Domestic Product Standards and Free Trade Areas*

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Abstract

This study considers endogenous determination of domestic standards on products that cause negative consumption externalities in the presence of a possible free trade area (FTA) in a three-country world, and examines how an FTA affects the optimal levels of (external) tariffs and standards chosen by each country and national welfare. We demonstrate that under an FTA, member countries' standards become more stringent than under a tariff-war equilibrium based on the most-favored-nation (MFN) clause. Member countries' welfare may or may not be higher under the FTA than under the MFN equilibrium, whereas the nonmember country unambiguously become better off after the FTA formation. We also compare two regimes, national standards and harmonization, regarding the choice of standards by the FTA members and show that in comparison with the national standards, harmonization of standards within an FTA will lead the member countries to choose less stringent standards and make the formation of the FTA more favorable.

Keywords: Regionalism; Optimal tariffs; Standards; Free trade areas; International oligopoly

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1 Introduction

Preferential trade agreements (PTAs) has dramatically been increased in the last two decades. For example, in 2012, WTO receives 511 notifications of PTAs and among them 319 in force, which is more than five times from the corresponding number in 1992.[1] Under the PTAs, tariffs and other trade barriers are removed in most of goods trade between its member countries.

Even though tariffs on trade in commodities are eliminated via trade agreements, nontariff barriers may still exist among the nations that conclude the agreements. Among others, technical regulations and product standards, the main purpose of which is to keep safety or environmental condition for the country, may vary from country to country, and such different regulations and standards may be obstacles for foreign exporters. Moreover, if regulations and standards are set arbitrarily, they could be used as an excuse for protectionism. These Technical Barriers to Trade (TBT) have become a big concern not only for today's WTO but also for PTAs. For example, when the European Union (EU) forms a PTA, the agreement often requests the partner country to harmonize its national standards and conformity assessment procedures with those of the EU (Stoler, 2011).[2] Of another example is the Trans-Pacific Partnership (TPP) agreement, negotiations for which have recently been taking place as an expanded version of the 2005 Trans-Pacific Strategic Economic Partnership Agreement (TPSEP). The TPP is intended to be a "high-standard" agreement specifically aimed at emerging trade issues in the 21st century, and the key features of broad outlines of the TPP includes regulatory coherence; commitments will promote trade between the countries by making trade among them more seamless and efficient.[3]

[1] See WTO website: http://www.wto.org/.

[2] Chapter 4 of the EU–South Korea FTA includes specific undertakings on good regulatory practice: transparency in making rules, use where possible of international standards, providing the other Party with an opportunity to discuss rules before they are made, and allowing sufficient time for the other Party to comment on then and to take account of their adoption.

[3] Chapter 8 of the TPSEP agreement is allotted for TBT. Article 8.7 states that the Parties shall use international standards, or the relevant parts of international standards, as a basis for their technical regulations and related conformity assessment procedures where relevant international standards exist or their completion is imminent, except when such international standards or their relevant parts are

In light of the growing importance of standards or regulations that may act as nontariff barriers in PTAs, several questions will arise. Do standards become more or less stringent under a PTA than in the absence of it? After a formation of the PTA, do member or nonmember countries become better off? Do potential PTA members have an incentive to harmonize their standards?

This paper addresses these issues theoretically by using a simple three-country oligopolistic trade model. In this paper, among the several forms of PTAs, we focus on free trade areas (FTAs), where each member country chooses its external tariffs independently.[4] The structure of the model employed in this paper is based on those in the studies on welfare effects of PTAs or the possibilities for PTAs to be multilateral free trade under international oligopoly (Yi, 1996, 2000; Krishna, 1998; Freund, 2000; Orneras, 2005a, b; Saggi, 2006). We extend the basic three-country model of imperfect competition by incorporating the endogenous determination of standards by national governments. In this paper, we consider standards for controlling negative externalities generated by consumption of goods. In order to enter the importer country's market, foreign exporters must produce goods that meet the import's standard, and thus the standard can be a nontariff barrier. Governments are assumed to be benevolent, without any political incentives to set their respective standards. Under these assumptions, we consider endogenous determination of standards as well as (external) tariffs.

The main results obtained in this paper are as follows. Compared with the policy game in the absence of FTAs, an FTA makes the member countries to choose more stringent standards. Regarding the national welfare in each country, the FTA member countries may or may be better off under the formation of an FTA, while the nonmember country becomes better off for the case of low degree of transboundary externalities. By comparing the case in which FTA members independently determine their respec-

ineffective or inappropriate to fulfil legitimate objectives.

[4]In view of the fact that most existing PTA arrangements take the form of FTAs and less than 10% can be considered to be fully fledged customs unions, Facchini et al. (2012) develop a political economy model of trade policy under imperfect competition to provide a positive explanation for the prevalence of FTAs.

tive national standards with the case in which the FTA member countries harmonize their standards within the FTA, such harmonization of standards will lead the member countries to choose less stringent standards and make the formation of the FTA more favorable, provided the degree of transboundary externalities is not so high.

Finally, we state about the existing studies in order to clarify this paper's standpoint. Recently, we often find theoretical studies on trade and standard.[5] Fischer and Serra (2000) point out the possibility of strategic use of standards under international oligopoly; i.e., governments can exclude foreign firms by setting the lowest standard though it increases costs of domestic firms. Costinot (2008) compares performance between two different agreements on product standards; WTO's approach based on a "National Treatment" (NT) principle and EU's approach that relies on a principle of "Mutual Recognition" (MR). More recently, Takarada et al. (2014) investigate regional and multilateral agreements on standards in a three-country oligopolistic trade model to shed light on how country/region specific regulations affect multilateralism. Notice that in these studies focus on standards as nontariff barrier by assuming no tariff-based protection. In contrast to these studies, we consider both tariffs and nontariff barriers to take account of the interactions between these "traditional" and "modern" forms of trade protection.

The rest of this paper is organized as follows. In section 2, we set up a three-country model of international oligopoly with standards imposed by the national governments. In section 3, we derive the equilibrium of the policy game in the absence of FTAs. In section 4, we derive the equilibrium of the policy game under an FTA. When governments in the member countries determine their respective standards, they may act independently or jointly. We consider both cases. We examine how a formation of the FTA affects the standards chosen by the member countries and national welfare in member and nonmember countries. We also compare the outcomes under national standards with

[5]In the text, we focus on theoretical studies on trade and standard, which have quite similar perspective. As well as theoretical studies, we can find empirical studies on this issue. For example, Baghdadi et al. (2013) empirically test the relationship with RTAs with environmental provisions and pollution levels.

those under harmonization of standards within the FTA. In section 5, we extend the basic model by incorporating transboundary externalities and discuss whether or not the results derived from the basic model are maintained. In section 6, we provide brief concluding remarks.

2 Model

We consider three symmetric countries, A, B, and C, each with one firm that produces a homogeneous product. Consumption of the product generates negative externalities, which is assumed to be local, and the level of the externalities depends on a standard imposed by the national government. Let us denote the standard imposed in country i by s_i $(i = A, B, C)$, and the externalities per unit of consumption is given by $b(s_i)$, which is assumed to be decreasing in s_i. There is also another homogeneous good, which serves as the numeraire and is assumed to be freely traded and produced under perfect competition with constant returns to scale technology, and generate no externalities.

There is a continuum of homogeneous consumers of measure one. Each consumer in country i has the following quasi-linear preference:

$$U(Q_i, Y_i; s_i, \bar{Q}_i) = u(Q_i) + Y_i - b(s_i)\bar{Q}_i,$$

where Q_i and Y_i are his consumption of the externality-generating product and the numeraire, respectively, and $\bar{Q}_i$ is the aggregate consumption of the product. As explained above, $b(s_i)\bar{Q}_i$ denotes the negative externalities in this country. Throughout the paper, we assume that $u(Q_i)$ is quadratic and hence the consumers' utility maximization derives the linear inverse demand function $P(Q_i) = \alpha - Q_i$, $\alpha > 0$.

