That is, the markets for the former products are completely integrated, whereas those for the latter products are not. This obviously results in different pricing behavior among firms. The firms meeting ROOs are forced to set a uniform price due to arbitrage, while those which do not meet ROOs, to some extent, can exercise price-discrimination. That is, ROOs affect market powers.

We investigate the role of ROOs in a simple Bertrand duopoly model: one firm produces a final good within an FTA (henceforth, the inside firm) and the other firm produces a final good outside the FTA (henceforth, the outside firm). These two goods are imperfect substitutes to each other. In our analysis, we focus on a simple case where the inside firm meets ROOs while the outside firm does not. In order to extract the effects of ROOs alone, we compare profits, prices, tariff revenue, and welfare with and without ROOs. Taking into account the two effects of ROOs, namely, the well-known effect of tariff circumvention prevention and the indirect effect of inside firm's market power mitigation, we build several outcomes incorporating the varying degrees of these two effects. Two cases, mentioned below, strike us as particularly interesting.

---

[4]Even if the tariff-elimination effect of FTA formation is taken into account, the effects of ROOs pointed out in this paper could outweigh it. See Section 3.4 (particularly, footnote 21). For further details, see Ishikawa and Mukunoki (2005) that analyzes the effects of FTA formation by taking tariff-elimination as well as ROOs into account.

In one case, both firms gain from ROOs at the expense of consumers. This implies that ROOs could serve as an anti-competitive device. This effect of ROOs is novel. In her analysis of FTAs, Krueger (1999) indicates that ROOs result in an important protectionist bias inherent in FTAs but not present in CUs. This protectionist bias stems from distortions in the intermediate-good markets. This paper isolates an additional distortion in FTAs arising in the final-good markets.

In another case, ROOs benefit the outside firm and hurt the inside firm. This outcome is a striking contrast to the studies that are concerned with the aspects of content protection. In those studies, producers try to meet ROOs to receive duty-free access in an FTA, while in our analysis, producers may not have such incentive. In fact, it is an option for the inside firm to meet ROOs and then enjoy tariff-free access to FTA member countries. In our analysis, we derive a condition under which the inside firm actually complies with ROOs but loses from ROOs; in other words, the losses become much larger if the inside firm will not comply with ROOs.

Anson et al.(2003) empirically show that only some of Mexican firms follow the ROOs in NAFTA.[5] Theoretical studies by Ju and Krishna (2002, 2005) attribute the reason of non-compliance to the price-increase of the intermediate goods produced within FTA. Our analysis suggests another reason why firms choose not to meet ROOs. By complying with ROOs, on one hand, firms can gain from the advantage of zero tariffs, but at the same time, lose pricing power as they are forced into uniform-pricing across the markets. By not following ROOs, firms can discriminate prices across the markets but have to pay tariffs. If the latter effect dominates the former, firms may not follow ROOs.[6]

It is often said that FTAs could induce foreign direct investment (FDI) from non-member countries. In our analysis, the outside firm could gain from ROOs; this development suggests that indirectly ROOs may deter the outside firm from undertaking FDI in the FTA.

There exists some literature which is closely related to our work in the sense that both market integration and segmentation play a crucial role. Takechi and Kiyono (2003) compare two kinds of local content schemes in a two-country model under perfect competition. They show that the effects of local content scheme crucially depend on how

---

[5] The overall rate of the compliance was 64% in 2000. There were large fluctuations across sectors: 97% for vehicles, and 20% for furniture, for instance. We thank anonymous referees for pointing out the possibility of the non-compliance.

[6] Ishikawa and Mukunoki (2005) examine in detail why FTA formation may not lead firms to comply with ROOs.

the local content scheme segments the final-good markets. We should note that the specific feature of this paper is the *coexistence* of completely and incompletely integrated (or segmented) markets for a differentiated final product in an FTA. Furthermore, since their analysis is that of content protection, both intermediate goods and FDI are indispensable. In contrast, as neither intermediate goods nor FDI are crucial to make our argument, we do not explicitly deal with them in our analysis.

Horn and Shy (1996), in their analysis of bundling products with non-tradable services, also consider a case where the integrated and segmented markets coexist. Using a spatial duopoly model, they show that in equilibrium, one firm will bundle its product with local service while the other firm will not. As a result, the markets are segmented for the former good, and integrated for the latter. While this feature is similar to ours, the focus of their analysis is obviously different. Moreover, we implement a benchmark in which both markets are integrated, whereas their benchmark reflects a case of both markets being segmented.

The remainder of this paper is organized as follows. Section 2 presents the basic model, Section 3 compares FTAs with and without ROOs, and Section 4 provides some concluding remarks. All proofs of Lemmas and Propositions are delegated to Appendix.

2   Model

We consider an FTA with two members, country 1 and 2. Further, we assume an industry with two firms, firm I and O. Each firm produces one final good, which is an imperfect substitute for the rival firm's product. While firm I (the inside firm) produces good I within the FTA, firm O (the outside firm) produces good O outside the FTA. We assume away relocation (i.e. FDI) of these two firms because of prohibitive transaction costs. The two firms supply their products to both countries 1 and 2 and compete in a Bertrand fashion. The member countries commit to zero tariffs on imports from the partner, but they set their own tariffs on imports from the non-members. The external tariff set by country i $(i = 1, 2)$ is denoted by t_i, which is positive and exogenously given.[7] Moreover, we confine ourselves to the case where both firms always serve both countries.

The indirect utility function of a represented consumer in country i is given by

$$V_i(p_i^I, p_i^O) = \overline{V}_i - a_i \left(p_i^I + p_i^O \right) + \frac{\left(p_i^I \right)^2 + \left(p_i^O \right)^2}{2} - b_i \left(p_i^I p_i^O \right) + Y_i, \tag{1}$$

---

[7]For simplicity, transport costs are assumed away. Even if there are transport costs, our point is still valid unless they are so high that the markets are always segmented.

where p_i^I and p_i^O are, respectively, the prices charged by firm I and firm O in country i; $\overline{V}_i$ is a positive constant; and Y_i is the income in country i.[8] By using Roy's identity, the demand for good j ($j \in \{I, O\}$) in country i is given by

$$x_i^j(p_i^j, p_i^k) = a_i - p_i^j + b_i p_i^k, \quad j, k \in \{I, O\} \ (j \neq k), \tag{2}$$

where a_i and $b_i \in (0, 1)$, respectively, represent the market size and substitutability of products in country i. As b_i approaches one, products become more similar. Note that both market size and substitutability of products may be different between countries. For ease of exposition, however, we assume $a_1 + a_2 = A$ and $b_1 + b_2 = B$ (where both A and B are constant), that is, any difference is a mean-preserving spread.

We compare two types of FTA: (i) an FTA without ROOs and (ii) an FTA with ROOs. To make our argument most clear, we consider a simple case where given the presence of ROOs, firm I meets ROOs, while firm O does not.[9] Thus, good I is always qualified for FTA preferential treatments (i.e. duty free access in the FTA). With ROOs, good O is subject to the external tariffs when being traded between countries 1 and 2. Without ROOs, firm O can supply good O to both countries 1 and 2 through the country with the lower external tariff, because both goods are freely traded within the FTA. That is, tariff circumvention is possible and takes place when ROOs are not in place.

A per-unit cost of producing differentiated goods is assumed to be identical across firms. It is constant and normalized to zero. The total profits of each firm are given by

$$\pi^I = \sum_{i=1,2} p_i^I x_i^I(p_i^I, p_i^O), \tag{3a}$$

$$\pi^O = \sum_{i=1,2} \left(p_i^O - \tau\right) x_i^O(p_i^O, p_i^I), \tag{3b}$$

where $\tau = t_i$ with ROOs and $\tau = \min\{t_1, t_2\}$ without ROOs.

We assume that in the FTA, there are many competitive arbitrageurs who supply parallel imports or re-imports by purchasing in the low price market and selling in the high price market; and that there is no additional cost in such arbitrage activities. Since good I is freely traded in the FTA, any price differential of good I within the FTA leads to arbitrage activities. Consequently, firm I is forced to set a uniform price in the two

---

[8]The indirect utility function is linear in income, so there are no income effects. It is derived from the standard quasi-linear utility function given by $U_i(x_i^I, x_i^O, m) = u(x_i^I, x_i^O) + m$ where m is the consumption of a numeráire good.

[9]Firm I may choose not to follow ROOs and to pay the tariff. In section 3.4, we derive the condition under which firm I will actually satisfy ROOs.

markets, implying that the markets for good I are completely integrated. In the absence of ROOs, such complete market integration also occurs in the markets for good O. In the presence of ROOs, however, arbitrage activities must bear the external tariff when good O is traded between countries 1 and 2. That is, arbitrage activities cannot eliminate the price differential made by firm O. Thus, the markets for good O are incompletely integrated or even segmented. When the markets for good O are incompletely integrated, firm O sets the price differential such that all arbitrage activities are actually exhausted. When the markets for good O are segmented, firm O freely sets the prices among the markets. To this effect, ROOs basically play a role to preserve the price differential.

Therefore, ROOs lead to two effects. On one hand, ROOs do not allow firm O to circumvent the higher tariff. We call this effect the *anti-circumvention effect*. On the other hand, ROOs allow firm O to exercise a pricing-market behavior, because arbitrage activities cannot eliminate the price differential made by firm O. We call this effect the *price-discrimination effect*.

2.1   Equilibrium without ROOs

As our benchmark case, we first derive the equilibrium in the absence of ROOs or the equilibrium without binding ROOs.[10] Without loss of generality, we assume $t_1 \geq t_2$ and define $\Delta t \equiv t_1 - t_2 \geq 0$.[11] Since markets are completely integrated for both goods I and O, each firm sets the same price across markets. We let $p^j (= p_1^j = p_2^j)$ denote the uniform price set by firm $j \in \{I, O\}$. Since firm O can export its product to country 1 via country 2, $\tau = \min\{t_1, t_2\} = t_2$.

Rearranging the first-order conditions of profit maximization, $\partial \pi^I / \partial p^I = 0$ and $\partial \pi^O / \partial p^O = 0$, yields the reaction functions:

$$p^I \equiv \widetilde{R}^I(p^O) = \frac{A + Bp^O}{4}, \tag{4a}$$

$$p^O \equiv \widetilde{R}^O(p^I) = \frac{A + 2t_2 + Bp^I}{4}. \tag{4b}$$

Recalling that both A and B are constant, any difference in demand does not affect each firm's choice. Intuitively, since each firm sets the same price across countries, each firm regards two markets as a single market. Hence, the pricing strategy of each firm depends only on the total demand within the FTA, not on the spread of the demand between

---

[10] In the following, we simply call this case the equilibrium without ROOs.

[11] As we see later, what is crucial to our results is not the level of the external tariff but the difference between the external tariff rates (i.e. Δt).

countries. The equilibrium prices are given by

$$\widetilde{p}^I \;=\; \frac{A(4+B)+2Bt_2}{16-B^2}, \tag{5a}$$

$$\widetilde{p}^O \;=\; \frac{A(4+B)+8t_2}{16-B^2}. \tag{5b}$$

An increase in t_2 raises both $\widetilde{p}^I$ and $\widetilde{p}^O$. However, the increase in $\widetilde{p}^O$ is less than the increase in t_2 and hence its producer price decreases. By substituting the first-order conditions into the profit functions, the equilibrium profits are, respectively, given by

$$\widetilde{\pi}^I \;=\; 2(\widetilde{p}^I)^2, \tag{6a}$$

$$\widetilde{\pi}^O \;=\; 2(\widetilde{p}^O - t_2)^2. \tag{6b}$$

Moreover, the equilibrium consumer surplus and tariff revenue are, respectively, given by

$$\widetilde{S}_i \;=\; V_i(\widetilde{p}^I, \widetilde{p}^O) - Y_i, \quad i = 1, 2, \tag{7}$$

$$\widetilde{R}_1 \;=\; 0, \quad \widetilde{R}_2 = t_2 \sum_{i=1,2} \widetilde{x}_i^O(\widetilde{p}^O, \widetilde{p}^I). \tag{8}$$

Without ROO, good O can cross between country 1 and country 2 without tariffs. Hence, firm O makes all exports through country 2, whose external tariff is lower than country 1's, and re-exports some of them to country 1. As a result, country 2 captures all tariff revenue of the FTA and country 1 earns no tariff revenue.

2.2 Equilibrium with ROOs

We next obtain the equilibrium in the presence of ROOs. As long as firm I meets ROOs, good I is freely traded between country 1 and country 2. The markets remain completely integrated for good I, and firm I still chooses the same price across internal markets. Firm O, on the other hand, can price-discriminate to some extent, because the arbitrage activities must incur the external tariff. Firm O sets the prices so that the arbitrage activities do not actually occur; in that regard, firm O maximizes its profits with an arbitrage constraint.[12] However, as long as both $\widehat{p}_1^O \leq \widehat{p}_2^O + t_1$ and $\widehat{p}_2^O \leq \widehat{p}_1^O + t_2$ (where $\widehat{p}_i^O$ is the price of good O in country i under segmented markets) hold, firm O is free from the constraint and hence can independently choose p_1^O and p_2^O. In the following analysis, to explicate our point most simply, we focus on the case of segmented markets.[13]

---

[12]Since there are competitive arbitragers, an equilibrium where firm O decides to serve only one market does not exist.

[13]The condition for segmented markets is derived in the appendix. Even if the markets are not segmented, our point is still valid unless the markets are completely integrated.

The first-order conditions of profit maximization under segmented markets are $\partial \pi^I / \partial p^I = 0$ and $\partial \pi^O / \partial p_i^O = 0$ $(i = 1, 2)$. Rearranging the three equations yields the following reaction functions:

$$p^I \equiv \widehat{R}^I(p_1^O, p_2^O) = \frac{A + \sum_{i=1,2} b_i p_i^O}{4}, \tag{9a}$$

$$p_i^O \equiv \widehat{R}_i^O(p^I) = \frac{a_i + t_i + b_i p^I}{2}, \quad i = 1, 2. \tag{9b}$$

Then the equilibrium prices are given by

$$\widehat{p}^I = \frac{2A + \sum_{i=1,2}(a_i + t_i) b_i}{\Gamma}, \tag{10a}$$

$$\widehat{p}_i^O = \frac{2Ab_i + (8 - b_j^2)(a_i + t_i) + b_i b_j (a_j + t_j)}{2\Gamma}, \tag{10b}$$

where $i, j = 1, 2$ $(j \neq i)$ and $\Gamma \equiv 8 - \sum_{i=1,2} b_i^2 > 0$ (see the appendix).

For ease of exposition, we restrict our attention to the case with $\widehat{p}_1^O \geq \widehat{p}_2^O$. This is the case if $\widehat{p}_1^O \geq \widehat{p}_2^O$ holds with $\Delta t = 0$, because an increase in Δt raises $(\widehat{p}_1^O - \widehat{p}_2^O)$.[14] This sufficient condition can be rewritten as

$$\Omega \equiv (16 - B^2) \Delta a + \{A(4 + B) + 2Bt_2\} \Delta b \geq 0, \tag{11}$$

where $\Delta a \equiv a_1 - a_2$ and $\Delta b \equiv b_1 - b_2$. This condition is assumed in the following analysis. Since Δa and Δb, respectively, represent the differences in market size and substitutability between two countries, the size of Ω is directly related to the difference between $\widehat{p}_1^O$ and $\widehat{p}_2^O$. Thus, Ω represents the extent of the price discrimination.

The equilibrium profits, consumer surplus, and tariff revenue are, respectively, given by

$$\widehat{\pi}^I = 2(\widehat{p}^I)^2, \tag{12a}$$

$$\widehat{\pi}^O = \sum_{i=1,2} (\widehat{p}_i^O - t_i)^2, \tag{12b}$$

$$\widehat{S}_i = V_i(\widehat{p}^I, \widehat{p}_i^O) - Y_i, \quad i = 1, 2, \tag{13}$$

$$\widehat{R}_i = t_i \widehat{x}_i^O(\widehat{p}_i^O, \widehat{p}^I), \quad i = 1, 2. \tag{14}$$

---

[14]If $\widehat{p}_1^O \leq \widehat{p}_2^O$ holds when $t_1 = t_2$, the ranking in price can be reversed as the difference in the external tariffs increases. This makes the analysis complicated without changing the results qualitatively.

3 Comparison

Now we compare the two equilibria: the equilibria with and without ROOs. For comparison, we should recall two effects generated by ROOs: the anti-circumvention effect and the price-discrimination effect.

3.1 Prices

First of all, we compare the prices with and without ROOs. To this end, we first consider both anti-circumvention and price-discrimination effects when p^I is fixed at $\widetilde{p}^I$. Whereas the price-discrimination effect is associated with market segmentation, the anti-circumvention effect is caused by the difference in tariff rates between countries 1 and 2. Once the markets become segmented, firm O increases the price in one market and decreases it in the other. Since we focus on the case where $p_1^O > p_2^O$, the price-discrimination effect with $p^I = \widetilde{p}^I$ raises p_1^O and lowers p_2^O. Once the tariff to export to country 1 rises from t_2 to t_1, the consumer price in country 1 increases. It follows from (9b) that the anti-circumvention effect with $p^I = \widetilde{p}^I$ increases p_1^O by $\Delta t/2$, which implies that the producer price (i.e. $p_1^O - t_1$) falls.

Now we investigate how the above two effects affect p^I. Since the prices of products are strategic complements, the anti-circumvention effect necessarily raises the uniform price charged by firm I. However, the price-discrimination effect ambiguously influences p^I. If the substitutability of products is higher in country 1 (i.e. $\Delta b > 0$), for firm I, the variation of p_1^O is more important than that of p_2^O. In this case, the price-discrimination effect also raises p^I. If it is higher in country 2 (i.e. $\Delta b < 0$), on the other hand, the effect decreases p^I. The overall effect depends on the magnitude of the two effects, and it is summarized in the following lemma.[15]

Lemma 1 *When $\Delta b \geq 0$, $\widehat{p}^I \geq \widetilde{p}^I$ holds. When $\Delta b < 0$, $\widehat{p}^I < \widetilde{p}^I$ if $-\Omega \Delta b / \left(16 - B^2\right)(B + \Delta b) > \Delta t$ and $\widehat{p}^I \geq \widetilde{p}^I$ otherwise.*

When $\Delta b > 0$, both anti-circumvention and price-discrimination effects work in the same direction to raise p^I. When $\Delta b < 0$, the anti-circumvention effect increases p^I while the price-discrimination effect decreases p^I. The latter effect is likely to dominate the former if Δt is low so that the anti-circumvention effect is small and Ω is high so that the

---

[15] The anti-circumvention effect disappears with $\Delta t = 0$, while the price-discrimination effect vanishes with $\Delta a = \Delta b = 0$. Moreover, it follows from (10a) that as long as $\Delta b = 0$, the price-discrimination effect does not affect p^I even with $\Delta a \neq 0$.

price-discrimination effect is large. Since Ω is positively related to Δa, a large difference in the market sizes with $\Delta b < 0$ is likely to decrease p^I.

As for p_i^O, we have the following lemma.

Lemma 2 $\widehat{p}_1^O \geq \widetilde{p}^O \geq \widehat{p}_2^O$ *when* $(8 - Bb_1)\,\Omega/\,(2b_1 b_2) > \Delta t$; *and* $\widehat{p}_1^O > \widehat{p}_2^O \geq \widetilde{p}^O$ *otherwise.*

If $\Delta t = 0$, only the price-discrimination effect exists. Thus, the price dispersion between countries 1 and 2 results in $\widehat{p}_1^O \geq \widetilde{p}^O \geq \widehat{p}_2^O$. An increase in Δt expands the price dispersion. At the same time, however, firm I makes p^I higher, because the increase in Δt leads to relatively high protection under ROOs. The increase in p^I in turn increases both p_1^O and p_2^O. Thus, both $\widehat{p}_1^O$ and $\widehat{p}_2^O$ exceed $\widetilde{p}^O$ if Δt is sufficiently large. It should be noted that there is a case where ROOs increase all the prices.