The three firms compete in quantities in each of the national markets, which are assumed to be segmented. We assume that these firms have identical technologies and each firm's unit production cost is a function of standard imposed in the country of consumption. Let us denote the unit production cost by $c(s_i)$, which is assumed to be increasing in s_i. That is, it is more expensive to produce at a higher standard.[6] This

[6]For example, if the use of a certain food additive is legally prohibited in a country, the firms

is because the firms are banned from selling goods that do not meet individual national standards, and thus the firms produce goods which exactly fulfill the requirements of standards in each country's market.

We also assume that the governments imposes tariffs on imports. Because the markets are segmented, we can consider the Cournot–Nash equilibrium in each market separately. Let us denote the output of the domestic firm by q_{ii} and the outputs of foreign exporters by q_{ij}, and q_{ik}, $i, j, k = A, B, C$, $i \neq j \neq k$, thus $Q_i = q_{ii} + q_{ij} + q_{ik}$. The foreign firms face a specific tariff when exporting to country i. Let us denote the tariff rates on imports that the national government in country i imposes by t_{ij} and t_{ik}, respectively. Assuming that the firms do not incur fixed costs, profits of the respective firms supplying to the market in country i are given by

$$\begin{aligned}
\pi_{ii} &= [P(Q_i) - c(s_i)]q_{ii} = [a(s_i) - Q_i]q_{ii}, \\
\pi_{ij} &= [P(Q_i) - c(s_i) - t_{ij}]q_{ij} = [a(s_i) - Q_i - t_{ij}]q_{ij}, \\
\pi_{ik} &= [P(Q_i) - c(s_i) - t_{ik}]q_{ik} = [a(s_i) - Q_i - t_{ik}]q_{ik},
\end{aligned}$$

where $a(s_i) \equiv \alpha - c(s_i)$. From the first-order conditions for profit maximization, Cournot–Nash equilibrium output of each firm is derived as follows:

$$q_{ii} = \frac{a(s_i) + t_{ij} + t_{ik}}{4}, \quad q_{ij} = \frac{a(s_i) - 3t_{ij} + t_{ik}}{4}, \quad q_{ik} = \frac{a(s_i) + t_{ij} - 3t_{ik}}{4}. \tag{1}$$

The total output sold in country i is therefore derived as

$$Q_i = \frac{3a(s_i) - t_{ij} - t_{ik}}{4}. \tag{2}$$

These equilibrium outputs are a function of policy variables imposed by the government in country i.

The total profit of the firm producing the externalities-generating product is the sum of profits from domestic and export sales: $\pi_i = \pi_{ii} + \pi_{ji} + \pi_{ki}$, $i, j, k = A, B, C$, $i \neq j \neq k$. National welfare in each country is defined as the sum of consumer surplus

supplying food products in that country's market should avoid using that material in their production process.

$CS_i = \int_0^{Q_i} P(x)dx - P(Q_i)Q_i$, total profit π_i, and tariff revenue $t_{ij}q_{ij} + t_{ik}q_{ik}$, minus the social cost from negative externalities $b(s_i)Q_i$. Given the linear demand function, it holds that $CS_i = (Q_i)^2/2$ and $\pi_i = (q_{ii})^2 + (q_{ji})^2 + (q_{ki})^2$. In light of (1) and (2), national welfare is therefore given by

$$W_i = \frac{[3a(s_i) - t_{ij} - t_{ik}]^2}{32} + \frac{[a(s_i) + t_{ij} + t_{ik}]^2}{16} + \frac{[a(s_j) - 3t_{ji} + t_{jk}]^2}{16} + \frac{[a(s_k) - 3t_{ki} + t_{kj}]^2}{16} + t_{ij}\frac{a(s_i) - 3t_{ij} + t_{ik}}{4} + t_{ik}\frac{a(s_i) + t_{ij} - 3t_{ik}}{4} - b(s_i)\frac{3a(s_i) - t_{ij} - t_{ik}}{4}. \quad (3)$$

In the following analysis, we assume that there are two standards available, s_H and s_L, with $s_H > s_L$. If the national government choose a high standard, firms incur a unit cost $c(s_H) = \gamma > 0$, but consumption of the good does not generate negative externalities, i.e., $b(s_H) = 0$. If the government choose a low standard, firms do not incur costs, i.e., $c(s_L) = 0$, but consumption generates negative externalities $b(s_L) = \beta > 0$. Due to these simplifications of unit cost and externality functions, we can compare the welfare levels under different regimes of policy games.

In our analysis, we consider the following order: in the first stage, each government determines tariffs and standards, and in the second stage the firms compete in the Cournot way. We derive the subgame perfect Nash equilibrium of this game by backward induction. Although we implicitly consider the situation in which the governments determine these policy instrument simultaneously, under our setting the same solutions are obtained even if the governments first determine the standards, and then chooses the optimal tariffs that maximizes national welfare taking the standard as given (see Appendix). We thus formulate the governments' behavior as if their policy games are played sequentially.

3 Policy Game without FTAs

In this section, we consider a policy game in the absence of FTAs as a benchmark. It is natural to assume that the determination of tariffs follows the principle of nondiscrimination, known as the most-favored-nation (MFN) clause. That is, the government in

each country imposes a single nondiscriminatory tariff on its trading partners and all countries simultaneously choose their respective tariffs to maximize their own welfare. Substituting $t_{ij} = t_{ik} = t_i$ into (3), the national welfare is rewritten as

$$W_i = \frac{[3a(s_i) - 2t_i]^2}{32} + \frac{[a(s_i) + 2t_i]^2}{16} + \frac{[a(s_j) - 2t_j]^2}{16} + \frac{[a(s_k) - 2t_k]^2}{16} + t_i \frac{a(s_i) - 2t_i}{2} - b(s_i) \frac{3a(s_i) - 2t_i}{4}. \tag{4}$$

Taking the tariffs in other countries t_j and t_k as given, the government in country i determines t_i so as to maximize welfare (4). From the first-order condition $\partial W_i / \partial t_i = 0$, the MFN tariff for a given standard is derived as

$$t_i = \frac{3a(s_i) + 4b(s_i)}{10} \equiv t^M(s_i). \tag{5}$$

Notice that because of the assumptions of segmented markets and a constant unit cost (for a given s_i), a country's MFN tariff does not depend on the other countries' tariffs. This also means that the MFN tariffs in the trading partners are $t^M(s_j)$ and $t^M(s_k)$. The stringency of standards affects the MFN tariff rate in the following manner:

$$t^M(s_H) = \frac{3(\alpha - \gamma)}{10} < \frac{3\alpha + 4\beta}{10} = t^M(s_L). \tag{6}$$

Because more stringent standards lead a higher cost of compliance, which reduces outputs of both domestic and foreign firms and raises the price. In order to compensate for the resulting losses in consumer surplus and tariff revenue, the national government will reduce the tariffs on imports.

We turn to the determination of standards, which are made noncooperatively in this benchmark situation. In light of (5), the national welfare (4) can be rewritten as $W_i^M = w_i^M(s_i) + \pi_{ji}^M(s_j) + \pi_{ki}^M(s_k)$, where

$$w_i^M(s_i) \equiv \frac{[11a(s_i) - 10t^M(s_i)][a(s_i) + 2t^M(s_i)]}{32} - \frac{b(s_i)[3a(s_i) - 2t^M(s_i)]}{4} \tag{7}$$

is the domestic surplus and

$$\pi_{ji}^M(s_j) \equiv \frac{[a(s_j) - 2t^M(s_j)]^2}{16}, \quad \pi_{ki}^M(s_k) \equiv \frac{[a(s_k) - 2t^M(s_k)]^2}{16} \tag{8}$$

are the export profits. Taking the standards in other countries s_j and s_k as given, the government in country i determines $s_i \in \{s_L, s_H\}$ so as to maximize the national welfare W_i^M. Since W_i^M is additively separable, the problem is equivalent to choose s_i that maximizes the domestic surplus (7). A direct calculation yields that $w_i^M(s_H) = 2(\alpha-\gamma)^2/5$ and $w_i^M(s_L) = (4\alpha^2 - 6\alpha\beta + \beta^2)/10$. Hence, if

$$\Delta w_i^M \equiv w_i^M(s_H) - w_i^M(s_L) = \frac{-8\alpha\gamma + 4\gamma^2 + 6\alpha\beta - \beta^2}{10} \tag{9}$$

is positive (negative), the government find it optimal to choose s_H (s_L). In order to exclude cases where governments set prohibitive tariffs, we restrict our attention to the parameter values that satisfy $\alpha > \gamma$ and $\alpha > 2\beta$.[7] Given these parameter restrictions, it is clear from (9) that $\Delta w_i^M > 0$ ($\Delta w_i^M < 0$) holds if and only if

$$\gamma < (>)\ \bar{\gamma}^M(\beta) \equiv \alpha - \sqrt{\alpha^2 - \frac{3}{2}\alpha\beta + \frac{\beta^2}{4}}.$$