3.2 Comparison when $\Delta b = 0$

We now examine the effects of ROOs on each component of welfare. We begin with the case with $\Delta b = 0$. That is, both markets have the same substitutability and hence the price-discrimination effect affects p^O but does not affect p^I (recall Lemma 1). In this case, therefore, $\Delta a \geq 0$ is necessary for the condition (11) to hold.

To begin with, we compare the equilibrium profits with and without ROOs. It follows from equations (6a), (6b), (12a) and (12b) that:

$$\Delta \pi^I \;\equiv\; \widehat{\pi}^I - \widetilde{\pi}^I = 2\left\{ \left(\widehat{p}^I\right)^2 - \left(\widetilde{p}^I\right)^2 \right\}, \tag{15}$$

$$\Delta \pi^O \;\equiv\; \widehat{\pi}^O - \widetilde{\pi}^O = \sum_{i=1,2} \left(\widehat{p}_i^O - t_i\right)^2 - 2\left(\widetilde{p}^O - t_2\right)^2. \tag{16}$$

We thus have the following proposition.

Proposition 1 *Suppose* $\Delta b = 0$. *If* $\Delta t > 0$, *firm I's profits are larger with ROOs than without them. When* $\Delta t = 0$, *firm I's profits are the same. If* $\Delta a > 0$, *then there exists a unique cut-off value of* Δt, $\Psi(> 0)$, *below which firm O's profits are larger with ROOs than without them.*

The proposition is illustrated in Figure 1.[16] As for firm I, its profits rise as the equilibrium level of p^I rises. From Lemma 1, the price-discrimination effect does not affect p^I with $\Delta b = 0$ and hence the anti-circumvention effect caused by $\Delta t > 0$ is

---

[16] In figures 1-3, an increase in Δt means an increase in t_1 keeping t_2 fixed.

the sole effect. Since p^I rises as Δt increases, $\Delta \pi^I$ also rises as t_1 (or, Δt) increases. Moreover, $\Delta \pi^I = 0$ holds when $\Delta t = 0$.

As for firm O's profits, the anti-circumvention effect is harmful to firm O. On the other hand, the price-discrimination effect generated by the market-size difference ($\Delta a > 0$) is beneficial to firm O. Intuitively, firm O is more likely to benefit from its ability to price discriminate when the difference in market size is large. Hence it is more likely that this effect exceeds the anti-circumvention effect.

If the external tariffs are identical (i.e. $\Delta t = 0$), the anti-circumvention effect does not exist and hence ROOs certainly benefit firm O. As the external-tariff differential increases, the anti-circumvention effect becomes larger. When Δt exceeds the critical level Ψ, the anti-circumvention effect dominates the price-discrimination effect so that firm O is made worse off with ROOs. If the market sizes are the same (i.e. $\Delta a = 0$), the price-discrimination effect does not exist and firm O loses from ROOs because of the anti-circumvention effect.

When $\Delta b = 0$, implying that two countries have very similar preferences, firm I always gains from ROOs. If both $\Delta a > 0$ and $\Delta t < \Psi$ hold, then both firms gain from ROOs. As is seen below, consumers as a whole lose in this case. Thus, it can be observed that given similar external tariff rates and preferences but different market sizes, ROOs are likely to generate the anti-competitive effect.

[**Figure 1 around here**]

We next compare consumer surplus with and without ROOs. From equations (7) and (13), the change in consumer surplus caused by ROOs is given by

$$\Delta S_i \equiv \widehat{S}_i - \widetilde{S}_i, \quad i = 1, 2. \tag{17}$$

We let $\Delta S \equiv \Delta S_1 + \Delta S_2$ denote the change in the total consumer surplus in the FTA. If $\Delta S < 0$, the introduction of ROOs makes consumers as a whole worse off.

Suppose $\Delta t = 0$. By virtue of Lemmas 1 and 2, if $\Delta a > 0$, the introduction of ROOs leads to only the price-discrimination effect which makes the price of good O higher in country 1 but lower in country 2. This benefits consumers in country 2 but hurts consumers in country 1. The price of good I and the total supply of good I in the FTA remain unchanged when $\Delta b = \Delta t = 0$.[17] As t_1 rises from $t_1 = t_2$ and hence Δt rises from $\Delta t = 0$, all prices increase so that consumer surplus in each country falls. The overall effect is stated in the following proposition.

---

[17]When $\Delta a = \Delta b = \Delta t = 0$, ROOs do not affect the prices at all.

Proposition 2 *Suppose $\Delta b = 0$. ROOs decrease the overall consumer surplus in the FTA if $\Delta a > 0$ and/or $\Delta t > 0$. It remains unchanged if $\Delta a = \Delta t = 0$.*

The anti-circumvention effect inevitably harms consumers. The price-discrimination effect is also detrimental. This is because the price dispersion from the uniform level of p^O is symmetric, but the market sizes are asymmetric (i.e. the market size of country 1 where p^O rises is larger than that of the country 2 where p^O falls). Proposition 2 states the change in the overall consumer surplus. Thus, some consumers may actually gain from ROOs. However, it should be emphasized that the case where all consumers lose from ROOs also exists.

Next we examine how ROOs affect the equilibrium amount of tariff revenue. From equations (8) and (14), the change in tariff revenue is given by

$$\Delta R_i \equiv \widehat{R}_i - \widetilde{R}_i, \quad (i = 1, 2). \tag{18}$$

$\Delta R_1 > 0$ obviously holds, because there is no tariff revenue in country 1 without ROOs but there is some with ROOs. As long as t_2 is positive, $\Delta R_2 < 0$ holds since the supply of good O to country 1 is no longer made via country 2, and we can verify that $\widehat{x}_2^O$ is smaller than $\widetilde{x}_1^O + \widetilde{x}_2^O$. We let $\Delta R \equiv \Delta R_1 + \Delta R_2$ denote the change in the total tariff revenue of the FTA.

Proposition 3 *Suppose $\Delta b = 0$. If $t_2 < \widetilde{t}_2(\equiv \{4A(4+B)+(16-B^2)\Delta a\}/\{8(8-B^2)\})$, then there is an unique cut-off value of Δt, $\Phi(> 0)$, below which the total tariff revenue in the FTA is larger with ROOs than without them.*

Since the tariff revenue is concave with respect to the tariff level, a tariff-increase reduces the tariff revenue when the tariff level is high enough. Noting $t_1 \geq t_2$, the high level of t_2 implies that t_1 is also high. Thus, ROOs decrease the total tariff revenue if the tariff level without ROOs (i.e. t_2) is high enough. If t_2 is not too high, on the other hand, ΔR becomes inverse-U-shaped with respect to Δt so that ROOs increase the total tariff revenue if Δt is not too large (i.e. $0 < \Delta t < \Phi$). The results are depicted in Figure 2.

[Figure 2 around here]

With respect to the change in the overall welfare of the FTA, $\Delta W = \Delta S + \Delta R + \Delta \pi^I$, the following proposition can be established.

Proposition 4 *If $\widehat{t}_2(\equiv A(2+B)/\{2(6-B^2)\}) \leq t_2$ or both $t_2 < \widehat{t}_2$ and $\nu \leq \Delta a < A(2+B)/(6-B^2)$ hold (where ν is a cut-off value defined in the appendix), ROOs deteriorate the total welfare of the FTA. If $t_2 < \widehat{t}_2$ and $0 \leq \Delta a < \nu$, there exists a pair of positive, cut-off values of Δt, $(\underline{\mu}, \overline{\mu})$, between which the total welfare is higher with ROOs than without them.*

As has been analyzed, ROOs lower the tariff revenue when t_2 is high enough. In this case, the negative effects of ROOs on the tariff revenue and consumer surplus always dominate the positive effect on π^I, and hence ROOs always lower the sum of FTA members' welfare. When t_2 is not too high, ROOs may raise the tariff revenue. Nonetheless, if Δa is large enough, the negative effect on consumer surplus always dominates the possible positive effect on tariff revenue as well as the producer's gain, so that $\Delta W < 0$. It should be noted that as Δa becomes large, the degree of price discrimination by firm O becomes large. When both t_2 and Δa are small, consumers' losses are moderate and the positive effect on tariff revenue may dominate the losses. Noting that the value of Δt that maximizes ΔR is positive in this case, $\Delta W > 0$ holds if Δt falls into some range (i.e. $\Delta t \in (\underline{\mu}, \overline{\mu})$). Figure 3 shows the results.

[Figure 3 around here]

3.3 Comparison when $\Delta b \neq 0$

To this point, we have concentrated on the case with $\Delta b = 0$. From Lemma 1, the price-discrimination effect does not affect the equilibrium level of p^I when $\Delta b = 0$. Since the anti-circumvention effect necessarily raises p^I, firm I always benefits from ROOs. In this subsection, investigating the profits with $\Delta b \neq 0$, we show that firm I could lose from ROOs. Any difference between b_1 and b_2 leads to the price-discrimination effect which changes p^I. Thus, ROOs may decrease the profits of firm I. In fact, by virtue of equation (15) and Lemma 1, we can obtain the following proposition.

Proposition 5 *ROOs decrease the profits of firm I only if $\Delta b < 0$. The profits of firm I are likely to fall when Δt is small and Δa is large.*

The case with $\Delta b > 0$ is depicted in Figure 4. In the figure, $R^I R^I$, $\widetilde{R}^O \widetilde{R}^O$, and $\widehat{R}^O \widehat{R}^O$ are, respectively, firm I's reaction function (4a) or (9a), firm O's reaction curve without ROOs (4b), and the weighted average of firm O's reaction curves with ROOs

(9c).[18] The equilibrium without ROOs is determined at $\widetilde{E}$, while that with ROOs is at $\widehat{E}$. Since both anti-circumvention and price-discrimination effects raise $\overline{p}^O$, $\widehat{R}^O\widehat{R}^O$ is located above $\widetilde{R}^O\widetilde{R}^O$. We can verify that the slope of $\widehat{R}^O\widehat{R}^O$ is (weakly) greater than that of $\widetilde{R}^O\widetilde{R}^O$.[19] Thus, we have $\widehat{p}^I \geq \widetilde{p}^I$ (where the equality holds with $\Delta a = \Delta t = 0$).

[**Figure 4 around here**]

On the other hand, the case with $\Delta b < 0$ is drawn in Figure 5. In this case, the price-discrimination effect is detrimental to firm I so that an increase in Δa shifts $\widehat{R}^O\widehat{R}^O$ downward. An increase in Δt shifts the curve upward as in the case with $\Delta b > 0$. Thus, when $\Delta b < 0$ and Δt is small relative to Δa, the negative price-discrimination effect dominates the positive anti-circumvention effect and hence ROOs harm firm I. That is, firm I could lose because of the negative price-discrimination effect on firm I which becomes larger as the market with the lower substitutability of the two products becomes larger.

[**Figure 5 around here**]

Next we consider the profits of firm O. Since the increase (decrease) in p^I raises (lowers) both $\widehat{p}_1^O$ and $\widehat{p}_2^O$, $\Delta\pi^O$ is more likely to be positive (negative) with $\Delta b > 0$ (with $\Delta b < 0$). However, the negative effect on firm O generated by $\Delta b < 0$ is mitigated as Δt decreases and hence the anti-circumvention effect becomes weaker. Thus, it is possible that firm I loses while firm O gains when the differences in both market size and preferences between two countries are large but the external tariff rates are similar.

The effects of ROOs on the profits of both firms with $\Delta b \neq 0$ are calculated by using a numerical example with $A = 5$, $B = 0.5$ (see Table 1). All cases satisfy $\widehat{p}_1^O \geq \widehat{p}_2^O$, the conditions for market segmentation, and the positive sales constraint. We can confirm that there actually exist the case where ROOs benefit both firms and the case where ROOs hurt firm I but benefit firm O.

[**Table 1 around here**]

---

[18]For details, see the appendix.

[19]Compared to the market integration case, firm O, which can price-discriminate, reacts to the change in p^I more in the country with higher b_i than in the other country. The definition of $\overline{p}^O$ places the larger weight on p_i^O with higher b_i, so that the overall substitutability is always greater in the market segmentation case if $\Delta b \neq 0$.

15

We should note that while ROOs never increase the overall consumer surplus when $\Delta b = 0$, they could increase it when $\Delta b < 0$. This is because ROOs could lower p^I with $\Delta b < 0$. Whenever p^I falls, firm I loses.

3.4 Firm I's compliance with ROOs

So far, we have assumed that firm I always meets ROOs when an FTA is in place. This subsection examines the condition under which firm I actually chooses to comply with ROOs when compliance to ROOs is optional (i.e., when firm I can choose not to make an application for ROOs even if it is qualified to do so). For simplicity, we assume that even if firm I chooses not to meet ROOs, the costs of firm I do not change.[20]

Suppose that an FTA with ROOs is in place and firm I can freely choose whether to follow the ROOs or not. When firm I in country i $(i = \{1, 2\})$ does not comply with ROOs, t_j is imposed on its exports to the partner country j $(j = \{1, 2\}, j \neq i)$, that is, good I is subject to the tariff, t_j. For simplicity, we assume that the level of t_j is the same with the external tariff on good O. We focus on the case where the markets for both goods are segmented because of the tariffs. The first-order conditions of profit maximization become:

$$\frac{\partial \pi^I}{\partial p_i^I} = x_i^I(p_i^I, p_i^O) + \left(p_i^I - \gamma t_i\right) \frac{\partial x_i^I(p_i^I, p_i^O)}{\partial p^I} = 0, \tag{19a}$$

$$\frac{\partial \pi^O}{\partial p_i^O} = x_i^O(p_i^O, p_i^I) + \left(p_i^O - t_i\right) \frac{\partial x_i^O(p_i^O, p_i^I)}{\partial p_i^O} = 0, \quad i = 1, 2, \tag{19b}$$

where γ is the parameter which takes $\gamma = 0$ if firm I is located in country i and $\gamma = 1$ if firm I is located in country k $(k = \{1, 2\}, k \neq i)$. Solving the above equations, we obtain the equilibrium prices:

$$\grave{p}_i^I = \frac{a_i\left(2 + b_i\right) + \left(2\gamma + b_i\right) t_i}{4 - b_i^2}, \tag{20a}$$

$$\grave{p}_i^O = \frac{a_i\left(2 + b_i\right) + \left(2 + \gamma b_i\right) t_i}{4 - b_i^2}, \quad i = 1, 2. \tag{20b}$$

As in the previous subsections, we restrict our attention to the case where $\grave{p}_1^I \geq \grave{p}_2^I$ and $\grave{p}_1^O \geq \grave{p}_2^O$, and both firms serve both markets. The conditions for market segmentation

---

[20] Firm I may not comply with ROOs by using more of foreign intermediate inputs. In this case, the costs are likely to change. We do not deal with this case in this paper.

are $\grave{p}_2^I > \grave{p}_1^I - t_1$ and $\grave{p}_2^O > \grave{p}_1^O - t_1$. The equilibrium profits are given by

$$\grave{\pi}^I = \sum_{i=1,2} \left(\grave{p}_i^I - \gamma t_i\right)^2, \tag{21a}$$

$$\grave{\pi}^O = \sum_{i=1,2} \left(\grave{p}_i^O - t_i\right)^2. \tag{21b}$$

We have the following proposition.

Proposition 6 *Suppose $\Delta b = 0$. When firm I is located in country 2, it always complies with ROOs. When firm I is located in country 1, on the other hand, it complies with ROOs if $t_2 \left(8 - B^2\right) \{4a_2 \left(4 + B\right) - t_2 \left(8 - 4B - B^2\right)\}/2 \geq \{(4 + B)\Delta a + B\Delta t\}^2$ but does not otherwise.*

Firm I located in country 2 necessarily gains from the removal of country 1's tariff. Since country 1's market is larger (recall $\Delta a \geq 0$ with $\Delta b = 0$) and its tariff is higher, the gains from tariff-free access to the partner market outweigh the losses due to the enforced uniform-pricing. When firm I produces in country 1, on the other hand, its gains from the tariff-free access to country 2, whose market-size and tariff rate are smaller, are not very large. In the latter case, firm I may not choose to meet ROOs if t_2 is relatively low and the factors that increase the gains from price discrimination (i.e. Δa and Δt) are large. We can also confirm in numerical examples that the results with $\Delta b \neq 0$ are similar to Proposition 6 (as long as conditions of market segmentation and positive sales constraints are satisfied); that is, firm I located in country 2 always meets ROOs, while firm I located in country 1 meets ROOs if t_2 is relatively large and Δa and Δt are small (see Table 2).[21]

[Table 2 around here]

It should be noted that the equilibrium with the noncompliance of firm I coincides with the pre-FTA equilibrium in which each country imposes nondiscriminatory tariffs on its imports. Hence, the change from $\grave{\pi}^I$ to $\widehat{\pi}^I$ can be regarded as the effects of forming FTA with ROOs on inside firm's profits.

The above proposition suggests that even if only a single firm produces within an FTA and there are no rivals that also enjoy trade liberalization, the inside firm may not gain from FTA formation. This is because the removal of tariffs entails market integration

---

[21]Note that all cases in Table 1 are consistent with the condition that firm I complies with ROOs.

which is harmful for the inside firm. In the last subsection 3.3, we have shown that firm I's profits can be larger without ROOs than with ROOs if $\Delta b < 0$ and Δt is small. It is important to also note the case where firm I located in country 1 becomes worse off by forming FTA with ROO and better off by forming FTA without ROO, which is a sharp contrast to the conventional wisdom of ROOs.[22]

4 Conclusion

In this paper, focusing on the final-good markets, we have explored the effects of ROOs in the framework of international oligopoly. In particular, in order to extract the pure effects of ROOs, we have contrasted FTAs with and without ROOs. We have shown how ROOs influence competitive outcomes in the final-good markets. In the presence of external tariffs of FTA member countries, ROOs lead to incomplete market integration (including market segmentation) for the outside firm (i.e. the non-FTA firm), because arbitrage activities have to bear the external tariff. Thus, ROOs generate two effects: the anti-circumvention and price-discrimination effects. The former effect is beneficial to the inside firm (i.e. the FTA firm) but is harmful to the outside firm. On the other hand, the latter effect benefits the outside firm. There is also a case where the price-discrimination effect is harmful to the inside firm. Therefore, the net effect of ROOs on profits is ambiguous and depends on the magnitude of these two effects.

For the producer located outside the FTA, the net effect of ROOs depends on the difference in the external tariffs and in the market sizes. If the difference in the external tariffs is large, the anti-circumvention effect is significant. If the difference in the market sizes is large, the price-discrimination effect is more dominant. Thus, if the difference in the external tariffs is small relative to the difference between market sizes, ROOs benefit the outside firm. For the inside firm, the net effect of ROOs depends on the degree of substitutability of products between markets as well as the difference in the external tariffs. If the substitutability is lower in the larger market and the difference in the external tariffs is small, ROOs could be harmful to the inside firm.

In particular, the following two cases are noteworthy. In one case, both firms gain from ROOs at the expense of consumers. In this case, ROOs become a device to generate an anti-competitive effect. In another case, ROOs benefit the outside firm and hurts the inside firm. Thus, although ROOs let the outside firm face the higher tariff, they may

---

[22]For instance, when $A = 4$, $B = 0.5$, $t_2 = 1.3$, $\Delta a = 2$, $\Delta b = -0.15$, and $\Delta t = 0$, $\widehat{\pi}^I - \check{\pi}^I = -0.004$ and $\widetilde{\pi}^I - \check{\pi}^I = 0.080$.

fail to protect the inside firm, that is, they would contradict their original purpose of protecting the inside firm.