It is easily verified that $\bar{\gamma}^M(\beta)$ is increasing and convex in β:

$$\frac{d\bar{\gamma}^M(\beta)}{d\beta} = \frac{3\alpha-\beta}{4}\left(\alpha^2 - \frac{3}{2}\alpha\beta + \frac{\beta^2}{4}\right)^{-1/2} > 0, \quad \frac{d^2\bar{\gamma}^M(\beta)}{d\beta^2} = \frac{5\alpha^2}{16}\left(\alpha^2 - \frac{3}{2}\alpha\beta + \frac{\beta^2}{4}\right)^{-3/2} > 0.$$

In addition, it holds that $\bar{\gamma}^M(\alpha/2) = (1-\sqrt{5}/4)\alpha \approx 0.4410\alpha$. Therefore, the government chooses a high standard if $(\beta,\gamma) \in S_H^M$, whereas it chooses a low standard if $(\beta,\gamma) \in S_L^M$, where $S_H^M \equiv \{(\beta,\gamma) \in [0,\alpha/2] \times [0,\alpha] \,|\, \gamma < \bar{\gamma}^M(\beta)\}$ and $S_L^M \equiv \{(\beta,\gamma) \in [0,\alpha/2] \times [0,\alpha] \,|\, \gamma > \bar{\gamma}^M(\beta)\}$.

Lemma 1. *Under the MFN, each government's dominant strategy for standards is to choose s_H if $0 < \gamma < \bar{\gamma}^M(\beta)$ and s_L if $\bar{\gamma}^M(\beta) < \gamma < \alpha$.*

The intuition behind Lemma 1 is straightforward. In tightening standards, national governments face a trade-off between a rise in the firms' unit cost γ and a mitigation of negative externalities β. If γ is relatively high compared with β, the former effect dominates the latter, and thus the governments will choose a less stringent standard. If β is relatively high, the government will make an opposite choice.

[7] Substituting (5) into the export outputs, we obtain $q_{ij} = q_{ik} = [a(s_i) - 2b(s_i)]/10$, which becomes positive if $\alpha > \gamma$ (in the case of high standard) and $\alpha > 2\beta$ (in the case of low standard).

4 Policy Games under an FTA

Let us now suppose that countries A and B form a free trade area (FTA), which reduces tariffs between these country to zero: $t_{AB} = t_{BA} = 0$. By definition of an FTA, the member countries set their respective external tariffs independently, and let us denote the external tariff rate by $t_{iC} = t_i$, $i = A, B$. Substituting these into (3), the national welfare of a member country is given by

$$W_i = \frac{[3a(s_i) - t_i]^2}{32} + \frac{[a(s_i) + t_i]^2}{16} + \frac{[a(s_j) + t_j]^2}{16} + \frac{[a(s_k) - 2t_C]^2}{16} + t_i \frac{a(s_i) - 3t_i}{4} - b(s_i)\frac{3a(s_i) - t_i}{4}, \quad i, j = A, B, j \neq i. \tag{10}$$

Because tariffs are eliminated within the FTA partners, total sales and the export to the FTA partner increase, which lead to increases in consumer surplus and export profit in the FTA partner's market. At the same time, the elimination of tariffs reduce the domestic profit and tariff revenue. In addition, the increase in the domestic consumption leads to larger negative externalities.

Taking the external tariff rate in the FTA partner t_j and the tariff rate in the non-member country t_C as given, the government in country i determines t_i so as to maximize welfare (10). The optimal external tariff for a given standard is derived as

$$t_i = \frac{3a(s_i) + 4b(s_i)}{21} \equiv t^F(s_i), \tag{11}$$

which is less than the optimal tariff level under the MFN, $t^M(s_i)$.

Lemma 2. *For a given level of standards, the optimal external tariff under an FTA is lower than the MFN tariff:* $t^F(s_i) < t^M(s_i)$.

Lemma 2 is a well-known tariff complementarity effect (Bagwell and Staiger, 1998). Intuitively, because of a change in competitive advantage in the member countries' markets, a formation of FTAs reduces imports from the nonmember country, which in turn reduces tariff revenue and consumer surplus, and in order to offset these negative effects the member countries encourage the import from the nonmember country by reducing external tariffs.

The government's behavior in the nonmember country is the same as that under MFN, and thus, for the firms in the FTA members, the export profit in the nonmember country is $\pi_{Ci}^M(s_C)$, $i = A, B$. Then, in light of (11), the member country's national welfare (10) can be rewritten as $W_i^F = w_i^F(s_i) + \pi_{ji}^F(s_j) + \pi_{Ci}^M(s_C)$, where

$$w_i^F(s_i) \equiv \frac{11[a(s_i)]^2 + 6a(s_i)t^F(s_i) - 21[t^F(s_i)]^2}{32} - \frac{b(s_i)[3a(s_i) - t^F(s_i)]}{4} \tag{12}$$

is the domestic surplus and

$$\pi_{ji}^F(s_j) \equiv \frac{[a(s_j) + t^F(s_j)]^2}{16} \tag{13}$$

is the export profit in the FTA partner's market.

In the following analysis, we consider two scenarios regarding the determination of the FTA members' standards. One is a "national standards" regime, where the government in each member country independently determines the level of standard so as to maximize its own welfare. The other is a "harmonization" regime, where the governments in member countries harmonize their standards; they jointly determine the standards so as to maximize the joint welfare within the FTA.

4.1 National standards

In the national-standards regime, taking the standards in other countries s_j and s_C as given, the government in country i determines $s_i \in \{s_L, s_H\}$ so as to maximize the national welfare W_i^F, or equivalently, the domestic surplus $w_i^F(s_i)$. From (11) and (12), it holds that $w_i^F(s_H) = 5(\alpha - \gamma)^2/14$ and $w_i^F(s_L) = (15\alpha^2 - 30\alpha\beta + \beta^2)/42$. Therefore, the government find it optimal to choose s_H (s_L) if

$$\Delta w_i^F \equiv w_i^F(s_H) - w_i^F(s_L) = \frac{-30\alpha\gamma + 15\gamma^2 + 30\alpha\beta - \beta^2}{42} \tag{14}$$

is positive (negative), or equivalently, if

$$\gamma < (>)\ \bar{\gamma}^F(\beta) \equiv \alpha - \sqrt{\alpha^2 - 2\alpha\beta + \frac{\beta^2}{15}}.$$

It is easily verified that $\bar{\gamma}^F(\beta)$ is increasing and convex in β. As in the policy game equilibrium in the absence of the FTAs, we can partition the set $\left\{(\beta, \gamma) \in \mathbb{R}_+^2 \mid \alpha > \gamma,\ \alpha > 2\beta\right\}$

into two regions, one in which the member countries choose s_H and the other in which they choose s_L.

Lemma 3. *Suppose that countries A and B form an FTA. If the governments in member countries choose their respective national standards, each government's dominant strategy is to choose* s_H *if* $0 < \gamma < \bar{\gamma}^F(\beta)$ *and* s_L *if* $\bar{\gamma}^F(\beta) < \gamma < \alpha$.

4.1.1 Comparison of optimal standards

Comparing Lemmas 1 and 3, we see that a formation of the FTA changes the regions of optimal standards. More specifically, we obtain the following lemma.

Lemma 4. *It holds that* $\bar{\gamma}^M(\beta) < \bar{\gamma}^F(\beta)\ \forall \beta \in (0, \alpha/2)$.