Our result also provides some new insight into the welfare effect of ROOs. In perfectly competitive markets, higher tariffs with ROOs would reduce overall welfare of FTA, because a decrease in consumer surplus exceeds the increase in tariff revenue and producer surplus. Some studies, however, suggest that ROOs may increase the overall welfare when trans-shipment costs are significant or markets for intermediates are considered (see, for example, Krishna and Krueger, 1995; Krueger, 1999). Using a perfectly-competitive, partial-equilibrium model, Falvey and Reed (2002) show that ROOs improve the terms of trade of both final and intermediate goods and hence could raise welfare. ROOs complement tariffs to improve the terms of trade.

The presence of ROOs in our model basically works as an increase in tariffs due to the anti-circumvention effect and raises rival's costs. Hence, ROOs may improve overall welfare. This indicates that ROOs may be used as substitutes for tariffs when external tariffs are bound by Article XXIV of GATT or concessions in the multilateral negotiations in GATT/WTO. It should be worth noting, however, that in contrast to the standard argument of strategic trade policy, ROOs may not hurt the rival firm because of the presence of the price-discrimination effect.

Our benchmark case is an FTA without ROOs. One may wonder if there exists any FTA that has no ROOs. However, our analysis does not aim to examine the effects of FTA formation. Thus, we need to separate the effects of ROOs alone from those of tariff removal. In that regard, our benchmark proves useful to make our analysis more effective. Even if pre-FTA situation is considered as a benchmark, the effects of ROO pointed out in the paper can be strong enough to outweigh the tariff-elimination effect of FTA formation. Our analysis suggests that consumers are likely to lose from an FTA formed between countries which have very similar economic structures except for their market sizes. Moreover, ROOs are likely to improve overall welfare when countries have very similar economic structures and low external tariffs. This may suggest that FTAs among advanced countries are more likely to enhance welfare.

Obviously, we cannot obtain our results without external tariffs. In this sense, the presence of external tariffs plays a crucial role in our analysis. However, we should emphasize that external tariffs alone never result in incomplete market integration (including market segmentation) within an FTA. It is possible only when external tariffs are accompanied by ROOs.

We have specifically used a Bertrand model for our analysis. The point of our analysis is a trade-off between the anti-circumvention and price-discrimination effects. As long as goods are differentiated, these effects also arise in a Cournot model. Therefore, our main results would still be valid in a Cournot model with differentiated goods.[23]

It is easy to say that markets are segmented or integrated in theoretical models. However, many empirical studies have shown that there exists a home bias in trade, and national borders create a substantial trade barrier (see McCallum,1995 and Obstfeld and Rogoff, 2001). The evidence suggests that, even if tariffs are reduced, transportation costs or some technical barriers are high enough to segment the international markets. New evidences, however, show that the home-bias has been declining recently, and RTAs seem to help reduce the border effect.[24] As far as we know, there is no empirical analysis that directly connects ROOs with market segmentation. The empirical investigation of our analysis is left for future research.

---

[23]For details, see the appendix. See also Mukunoki (2004).

[24]Wei (1996) and Okubo (2004) show that border effect in many countries has been declining. Helliwell(1998) shows the border effect of Canada becomes lower after US-Canada FTA and Evans(2003) shows that membership in the EU reduces the effects of borders. In addition, price convergence is observed in the EU car market (Goldberg and Verboven, 2005) and there is a remarkable decline in relative-price differences among developed countries (Knetter and Slaughter, 2001).

Appendix

The condition for market segmentation

Since we restrict our attention to the case with $\widehat{p}_1^O \geq \widehat{p}_2^O$, arbitrage activities are blocked and hence the markets for good O are segmented if $t_1 \geq \left(\widehat{p}_1^O - \widehat{p}_2^O\right)$. From equation (10b), the inequality is rewritten as $2\left(24 - b_1 b_2 - 2b_1^2 - 3b_2^2\right)\Delta t + 2t_2\left(16 - B^2 - 2b_1 \Delta b\right) \geq \left(16 - B^2\right)\Delta a + A\left(4 + B\right)\Delta b$. If this inequality holds, the markets for good O are segmented. In order for markets to be segmented with $\Delta t = 0$,

$$t_2 \geq \underline{t_2} \equiv \frac{\left(16 - B^2\right)\Delta a + A\left(4 + B\right)\Delta b}{2\left(16 - B^2 - 2b_1 \Delta b\right)}$$

must be satisfied.

The determination of equilibrium prices

By (9a), p^I set by firm I depends on both p_1^O and p_2^O set by firm O. p_1^O influences p^I more than p_2^O if $b_1 > b_2$ and vice versa. We define $\overline{p}^O \equiv \left(b_1 p_1^O + b_2 p_2^O\right)/B$ as the weighted sum of the prices of good O where the weights are each country's relative substitutability, b_i/B. Using $\overline{p}^O$, we can rewrite firm I's reaction function and define the weighted sum of firm O's reaction functions as follows:

$$
\begin{aligned}
p^I &= \widehat{R}^I(\overline{p}^O) = \frac{A + B\overline{p}^O}{4}, & \text{(9a)} \\
\overline{p}^O &= \widehat{R}^O(p^I) \equiv \frac{1}{B}\sum_{i=1,2} b_i \widehat{R}_i^O(p^I) \\
&= \frac{\sum_{i=1,2}\left(a_i + t_i\right)b_i + \left(\sum_{i=1,2} b_i^2\right)p^I}{2B}. & \text{(9c)}
\end{aligned}
$$

This arrangement makes the strategic interaction as if the firms compete by setting p^I and $\overline{p}^O$. Once the equilibrium level of p^I is determined, the equilibrium level of p_i^O ($i = 1, 2$) can be obtained from equation (9b).

Proof of Lemma 1

From equations (5a) and (10a), we have

$$\widehat{p}^I - \widetilde{p}^I = \frac{\Omega\Delta b + \left(16 - B^2\right)\left(B + \Delta b\right)\Delta t}{2\left(16 - B^2\right)\Gamma}.$$

If $\Delta b \geq 0$, the numerator is always positive. If $\Delta b < 0$, the sign of the numerator depends on the levels of Δt and Ω:

$$\widehat{p}^I \overset{\leqq}{\underset{\geqq}{}} \widetilde{p}^I \iff \frac{\Omega \Delta b}{(16 - B^2)(B + \Delta b)} \overset{\geqq}{\underset{\leqq}{}} \Delta t.$$

Hence, we obtain Lemma 1. Q.E.D.

Proof of Lemma 2

From equation (5b) and (10b),

$$
\begin{aligned}
\widehat{p}_1^O - \widetilde{p}^O &= \frac{2(8 - Bb_2)\Omega + (16 - B^2)(32 - 4b_2^2)\Delta t}{8\Gamma(16 - B^2)}, \\
\widehat{p}_2^O - \widetilde{p}^O &= -\frac{(8 - Bb_1)\Omega - 2b_1 b_2 \Delta t}{4\Gamma(16 - B^2)}.
\end{aligned}
$$

From the above equations, $\widehat{p}_1^O \geq \widetilde{p}^O$ (with equality if $\Omega = \Delta t = 0$) and

$$\widehat{p}_2^O \overset{\leqq}{\underset{\geqq}{}} \widetilde{p}^O \iff \frac{(8 - Bb_1)\Omega}{2b_1 b_2} \overset{\geqq}{\underset{\leqq}{}} \Delta t.$$

Thus, we obtain Lemma 2. Q.E.D.

Proof of Proposition 1

From Lemma 1, we have $\widehat{p}^I \geq \widetilde{p}^I$ (where equality holds with $\Delta t = 0$) and hence $\Delta \pi^I \geq 0$ (where equality holds with $\Delta t = 0$). With respect to $\Delta \pi^O$, we first check the assumption of the positive sales of firm O under $\Delta b = 0$. Without ROOs, $x_2^O(\widetilde{p}_2^O, \widetilde{p}^I)$ is the smallest and it is positive if

$$\frac{4A(4 + B) - (16 - B^2)\Delta a}{4(8 - B^2)} \equiv \overline{t_2} > t_2,$$

that is, if t_2 is not too large. With ROOs, $x_2^O(\widehat{p}_2^O, \widehat{p}^I)$ is also positive under $\overline{t_2} > t_2$. Alternatively, $x_1^O(\widehat{p}_1^O, \widehat{p}^I)$ is positive if

$$\frac{4A(4 + B) + (16 - B^2)\Delta a - 4(8 - B^2)t_2}{(32 - 3B^2)} \equiv \overline{\Delta t} > \Delta t$$

where $\overline{\Delta t}$ is positive by $\overline{t_2} > t_2$. Using equations (5b), (6b), (10b), and (12b), the difference in firm O's profits with $\Delta b = 0$ is given by

$$\Delta \pi^O = \frac{(\Delta a)^2}{8} - C\Delta t + D(\Delta t)^2,$$

where

$$C \equiv \frac{8\left(8-B^2\right)\left\{(4+B)A-\left(8-B^2\right)t_2\right\}+\left(16-B^2\right)^2\Delta a}{4\left(16-B^2\right)^2} > \frac{32-3B^2}{4\left(16-B^2\right)}\Delta a \geq 0,$$

$$D \equiv \frac{\left(512-96B^2+5B^4\right)}{8\left(16-B^2\right)^2} > 0.$$

The first inequality of C is due to $\overline{t_2} > t_2$. If $\Delta\pi^O > 0$, firm O's profits are higher with ROOs and vice versa. Note that $\Delta\pi^O$ is U-shaped in Δt with a non-negative intercept. We can verify that

$$\Delta\pi^O\big|_{\Delta t=0} = \frac{(\Delta a)^2}{8} \geq 0,$$

$$\Delta\pi^O\big|_{\Delta t=\overline{\Delta t}} = -\frac{\left[\begin{array}{c}\left(8-B^2\right)\left(16-B^2\right)^2\left\{4A(4+B)-\left(8-B^2\right)\Delta a-4\left(8-B^2\right)t_2\right\}\Delta a\\+2\left(512-128B^2+7B^4\right)\left((4+B)A-\left(8-B^2\right)t_2\right)^2\end{array}\right]}{\left(32-3B^2\right)^2\left(16-B^2\right)^2}$$

$$< -\frac{\left[\begin{array}{c}8\left(8-B^2\right)\left(16-B^2\right)^2(\Delta a)^2\\+2\left(512-128B^2+7B^4\right)\left\{(4+B)A-\left(8-B^2\right)t_2\right\}^2\end{array}\right]}{\left(32-3B^2\right)^2\left(16-B^2\right)^2} \quad \left(\because t_2 < \overline{t_2}\right)$$

$$< 0.$$

Accordingly, there exists an unique value of $\Delta t = \Psi \geq 0$ which satisfies $\Delta\pi^O > 0$ if $\Delta t < \Psi$, $\Delta\pi^O = 0$ if $\Delta t = \Psi$, and $\Delta\pi^O < 0$ if $\Delta t > \Psi$. Note that $\Psi = 0$ if and only if $\Delta a = 0$. Q.E.D.