(Proof) Comparing the slopes at the origin, we have $d\bar{\gamma}^M(0)/d\beta = 3/4 < 1 = d\bar{\gamma}^F(0)/d\beta$. In addition, it holds that $\bar{\gamma}^F(\alpha/2) = (1 - \sqrt{15}/30)\alpha \approx 0.8709\alpha > \bar{\gamma}^M(\alpha/2)$. Since both $\bar{\gamma}^M(\beta)$ and $\bar{\gamma}^F(\beta)$ are increasing and convex in β, the statement of the lemma holds. □

Lemma 4 implies that the FTA further partitions the region S_L^M defined in the previous section, where the governments choose a low standard under the MFN, into two subsets. In light of Lemmas 1 and 3, if $\bar{\gamma}^M(\beta) < \gamma < \bar{\gamma}^F(\beta)$, the member countries change their behavior in such a way that they choose a low standard under the MFN but they choose a high standard after the formation of the FTA. This is illustrated in Figure 1. If (β, γ) is in region I, the member countries choose s_L both under the MFN and FTA. If (β, γ) is in region II, the member countries choose s_L under the MFN but they choose s_H under the FTA. If (β, γ) is in region III, which is the same as S_H^M defined in the previous section, the member countries choose s_H both under the MFN and FTA.

Proposition 1. *In comparison with the MFN, an FTA makes the member countries to choose more stringent standards in the sense that there exists a set of parameters* (β, γ) *in which the member countries choose a low standard under the MFN but choose a high standard under an FTA and if* (β, γ) *is not an element of this set, the member countries do not change their standards before and after an FTA formation.*

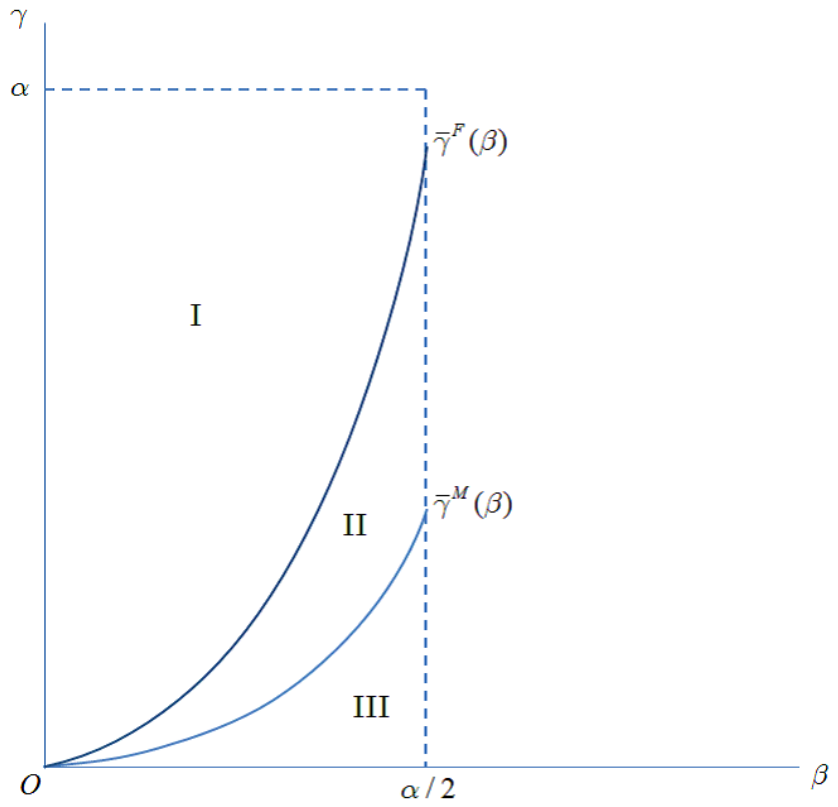

Figure 1: Comparison of optimal standards before and after an FTA

The intuition behind Proposition 1 is as follows. Eliminating tariffs between FTA partners increases consumption and production in the member countries, but at the same time, the member countries suffer from reduced tariff revenue. However, because of the tariff complementarity effect demonstrated in Lemma 2, the import from the nonmember country increases, which mitigates the reduction of tariff revenue. Therefore, the positive effect of the FTA dominates the negative one, and the member countries will not be worse off even they raise the unit costs of firms supplying to the market by adopting more stringent standards. Moreover, the increase in consumption will cause expansion of negative externalities, and thus the member countries should actually adopt more stringent standards.

4.1.2 Comparison of national welfare

We are now in a position to examine whether or not an FTA makes each country better off. As shown in Figure 1, there are three possibilities regarding the combination of opti-

mal standards under MFN and FTA. Therefore, we make comparisons of each country's national welfare in the respective regions.

Member countries We begin with the member countries. In region I, the national welfare is given by $W_i^M = w_i^M(s_L) + \pi_{ji}^M(s_L) + \pi_{Ci}^M(s_L)$ under the MFN and $W_i^F = w_i^F(s_L) + \pi_{ji}^F(s_L) + \pi_{Ci}^M(s_L)$ under the FTA, $i, j = A, B$, $j \neq i$. Then, from (5), (7), (8), (11), (12), and (13), we have

$$\begin{aligned} W_i^M - W_i^F &= w_i^M(s_L) + \pi_{ji}^M(s_L) - [w_i^F(s_L) + \pi_{ji}^F(s_L)] \\ &= -\frac{(423\alpha - 1256\beta)(3\alpha + 4\beta)}{44100}. \end{aligned}$$

Then, $W_i^M > W_i^F$ ($W_i^M < W_i^F$) if and only if $\beta > (<)\ 423\alpha/1256 \approx 0.3368\alpha$.[8]

In region II, the national welfare under the MFN is given by $W_i^M = w_i^M(s_L) + \pi_{ji}^M(s_L) + \pi_{Ci}^M(s_L)$ and under the FTA, $W_i^F = w_i^F(s_H) + \pi_{ji}^F(s_H) + \pi_{Ci}^M(s_L)$. Then, it holds that

$$\begin{aligned} W_i^M - W_i^F &= w_i^M(s_L) + \pi_{ji}^M(s_L) - [w_i^F(s_H) + \pi_{ji}^F(s_H)] \\ &= \frac{-141\alpha^2 - 3136\alpha\beta + 686\beta^2 + 4300\alpha\gamma - 2150\gamma^2}{4900}. \end{aligned}$$

Given the parameter restrictions $\alpha > \gamma$ and $\alpha > 2\beta$, it can be verified that $W_i^M > W_i^F$ ($W_i^M < W_i^F$) holds if and only if

$$\gamma > (<)\ \tilde{\gamma}(\beta) \equiv \alpha - \frac{7}{5}\sqrt{\frac{41}{86}\alpha^2 - \frac{32}{43}\alpha\beta + \frac{7}{43}\beta^2}.$$

It also holds that $\tilde{\gamma}(0) \approx 0.0333\alpha$ and $\tilde{\gamma}(\alpha/2) \approx 0.4663\alpha \in \big(\bar{\gamma}^M(\alpha/2), \bar{\gamma}^F(\alpha/2)\big)$.

In region III, the national welfare is given by $W_i^M = w_i^M(s_H) + \pi_{ji}^M(s_H) + \pi_{Ci}^M(s_H)$ under the MFN and $W_i^F = w_i^F(s_H) + \pi_{ji}^F(s_H) + \pi_{Ci}^M(s_H)$ under the FTA. Then, it follows that

$$W_i^M - W_i^F = w_i^M(s_H) + \pi_{ji}^M(s_H) - [w_i^F(s_H) + \pi_{ji}^F(s_H)] = -\frac{141(\alpha - \gamma)^2}{4900} < 0.$$

Therefore, the FTA achieves higher welfare than MFN for the member countries.

To sum up, we have the following lemma (see also Figure 2).

[8] It holds that $\bar{\gamma}^F(423^\alpha/1256) \approx 0.4221\alpha < \bar{\gamma}^M(\alpha/2)$.