Proof of Proposition 2

With $\Delta b = 0$,

$$\frac{\partial(\Delta S)}{\partial(\Delta t)} = -\frac{16A(4+B)^2+\left(16-B^2\right)^2\Delta a-\left(512-80B^2+B^4\right)\Delta t-32\left(16-3B^2\right)t_2}{8\left(16-B^2\right)^2}$$

$$< -\frac{\left\{2A\left(32+16B+B^2\right)+B^3\Delta a+2B^3t_2\right\}B}{4\left(32-3B^2\right)\left(16-B^2\right)} \quad \left(\because \Delta t < \overline{\Delta t}\right)$$

$$< 0.$$

Besides that, $\Delta S|_{\Delta t=0} = -3(\Delta a)^2/16 < 0$. Hence, ΔS is decreasing in Δt and it is negative when $\Delta t = 0$. Q.E.D.

Proof of Proposition 3

23

With $\Delta b = 0$, we obtain $\Delta R|_{\Delta t=0} = 0$. In addition,

$$\frac{\partial\left(\Delta R\right)}{\partial\left(\Delta t\right)} \gtreqqless 0 \Longleftrightarrow \frac{4A\left(4+B\right)+\left(16-B^2\right)\Delta a - 8\left(8-B^2\right)t_2}{2\left(32-3B^2\right)} \equiv T \gtreqqless \Delta t,$$

$$\frac{\partial^2\left(\Delta R\right)}{\left\{\partial\left(\Delta t\right)\right\}^2} = -\frac{\left(32-3B^2\right)}{2\left(16-B^2\right)} < 0.$$

Note that $T < \overline{\Delta t}$. Hence, ΔR is concave in Δt, and $\Delta R = 0$ holds with $\Delta t = 0$. It is maximized at $\Delta t = T$. If $\left\{4A\left(4+B\right)+\left(16-B^2\right)\Delta a\right\}/8\left(8-B^2\right) \equiv \widetilde{t_2} < \overline{t_2}$ and $\widetilde{t_2} < t_2$, $T < 0$ so that an increase in Δt always decreases ΔR.[25] If $\overline{t_2} < \widetilde{t_2}$ or $\underline{t_2} < t_2 < \widetilde{t_2}$, $T > 0$ and we have :

$$\Delta R|_{\Delta t=T} = \frac{\left\{4A\left(4+B\right)+\left(16-B^2\right)\Delta a - 8\left(8-B^2\right)t_2\right\}^2}{16\left(32-3B^2\right)\left(16-B^2\right)} \geq 0,$$

$$\Delta R|_{\Delta t=\overline{\Delta t}} = -\frac{\left(8-B^2\right)\left\{4A\left(4+B\right)+\left(16-B^2\right)\Delta a - 8\left(8-B^2\right)t_2\right\}t_2}{\left(16-B^2\right)\left(32-3B^2\right)}$$

$$= -\frac{2\left(8-B^2\right)Tt_2}{\left(16-B^2\right)} < 0.$$

Since ΔR is concave in Δt, there exists a unique value of Δt, $\Phi(\geq 0)$, which satisfies $\Delta R > 0$ if $\Delta t < \Phi$, $\Delta R = 0$ if $\Delta t = \Phi$, and $\Delta R < 0$ if $\Delta t > \Phi$. Q.E.D.

Proof of Proposition 4

With $\Delta b = 0$, we have

$$\Delta W|_{\Delta t=0} = \Delta S|_{\Delta t=0} = -\frac{3\left(\Delta a\right)^2}{16} < 0.$$

$$\Delta W|_{\Delta t=\overline{\Delta t}} = -\frac{\left[\begin{array}{l}\left(16-B^2\right)\left[\begin{array}{c}\left(224-43B^2+2B^4\right)\left(\Delta a\right)^2 \\ +\left\{A\left(64-10B^2-B^3\right)+2t_2\left(64-18B^2+B^4\right)\right\}\Delta a\end{array}\right] \\ +\left\{A\left(4+B\right)-\left(8-B^2\right)t_2\right\}\left\{\begin{array}{c}A\left(128-32B-20B^2+B^3\right) \\ +\left(768-216B^2+13B^4\right)t_2\end{array}\right\}\end{array}\right]}{\left(32-3B^2\right)^2\left(16-B^2\right)}$$

$$< -\frac{\left[\begin{array}{c}\left(224-43B^2+2B^4\right)\left(\Delta a\right)^2 \\ +\left\{A\left(384-32B-60B^2-3B^3\right)+\left(1280-360B^2+21B^4\right)t_2\right\}\Delta a\end{array}\right]}{4\left(32-3B^2\right)^2}$$

$$\left(\because t_2 < \overline{t_2}\right)$$

$$< 0.$$

---

[25] We can verify that $\underline{t_2} < \widetilde{t_2}$, but it is ambiguous whether $\widetilde{t_2}$ is higher or lower than $\overline{t_2}$. $\widetilde{t_2} < \overline{t_2}$ if $4A - \left(12 - 3B\right)\Delta a > 0$ and $\overline{t_2} \leq \widetilde{t_2}$ otherwise.

We also have

$$\frac{\partial\left(\Delta W\right)}{\partial\left(\Delta t\right)} \gtreqqless 0 \Longleftrightarrow \frac{8A\left(2+B\right)+\left(16-B^{2}\right)\Delta a-16\left(6-B^{2}\right)t_{2}}{96-11B^{2}} \equiv \Theta \gtreqqless \Delta t,$$

$$\frac{\partial^{2}\left(\Delta W\right)}{\left\{\partial\left(\Delta t\right)\right\}^{2}} = -\frac{96-11B^{2}}{8\left(16-B^{2}\right)} < 0.$$

This suggests that ΔW is an inverse-U-shaped function of Δt which takes the maximum value at $\Delta t = \Theta$, and it is given by $\Delta W^{\max} \equiv \Delta W|_{\Delta t=\Theta} = E + F\Delta a - G\left(\Delta a\right)^{2}$, where $E \equiv 4\left\{A\left(2+B\right)-2\left(6-B^{2}\right)t_{2}\right\}^{2}/\left\{\left(16-B^{2}\right)\left(96-11B^{2}\right)\right\}$, $F \equiv \left(16-B^{2}\right)\left\{A\left(2+B\right)-2\left(6-B^{2}\right)t_{2}\right\}$, $G \equiv 272 - 49B^{2} + 2B^{4} > 0$. When $A\left(2+B\right)/\left\{2\left(6-B^{2}\right)\right\} \equiv \widehat{t}_{2} \leq t_{2}$, $F \leq 0$ so that an increase in Δa decreases $\Delta W|_{\Delta t=\Theta}$. In this case, $\Delta W^{\max}$ is highest at $\Delta a = 0$. From the above equation, $\Theta \leq 0$ with $\widehat{t}_{2} \leq t_{2}$ and $\Delta a = 0$, so that ΔW is decreasing in Δt and it is always negative. Alternatively when $\underline{t_{2}} < t_{2} < \widehat{t}_{2}$, we have $\Theta > 0$ and $F > 0$. Note that $\underline{t_{2}} < \widehat{t}_{2}$ if $\Delta a < A\left(2+B\right)/\left(6-B^{2}\right)$. In this case, $\Delta W^{\max}$ is an inverse-U-shaped function as to Δa:

$$\Delta W^{\max}|_{\Delta a=0} = E > 0,$$

$$\Delta W^{\max}|_{\Delta a=\frac{A(2+B)}{(6-B^{2})}} = -\frac{\left[\begin{array}{c} A^{2}\left(270\,192 - 89\,296B^{2} + 10\,812B^{4} - 569B^{6} + 11B^{8}\right)\\ +2A\left(6-B^{2}\right)^{2}\left(2+B\right)\left(24\,624 - 5896B^{2} + 448B^{4} - 11B^{6}\right)t_{2}\\ -16\left(B^{2}-6\right)^{4}t_{2}^{2} \end{array}\right]}{\left(6-B^{2}\right)^{2}\left(16-B^{2}\right)\left(96-11B^{2}\right)}$$

$$< -\frac{\left[\begin{array}{c} A^{2}\left(\begin{array}{c} 269\,616 - 576B - 89\,248B^{2} + 192B^{3}\\ +10\,844B^{4} - 16B^{5} - 573B^{6} + 11B^{8} \end{array}\right)\\ +2A\left(6-B^{2}\right)^{2}\left(2+B\right)\left(24\,624 - 5896B^{2} + 448B^{4} - 11B^{6}\right)t_{2} \end{array}\right]}{\left(6-B^{2}\right)^{2}\left(16-B^{2}\right)\left(96-11B^{2}\right)}$$

$$< 0.$$

where the first inequality is due to $t_{2} < \widehat{t}_{2}$. Hence, if $\Delta a < \nu \equiv (F + \sqrt{4EG + F^{2}})/(2G)$, $\Delta W|_{\Delta t=\Theta} > 0$. In this case, there exist two positive, cut-off values denoted by $(\underline{\mu}, \overline{\mu})$. $\Delta W < 0$ if $\Delta t < \underline{\mu}$ or $\overline{\mu} < \Delta t$, $\Delta W = 0$ if $\Delta t = \underline{\mu}$ or $\overline{\mu} = \Delta t$, and $\Delta W > 0$ if $\underline{\mu} < \Delta t < \overline{\mu}$. If $\nu \leq \Delta a < A\left(2+B\right)/\left(6-B^{2}\right)$, $\Delta W|_{\Delta t=\Theta} \leq 0$, implying that ΔW is not positive. Q.E.D.