Lemma 5. *For the FTA member countries $i = A, B$, the national welfare under the FTA and the national standards compared with the MFN is as follows.*

(i) If $\bar{\gamma}^F(\beta) < \gamma < \alpha$, $W_i^M > W_i^F$ ($W_i^M < W_i^F$) for $\beta >$ (<) $423\alpha/1256$.

(ii) If $\tilde{\gamma}(\beta) < \gamma < \bar{\gamma}^F(\beta)$, $W_i^M > W_i^F$.

(iii) If $0 < \gamma < \tilde{\gamma}(\beta)$, $W_i^M < W_i^F$.

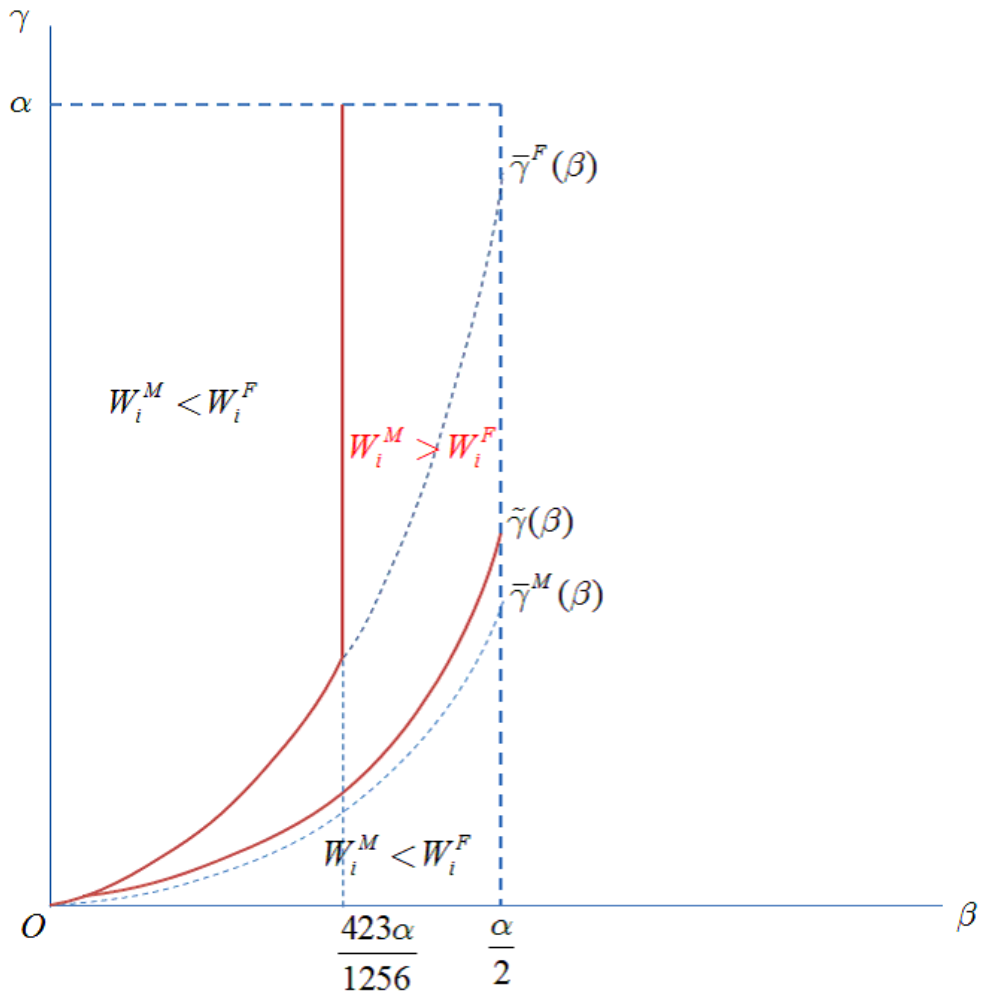

Figure 2: Comparison of the FTA members' welfare before and after an FTA

Lemma 5 can be interpreted as follows. In region I, where the member countries choose s_L both under the MFN and FTA. Because of the elimination of tariffs within the FTA and the tariff complementarity effect, output and consumption become larger under the FTA. Therefore, the member countries gains from the formation of the FTA unless the negative externalities per unit of consumption indicated by the parameter β

are large enough. In region III, where the member countries choose s_H both under MFN and the FTA. In this case, the negative externalities are internalized by the imposition of a high standard, and thus the FTA unambiguously achieves higher welfare to the member countries. In region II, where the member countries choose s_L under MFN but they choose s_H under the FTA, the member countries face the firms' higher compliance costs but the negative externalities will be reduced under the FTA. If γ is relatively high, the high compliance costs harm the member countries, but if β is high, the escape from the negative externalities benefits the member countries.

Although the process of the forming of FTAs is not explicitly considered in our analysis, we may examine the determination of trade and standard regimes by applying the present model to a framework of endogenous trading-bloc formation game. If we consider "stage 0" in which the governments decide whether to form an FTA prior to stage 1 (i.e., determination of tariffs and standards), the member country may not have incentive to form an FTA. If so, the FTA is not hold.

Nonmember country In the nonmember country, the national government always chooses the MFN tariff and does not change the standard before and after the formation of FTA. Therefore, comparisons of the nonmember's welfare are equivalent to those of its export profits: $W_C^M - W_C^F = 2[\pi_{iC}^M(s_i) - \pi_{iC}^F(s_i)]$, $i = A, B$, where

$$\pi_{iC}^F(s_i) = \frac{[a(s_i) - 3t^F(s_i)]^2}{16}$$

is the export profit in each member country's market.

In both regions I and III, $W_C^M < W_C^F$ holds because $\pi_{iC}^M(s_L) - \pi_{iC}^F(s_L) = -(17\alpha - 24\beta)(3\alpha + 4\beta)/4900 < 0$ and $\pi_{iC}^M(s_H) - \pi_{iC}^F(s_H) = -51(\alpha - \gamma)^2/4900 < 0$. In region II, where the members choose s_L under the MFN and s_H under the FTA, it holds that

$$\pi_{iC}^M(s_L) - \pi_{iC}^F(s_H) = -\frac{(17\alpha - 14\beta - 10\gamma)(3\alpha + 14\beta - 10\gamma)}{4900}.$$

Since $\alpha > 2\beta$, it holds that $17\alpha - 14\beta - 10\gamma > 10(\alpha - \gamma) > 0$. Therefore, the sign of the above expression is positive (negative) if and only if $\gamma > (<)\ (3\alpha + 14\beta)/10$ holds.

Region II is contained in the set $\left\{(\beta,\gamma)\in\mathbb{R}^2_+ \mid \gamma<(3\alpha+14\beta)/10,\ \alpha>2\beta\right\}$. Therefore, also in region II it holds that $W_C^M < W_C^F$. To sum up, we have the following proposition.

Proposition 2. *In comparison with the MFN, the nonmember country of the FTA unambiguously becomes better off under the formation of an FTA.*

Intuitively, Proposition 2 can be interpreted as follows. When (β,γ) is in region I or region III, the nonmember's welfare improvement stems from the tariff complementarity effect shown in Lemma 2. Because the members adopt the same standards under the FTA as under the MFN, the nonmember country will face a lower tariff rate under the FTA than under the MFN, which increases its exports to the member countries and hence export profits of the domestic firm. If (β,γ) is in region II, the member countries will tighten up their standards under the FTA, which raises the unit production cost of the firm in the nonmember country. At the same time, as we have shown in (6) and similar result holds for the comparison of $t^F(s_H)$ and $t^F(s_L)$, a more stringent standard lowers the optimal (external) tariff. Therefore, in region II, the tariff rate that the nonmember country faces under the FTA becomes lower than the MFN tariff in two channels: one is the tariff complementarity effect and the other is a more stringent standards chosen by the FTA members. Because the unit cost is at a "moderate" level in region II, the reduction in the tariff offsets the increase in the unit cost, and thus the nonmember country can increase its export under the FTA.

4.2 Harmonization of standards

We now consider the second scenario: Suppose that the FTA member countries harmonize their standards in addition to eliminate tariffs between them. More specifically, the member countries A and B determine the common standards $s_A = s_B = s \in \{s_L, s_H\}$, taking the standards in the nonmember country s_C as given, so as to maximize the sum of the national welfare $W_A^F + W_B^F$. Notice that in advance to the determination of standards, the member countries choose their respective external tariffs independently. Since W_i^F is additively separable, the member countries determine the pair of standards

that maximizes$\sum_{i,j=A,B}[w_i^F(s)+\pi_{ji}^F(s)] \equiv \omega(s)$.

Lemma 6. *Suppose that countries A and B form an FTA and harmonize their standards. Then, it is optimal for both member countries to choose* s_H *if* $0<\gamma<\bar{\bar{\gamma}}^F(\beta)$ *and* s_L *if* $\bar{\bar{\gamma}}^F(\beta)<\gamma<\alpha$*, where* $\bar{\bar{\gamma}}^F(\beta) \equiv \alpha - \sqrt{\alpha^2 - \frac{202}{129}\alpha\beta + \frac{23}{387}\beta^2}$.

(Proof) In light of (11), (12), and (13), we have

$$\omega(s_H) - \omega(s_L) = \frac{387\gamma^2 - 774\alpha\gamma + 606\alpha\beta - 23\beta^2}{441}. \tag{15}$$

Therefore, $\omega(s_H) > \omega(s_L)$ holds if and only if $387\gamma^2 - 774\alpha\gamma + 606\alpha\beta - 23\beta^2 > 0$, or equivalently, given the parameter restrictions, $\gamma < \bar{\bar{\gamma}}^F(\beta)$. Conversely, if $\gamma > \bar{\bar{\gamma}}^F(\beta)$, it holds that $\omega(s_H) < \omega(s_L)$. □

Since $d\bar{\bar{\gamma}}^F(0)/d\beta = 101/129 \approx 0.7829$ and $\bar{\bar{\gamma}}^F(\alpha/2) = (1-\sqrt{359}/6\sqrt{43})\alpha \approx 0.5184\alpha$, it follows that $\bar{\gamma}^M(\beta) < \bar{\bar{\gamma}}^F(\beta) < \bar{\gamma}^F(\beta)$ for all $\beta \in (0, \alpha/2)$. This implies that, in light of Lemmas 3 and 6, region II in Figure 1 is further partitioned into two subregions: one in which s_H is chosen by member countries both under national standards and harmonization (when $\bar{\gamma}^M(\beta) < \gamma < \bar{\bar{\gamma}}^F(\beta)$), and the other in which s_H is chosen under the national standards but s_L is chosen under harmonization (when $\bar{\bar{\gamma}}^F(\beta) < \gamma < \bar{\gamma}^F(\beta)$). See also Figure 3.

Proposition 3. *The FTA member countries choose less stringent standards when they harmonize their standards than when they choose their respective national standards in the sense that there exists a set of parameters* (β, γ) *in which the member countries choose a low standard under harmonization but choose a high standard under the national standards.*

Intuitively, Proposition 3 can be interpreted as follows. If the FTA member countries determine their respective standards independently, their objective is to maximize the domestic surplus $w_i^F(s_i)$. By contrast, if the member countries harmonize their standards, they mutually take the export profit of the FTA partner $\pi_{ij}^F(s_i)$. Because

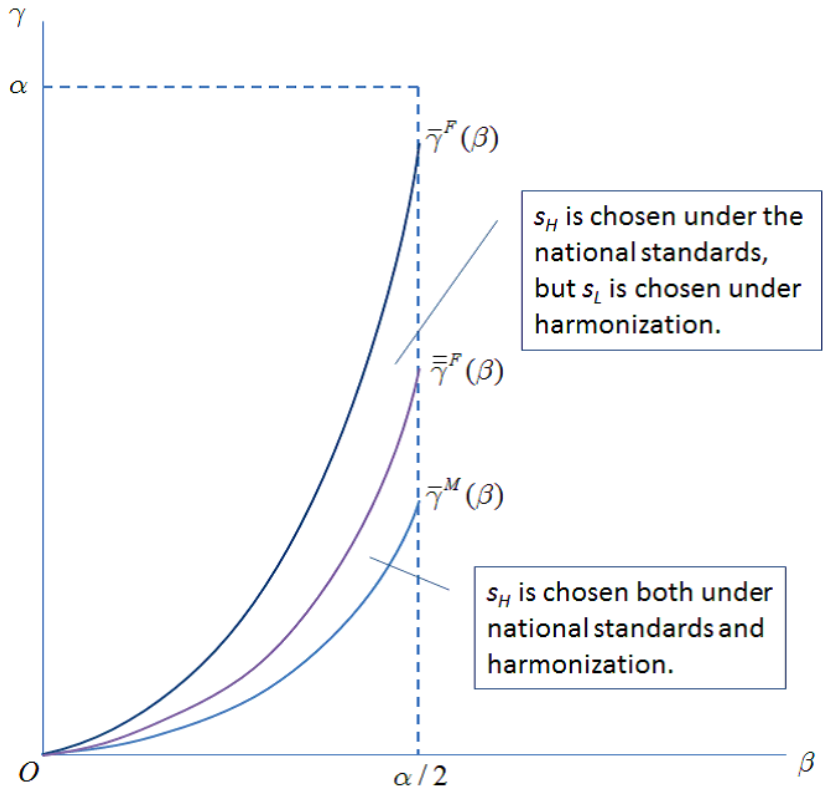

Figure 3: Harmonization of standards under the FTA

an increase in the standard reduces the FTA partner's export profit, compared to the national standards, each member country should adopt less stringent standards under harmonization.[9]

Let us conclude this section by analyzing the welfare effects of the FTA with harmonization of standards. For the nonmember country, it is verified that Proposition 2 remains valid; the nonmember country unambiguously gains from a formation of FTAs. For the member countries, because $\bar{\gamma}^M(\alpha/2) < \tilde{\gamma}(\alpha/2) < \bar{\bar{\gamma}}^F(\alpha/2)$ holds, we obtain the following lemma.

Lemma 7. *For the FTA member countries $i = A, B$, the national welfare under the FTA and harmonization of standards compared with the MFN is as follows.*

(i) If $\bar{\bar{\gamma}}^F(\beta) < \gamma < \alpha$, $W_i^M > W_i^F$ $(W_i^M < W_i^F)$ for $\beta > (<)$ $423\alpha/1256$.

(ii) If $\tilde{\gamma}(\beta) < \gamma < \bar{\bar{\gamma}}^F(\beta)$, $W_i^M > W_i^F$.

[9]Notice that similar intuition and result hold under more general economic environment (see Takarada, et al., 2014).

(iii) If $0 < \gamma < \tilde{\gamma}(\beta)$, $W_i^M < W_i^F$.

From Lemmas 5 and 7, we find that if β and γ are of moderate size, the member countries' welfare under the FTA becomes higher than the MFN level when they jointly determine the standards even though the opposite holds when they determine their respective standards independently, as illustrated by the shaded area in Figure 4. In other regions, such a reversal of welfare ranking between the MFN and the FTA does not occur. The reversal of the welfare ranking implies that harmonization of standards within an FTA makes the formation of the FTA more favorable.