Proof of Proposition 6

When $\Delta b = 0$ and firm I makes production in country 2, $\widehat{p}^{I} - \grave{p}_{2}^{I} = \left\{\left(B+4\right)\Delta a + B\Delta t\right\}/\left(16-B^{2}\right)$. By (11), $\Delta a \geq 0$ with $\Delta b = 0$ and hence $\widehat{p}^{I} \geq \grave{p}_{2}^{I}$. In view of

the condition of market segmentation, $\grave{p}_2^I \geq \grave{p}_1^I - t_1$. Thus, we have $\widehat{\pi}^I \geq \grave{\pi}^I$. When $\Delta b = 0$ and firm I is located in country 1, $\widehat{\pi}^I - \grave{\pi}^I = [t_2 \left(8 - B^2\right) \{4a_2 \left(4 + B\right) - t_2 \left(8 - 4B - B^2\right)\} - 2\{(4 + B) \Delta a + 2B\Delta t\}^2] / \left(16 - B^2\right)^2$. Therefore, $\widehat{\pi}^I \geq \grave{\pi}^I$ is satisfied if $t_2 \left(8 - B^2\right) \{4a_2 \left(4 + B\right) - t_2 \left(8 - 4B - B^2\right)\}/2 \geq \{(4 + B) \Delta a + B\Delta t\}^2$ where the left-hand side of the inequality is positive because $x_2^O(\grave{p}_2^O, \grave{p}_2^I) > 0$ requires $2a_2/(2 - B) > t_2$. Q.E.D.

Cournot competition

As long as products are differentiated, the results obtained with the quantity competition à la Cournot are essentially the same. Suppose that the inverse demands are given by $p_i^I = \alpha_i - x_i^I - \beta_i x_i^O$ and $p_i^O = \alpha_i - x_i^O - \beta_i x_i^I$ where $\beta_i \in [0, 1)$ measures the degree of product similarity in country i. As in the subsection 2.2, we focus on the case where the equilibrium prices satisfy $\widehat{p}_1^O \geq \widehat{p}_2^O$ if the markets of good O are segmented and $\Delta t = 0$. Without ROOs, firm O must set the amount of supplies to two countries so that $p_1^O = p_2^O$. In this case, compared to the segmentation case, firm O needs to increase the supply in country 1 and decrease the supply in country 2. ROOs make firm O free from the uniform-price constraint, and the price-discrimination effect decreases x_1^O and increases x_2^O. The anti-circumvention effect, on the other hand, decreases x_1^O. Since the products are strategic substitutes, both effects are positive for firm I and it necessarily benefits from ROOs if $\beta_1 \geq \beta_2$. If $\beta_1 < \beta_2$ and Δt is not very high, on the other hand, firm I may be worse off, because the price-discrimination effect hurts firm I. For firm O, whether or not ROOs increase its profits depends on the relative magnitude of the positive price-discrimination effect and the negative anti-circumvention effect. Thus, all four cases observed in Table 1 are possible, though the condition for the product similarity is reversed.

References

[1] Anson, José, Olivier Cadot, Antoni Estevadeordal, Jaime de Melo, Akiko Suwa-Eisenmann, and Bolormaa Tumurchudur (2003) "Rules of origin in North-South preferential trading arrangements with an application to NAFTA", CEPR Discussion Papers No.4166.

[2] Cadot, Olivier, Antoni Estevadeordal, and Akiko Suwa-Eisenmann (2005) "Rules of origin as export subsidies," CEPR Discussion Paper No. 4999.

[3] Duttagupta, Rupa, and Arvind Panagariya (2003) "Free trade areas and rules of origin: Economics and politics," IMF Working Paper WP/03/229.

[4] Evans, Carolyn L. (2003) "The economic significance of national border effects", *American Economic Review* 93(4): 1291-1312.

[5] Falvey, Rod and Geoff Reed (1998) "Economic effects of rules of origin", *Weltwirtshaftliches Archiv* 134(2): 209-229.

[6] Falvey, Rod and Geoff Reed (2002) "Rules of origin as commercial policy instruments", *International Economic Review* 43(2): 393-407.

[7] Goldberg, Pinelopi K. and Frank Verboven (2005) "Market integration and convergence to the Law of One Price: evidence from the European care market", *Journal of International Economics* 65(1): 49-73.

[8] Helliwell, John F. (1998) *How Much Do National Borders Matter?* Brookings Institution; Washington, D.C.

[9] Horn, Henrik and Oz Shy (1996) "Bundling and international market segmentation", *International Economic Review* 37(1): 51-69.

[10] Ishikawa, Jota and Hiroshi Mukunoki (2005) "FTA formation and rules of origin under international oligopoly", mimeo.

[11] Ju, Jiandong and Kala Krishna (2002) "Regulations and regime switches and non-monotonicity when non-compliance is an option: An application to content protection and preference", *Economics Letters* 77, 315-321.

[12] Ju, Jiandong and Kala Krishna (2005) "Firm behavior and market access in a free trade area with rules of origin", *Canadian Journal of Economics* 38 (1): 290-308.

[13] Knetter, Michael M. and Matthew J. Slaughter (2001) "Measuring product-market integration", in Magnus Blomström and Linda S. Goldberg (eds.) *Topics in Empirical International Economics: A Festschrift in Honor of Robert E. Lipsey*, University of Chicago Press, Chicago.

[14] Krishna, Kala and Anne O. Krueger (1995) "Implementing free trade agreements: Rules of origin and hidden protection", in Alan V. Deardorff, Jim Levinson, and Robert M. Stern (eds.) *New Directions in Trade Theory*. Ann Arbor; University of Michigan Press, 149-187.

[15] Krueger, Anne O. (1999), "Free Trade Agreements as Protectionist Devices: Rules of Origin", in James Melvin et al. (eds.) *Trade, Theory and Econometrics: Essays in Honor of John Chipman*, Routledge, London.

[16] McCallum, John (1995) "National borders matter: Canada-U.S. regional trade patterns", *American Economic Review* 85(3): 615-623.

[17] Mukunoki, Hiroshi (2004) "On the optimal external tariffs of a free trade area with internal market integration", *Japan and the World Economy* 16(4) : 431-448.

[18] Obstfeld, Maurice and Kenneth Rogoff (2001) "The six major puzzles in international macroeconomics: is there a common cause?", in Ben Bernanke and Kenneth Rogoff (eds.), *NBER Macroeconomics Annual 2000*, MIT Press; Cambridge, 339-390.

[19] Okubo, Toshihiro (2004) "The border effect in the Japanese market: A Gravity Model analysis", *Journal of the Japanese and International Economies* 18(1): 1-11.

[20] Richardson, Martin (1995) "Tariff revenue competition in a free trade area", *European Economic Review* 39: 1429-1437.

[21] Rodriguez, Peter L. (2001) "Rules of origin with multistage production", *World Economy* 24(2): 201-220.

[22] Rosellón, Juan (2000) "The economics of rules of origin", *Journal of International Trade and Economic Development* 9(4): 397-425.

[23] Takechi, Kazutaka and Kazuharu Kiyono (2003) "Local content protection: specific-factor model for intermediate goods production and market segmentation", *Japan and the World Economy* 15(1) : 69-87.

[24] Wei, Shang-Jin (1996) "Intra-national versus international trade: How stubborn are nations in global integration?", NBER Working Papers No.5531.

[25] WTO (2002) "Rules of origin regimes in regional trade agreements", WT/REG/W/45.

Tables and Figures

Table 1

Numerical example of profit changes : Without ROOs $\Longrightarrow$ With ROOs

$(A = 5,\ B = 0.5, \Delta a = 1,\ t_2 = 0.7)$

	$\Delta b = 0$		$\Delta b = 0.1$		$\Delta b = -0.1$	
	$(\overline{\Delta t} = 2.69)$		$(\overline{\Delta t} = 2.78)$		$(\overline{\Delta t} = 2.61)$	
	Firm I	Firm O	Firm I	Firm O	Firm I	Firm O
$\Delta t = 0.0$	0.000	0.125	0.043	0.169	-0.032	0.088
$\Delta t = 0.5$	0.094	-0.472	0.157	-0.445	0.043	-0.492
$\Delta t = 1.0$	0.189	-0.946	0.272	-0.937	0.119	-0.948
$\Delta t = 1.5$	0.285	-1.297	0.388	-1.307	0.195	-1.280
$\Delta t = 2.0$	0.382	-1.525	0.506	-1.555	0.272	-1.489
$\Delta t = 2.5$	0.480	-1.629	0.626	-1.680	0.349	-1.574

Table 2

Numerical example of firm I's profit changes by the compliance of ROOs when located in country 1

$(A = 4,\ B = 0.5)$

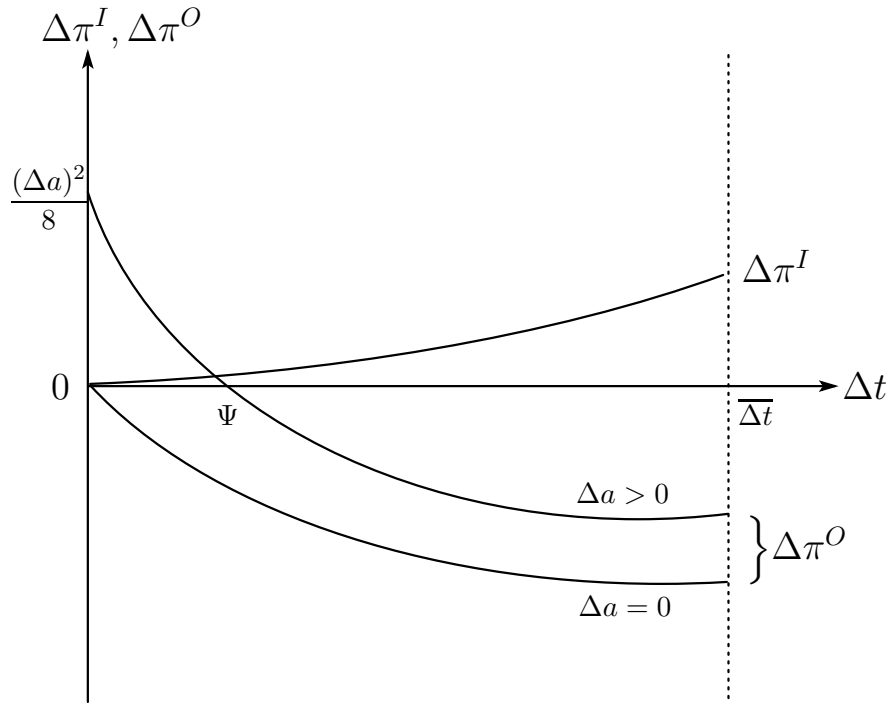|	$\Delta b = -0.05$			$\Delta b = 0.05$		
Δa	1.5	1.5	1.75	1.5	1.5	1.75
t_2	0.75	1.0	1.0	0.75	1.0	1.0
$\overline{\Delta t}$	2.28	2.03	2.15	2.35	2.10	2.22
$\Delta t = 0.0$	0.111	0.216	0.020	0.004	0.093	-0.117
$\Delta t = 1.0$	0.063	0.169	-0.036	-0.062	0.027	-0.193
$\Delta t = 2.0$	0.012	0.118	-0.094	-0.133	-0.045	-0.275
$\Delta t = \overline{\Delta t}$	-0.002	0.116	-0.104	-0.159	-0.053	-0.294

Figure 1 : Comparison of profits $(\Delta b = 0)$

$\Delta \pi^I, \Delta \pi^O$

$\frac{(\Delta a)^2}{8}$

0

Ψ

$\Delta \pi^I$

$\overline{\Delta t}$

Δt

$\Delta a > 0$

$\left. \right\} \Delta \pi^O$

$\Delta a = 0$

Figure 2 : Comparison of tariff revenues $(\Delta b = 0)$

ΔR

0

T

Φ

$\overline{\Delta t}$

Δt

$t_2 < \tilde{t}_2$

$\tilde{t}_2 < t_2$
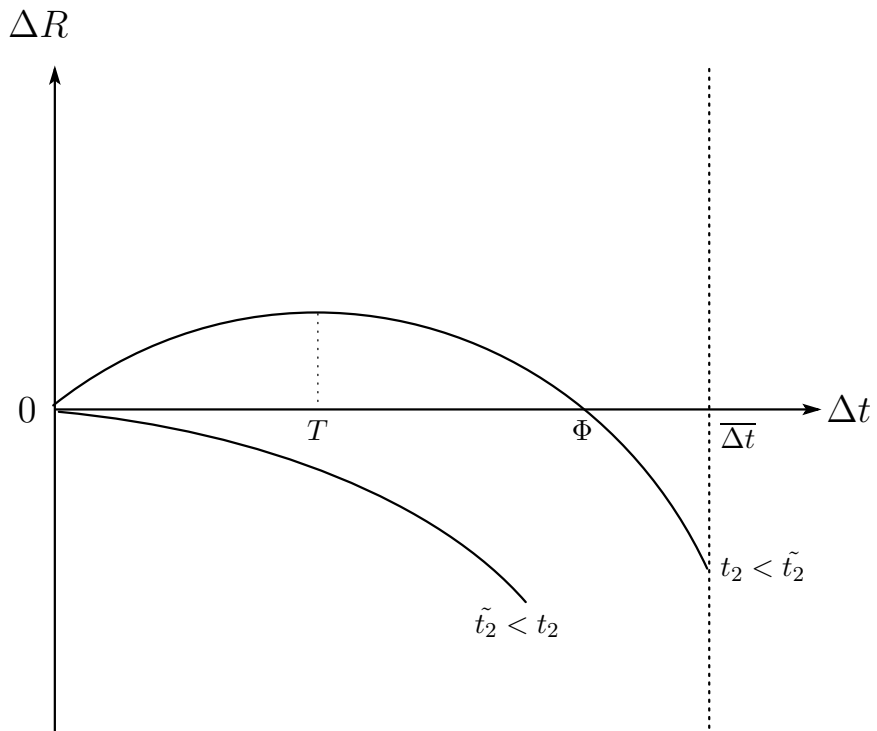
Figure 3 : Comparison of total welfare $(\Delta b = 0)$

ΔW

0

$\underline{\mu}$

$\bar{\mu}$

$\overline{\Delta t}$

Δt

$\underline{t_2} < t_2 < \hat{t}_2,$
$\nu \leq \Delta a < A(2 + B)/(6 - B^2)$

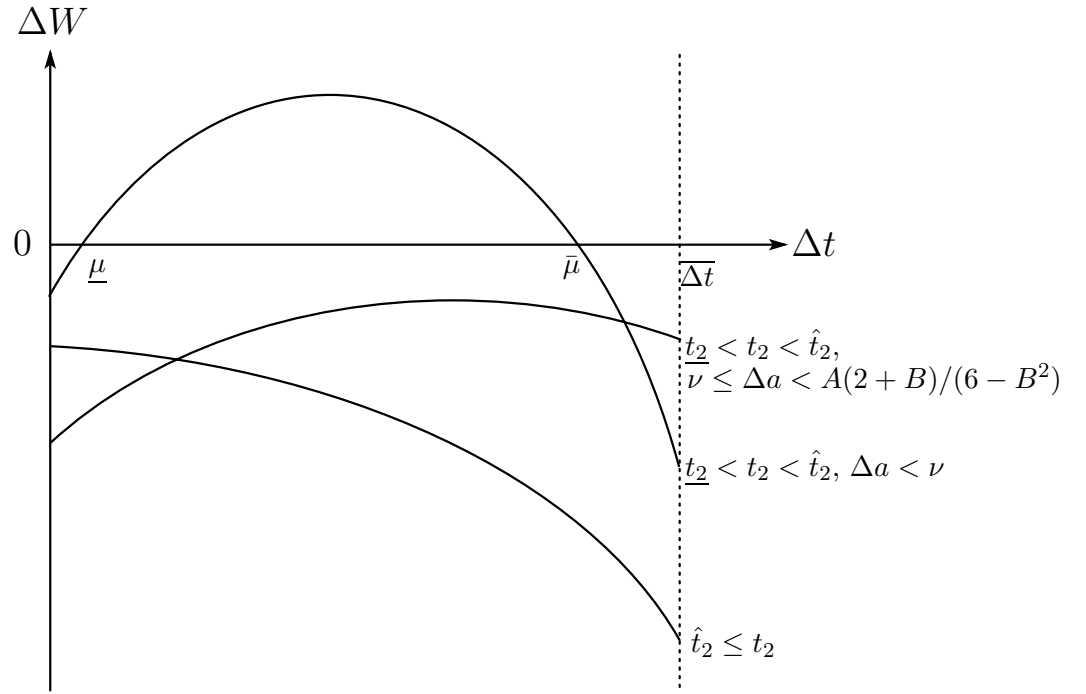$\underline{t_2} < t_2 < \hat{t}_2, \ \Delta a < \nu$

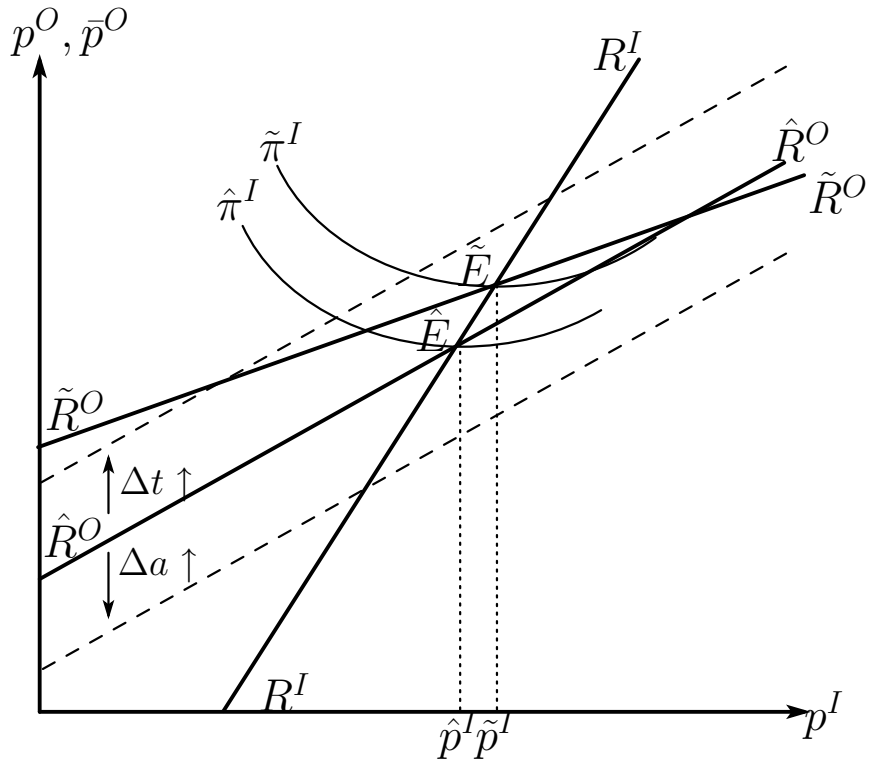$\hat{t}_2 \leq t_2$

Figure 4 : Comparison of firm I's profits $(\Delta b > 0)$

Figure 5 : Comparison of firm I's profits $(\Delta b < 0)$