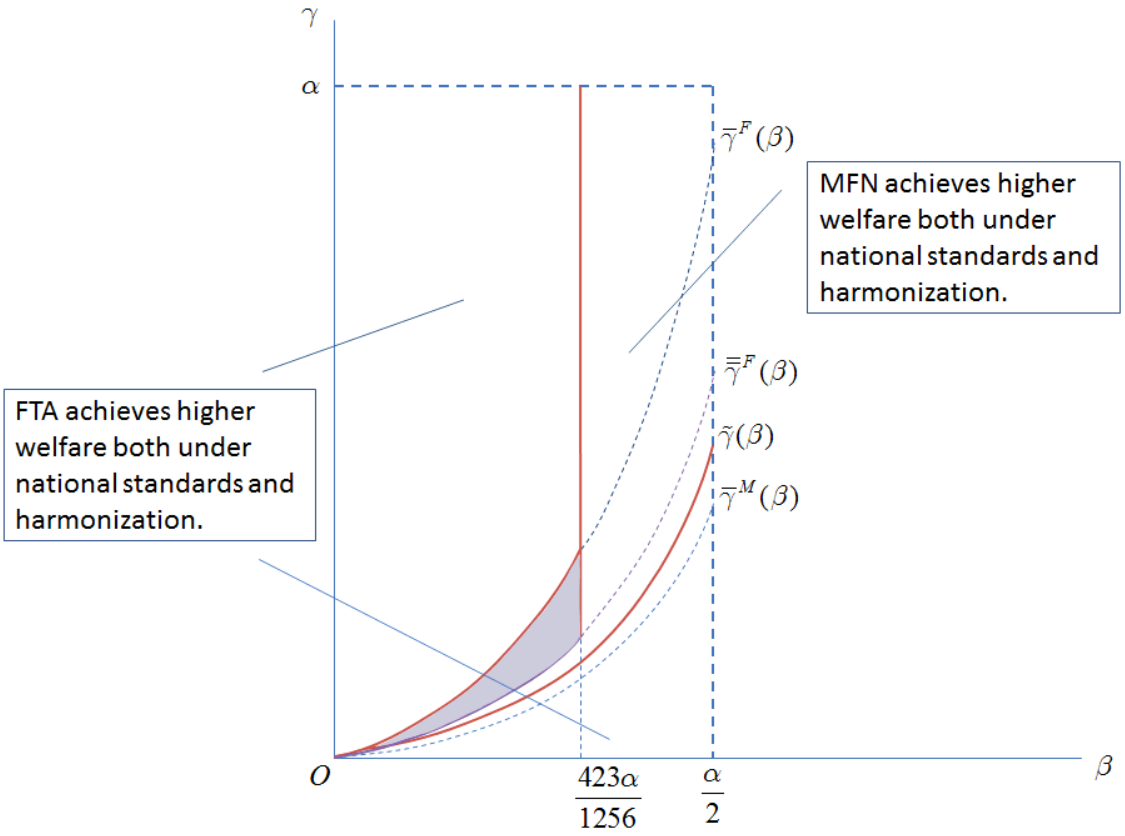

Figure 4: Comparison of the welfare effects of FTA between national standards and harmonization

Proposition 4. *Regional harmonization of standards increases the gains from an FTA formation in the sense that there exists a set of parameters* (β, γ) *in which, for* $i = A, B$, $W_i^M > W_i^F$ *holds when the member countries seek their national standards but* $W_i^M < W_i^F$ *holds under harmonization of standards.*

Proposition 4 has the following implications. The FTA member countries prefer harmonizing their standards in addition to remove tariffs between them. This can explain the recent regional and preferential economic agreements being the form of harmonized domestic regulations as well as tariff reductions. Notice that the less stringent standards are chosen by the members at the expense of increasing the gains from FTA.

5 Transboundary Externalities

In this section, we consider an extension by incorporating transboundary consumption externalities into our basic model. When considering regulations to limit automobile exhaust emissions, such transboundary externalities will be an important aspect to deal with.

Let us denote the degree of transboundary externalities by $\delta \in [0,1]$. Then, the representative consumer's utility function is rewritten as $U(Q_i, Y_i; s_i, \bar{Q}_i) = u(Q_i) + Y_i - b(s_i)\bar{Q}_i - \sum_{j \neq i} \delta b(s_j)\bar{Q}_j$ and hence the national welfare (3) is rewritten as

$$\begin{aligned} W_i = {} & \frac{[3a(s_i) - t_{ij} - t_{ik}]^2}{32} + \frac{[a(s_i) + t_{ij} + t_{ik}]^2}{16} + \frac{[a(s_j) - 3t_{ji} + t_{jk}]^2}{16} + \frac{[a(s_k) - 3t_{ki} + t_{kj}]^2}{16} \\ & + t_{ij}\frac{a(s_i) - 3t_{ij} + t_{ik}}{4} + t_{ik}\frac{a(s_i) + t_{ij} - 3t_{ik}}{4} - b(s_i)\frac{3a(s_i) - t_{ij} - t_{ik}}{4} \\ & - \delta\left[b(s_j)\frac{3a(s_j) - t_{ji} - t_{jk}}{4} + b(s_k)\frac{3a(s_k) - t_{ki} - t_{kj}}{4}\right]. \end{aligned} \tag{16}$$

The above expression implies that the presence of transboundary externalities does not affect the first-order conditions for optimal unilateral tariffs $\partial W_i/\partial t_j = 0$, and thus the optimal tariff formulas, i.e., (5) under the MFN and (11) under an FTA, are still valid when transboundary externalities exist.

5.1 MFN

In the presence of transboundary externalities, the national welfare under the MFN can now be rewritten as $W_i^M = w_i^M(s_i) + \eta_{ji}^M(s_j) + \eta_{ki}^M(s_k)$, where the domestic surplus $w_i^M(s_i)$

is defined by (7) and

$$\begin{aligned}\eta_{li}^{M}(s_l) &\equiv \pi_{li}^{M}(s_l) - \delta b(s_l)Q_l \\ &= \frac{[a(s_l) - 2t^{M}(s_l)]^2}{16} - \delta b(s_l)\frac{3a(s_l) - 2t^{M}(s_l)}{4}, \quad l = j, k \end{aligned} \tag{17}$$

is the net export profits deducted the costs of transboundary externalities.

Notice that because the optimal standards depend on the comparison between $w_i^M(s_H)$ and $w_i^M(s_L)$, the replacement of $\pi_{li}^M(s_l)$ by $\eta_{li}^M(s_l)$ due to the presence of transboundary externalities does not affect the condition under which whether s_H or s_L is chosen. In other words, Lemma 1 is still valid.

5.2 FTA with national standards

After the formation of an FTA between countries A and B, each member country's national welfare can be rewritten as $W_i^F = w_i^F(s_i) + \eta_{ji}^F(s_j) + \eta_{Ci}^M(s_C)$, $i = A, B$, where the domestic surplus $w_i^F(s_i)$ is the same as (12) and

$$\begin{aligned}\eta_{ji}^{F}(s_j) &\equiv \pi_{ji}^{F}(s_j) - \delta b(s_j)Q_j \\ &= \frac{[a(s_j) + t^{F}(s_j)]^2}{16} - \delta b(s_j)\frac{3a(s_j) - t^{F}(s_j)}{4} \end{aligned} \tag{18}$$

is the export profits net of transboundary externality costs associated with the FTA member country.

Again, the presence of transboundary externalities does not affect the optimal choice of standards characterized in Lemma 3. Therefore, Lemma 4 also holds, and so does Proposition 1. That is, in comparison with the MFN, an FTA makes the member countries to choose more stringent standards.

The welfare effects of the FTA compared with the MFN are obtained by a comparison between W_i^M and W_i^F, as implemented in section 4.1. Given the components of national welfare explained above, the welfare effects can be dependent on the degree of transboundary externalities, δ, as well as the other parameters β and γ.

Let us begin with the welfare comparison in the member countries. As in the case without transboundary externalities, there are three possibilities, i.e., the case where the

member countries choose s_L both under the MFN and FTA (region I in Figure 1), the case where the member countries choose s_L under the MFN but they choose s_H under the FTA (region II), and the case where the member countries choose s_H both under the MFN and FTA (region III), depending on the values of β and γ. In region I, the difference between W_i^M and W_i^F is

$$\begin{aligned} W_i^M - W_i^F &= w_i^M(s_L) + \eta_{ji}^M(s_L) - [w_i^F(s_L) + \eta_{ji}^F(s_L)] \\ &= -\frac{(3\alpha + 4\beta)[423\alpha - 8(157 + 210\delta)]}{44100}, \end{aligned}$$

from which it holds that $W_i^M > W_i^F$ ($W_i^M < W_i^F$) if and only if $\beta > (<)\ 423\alpha/[8(157 + 210\delta)]$. The cutoff value for β becomes smaller if δ becomes higher, implying that the transboundary externalities make the formation of an FTA less beneficial for the member countries when these countries choose a low standard both under the MFN and FTA.

In region II, the difference between W_i^M and W_i^F is

$$\begin{aligned} W_i^M - W_i^F &= w_i^M(s_L) + \eta_{ji}^M(s_L) - [w_i^F(s_H) + \eta_{ji}^F(s_H)] \\ &= \frac{-2150\gamma^2 + 4300\alpha\gamma - 141\alpha^2 - 196(16 + 15\delta)\alpha\beta + 98(7 + 10\delta)\beta^2}{4900}, \end{aligned}$$

which becomes positive (negative) if and only if

$$\gamma > (<)\ \tilde{\gamma}(\beta, \delta) \equiv \alpha - \frac{7}{5}\sqrt{\frac{41}{86}\alpha^2 - \frac{32 + 30\delta}{43}\alpha\beta + \frac{7 + 10\delta}{43}\beta^2}.$$

Note that $\tilde{\gamma}(\beta, \delta)$ is increasing in δ:

$$\frac{\partial\tilde{\gamma}(\beta, \delta)}{\partial\delta} = \frac{7\beta(3\alpha - \beta)}{43\sqrt{\frac{41}{86}\alpha^2 - \frac{32+30\delta}{43}\alpha\beta + \frac{7+10\delta}{43}\beta^2}} > 0.$$

In other words, an increase in the degree of transboundary externalities make the formation of an FTA more beneficial for the member countries in the case where the member countries choose more stringent standard under the FTA than under the MFN. Finally, in region III, all countries choose s_H both under the MFN and FTA and the analysis in the absence of transboundary externalities remains valid since $b(s_H) = 0$ in the present model.

While transboundary externalities narrow the region in which $W_i^M < W_i^F$ holds for the member countries when these countries choose the low standard both under the MFN and FTA, the region with $W_i^M < W_i^F$ expands when the member countries choose more stringent standard under the FTA than under the MFN. Intuitively, these findings can be interpreted as follows. A formation of an FTA increases consumption in member countries, and so does the consumption externalities for a given standard. In the presence of transboundary externalities, the social costs of externalities become higher if the member countries choose the same standard both under the MFN and FTA. Because of this, transboundary externalities will have a pressure to reduce welfare under the FTA in region I. In region II, however, the member countries choose more stringent standards under the FTA than the MFN equilibrium, and in this particular model, $b(s_H) = 0$ and hence the social costs of externalities disappear completely under the FTA. Therefore, the advantage of the FTA in terms of the social costs of externalities increases as δ becomes higher.

Let us proceed to the nonmember country's welfare. Comparisons of the nonmember's welfare are now equivalent to those of its export profits net of the social costs of transboundary externalities since $W_C^M - W_C^F = 2[\eta_{iC}^M(s_i) - \eta_{iC}^F(s_i)]$, $i = A, B$, where

$$\eta_{iC}^F(s_i) = \frac{[a(s_i) - 3t^F(s_i)]^2}{16} - \delta b(s_i)\frac{3a(s_i) - t^F(s_i)}{4}.$$

If member countries choose s_L both before and after the formation of the FTA (i.e., region I in Figure 1), it holds that

$$\eta_{iC}^M(s_L) - \eta_{iC}^F(s_L) = -\frac{(3\alpha + 4\beta)[51\alpha - 8(9 + 70\delta)\beta]}{14700}.$$

As shown in section 4.1, given the condition $\alpha > 2\beta$, the sign of the above equation is unambiguously negative if $\delta = 0$. However, even if the condition $\alpha > 2\beta$ is satisfied, the sign of the above equation can be positive when $\delta > (51\alpha - 72\beta)/560\beta$. The intuition behind this result is similar to the narrowing of the region in which $W_i^M < W_i^F$ holds in region I for the member countries: since an FTA increases consumption in member countries, the consumption externalities in these countries become larger, and if the degree of transboundary externalities is sufficiently high, the social costs of transboundary

externalities may outweigh the benefit of the FTA which the nonmember country can earn.

In the case where the member countries choose s_L under the MFN and s_H under the FTA (i.e., region II), it follows that

$$\eta_{iC}^M(s_L) - \eta_{iC}^F(s_H) = -\frac{(17\alpha - 14\beta - 10\gamma)(3\alpha + 14\beta - 10\gamma) + 980\delta\beta(3\alpha - \beta)}{4900},$$

the sign of which is, in view of the discussion in section 4.1, unambiguously negative for any $\delta \in [0, 1]$. Therefore, as in the case of no transboundary externalities, the nonmember country becomes better off under the FTA. Finally, if the member countries choose s_H both under the MFN and FTA, $\pi_{iC}^M(s_H) - \pi_{iC}^F(s_H) = -51(\alpha - \gamma)^2/4900 < 0$ holds, as in the case of no transboundary externalities, because $b(s_H) = 0$.

Proposition 5. *In comparison with the MFN, the nonmember country of the FTA may be worse off under the formation of an FTA if $\bar{\gamma}^F(\beta) < \gamma < \alpha$ and if the degree of transboundary externalities is sufficiently high.*

5.3 FTA with harmonization of standards

As discussed in section 4.2, the FTA member countries jointly determine the common standards $s_A = s_B = s$ so as to maximize the sum of their national welfare $W_A^F + W_B^F$. In the presence of transboundary externalities, the problem is equivalent to maximize $\sum_{i,j=A,B}[w_i^F(s) + \eta_{ji}^F(s)] \equiv \tilde{\omega}(s)$. It is verified that

$$\begin{aligned}\tilde{\omega}(s_H) - \tilde{\omega}(s_L) &= \omega(s_H) - \omega(s_L) + \frac{\delta b(s_L)[3a(s_L) - t^F(s_L)]}{2} \\ &= \frac{387\gamma^2 - 774\alpha\gamma + (606 + 630\delta)\alpha\beta - (23 + 42\delta)\beta^2}{441} \qquad (19)\end{aligned}$$

hold, where $\omega(s) = \sum_{i,j=A,B}[w_i^F(s) + \pi_{ji}^F(s)]$ as is defined in section 4.2. Therefore, in view of Lemma 6, it follows that the cutoff value for γ is

$$\bar{\bar{\gamma}}^F(\beta, \delta) \equiv \alpha - \sqrt{\alpha^2 - \frac{202 + 210\delta}{129}\alpha\beta + \frac{23 + 42\delta}{387}\beta^2}$$

and if γ is higher than this value, it is optimal for both member countries to choose s_L, while the member countries choose s_H if γ is lower than the cutoff value. It is easily

verified that this cutoff value is increasing in δ. This implies that, as expected, the existence of transboundary externalities motivates the FTA member countries to choose more stringent standards if they harmonize their standards.

Compared with the cutoff value in the case of national standards under the FTA, it follows that

$$\begin{aligned}
&\bar{\gamma}^F(\beta) - \bar{\bar{\gamma}}^F(\beta,\delta) \\
&= \sqrt{\alpha^2 - \frac{202+210\delta}{129}\alpha\beta + \frac{23+42\delta}{387}\beta^2} - \sqrt{\alpha^2 - 2\alpha\beta + \frac{\beta^2}{15}} \\
&> 0\ (<0) \quad \Leftrightarrow \quad 15\alpha(4-15\delta) - \beta(1-15\delta) > 0\ (<0).
\end{aligned}$$

Therefore, in contrast to the case without transboundary externalities, $\bar{\bar{\gamma}}^F(\beta,\delta)$ can be larger than $\bar{\gamma}^F(\beta)$ if the degree of transboundary externalities satisfies[10]

$$\frac{60\alpha-\beta}{15(15\alpha-\beta)} < \delta < \frac{387\alpha^2 - 606\alpha\beta + 23\beta^2}{42(15\alpha-\beta)\beta}.$$

That is, for sufficiently high values of δ, there can exist a set of parameters (β,γ) in which the member countries choose s_H under harmonization but choose s_L under the national standards, or in other words, Proposition 3 may not hold. The possibility that $\bar{\bar{\gamma}}^F(\beta,\delta)$ can be larger than $\bar{\gamma}^F(\beta)$ implies that the ranking of welfare gains from an FTA between national standards and harmonization, illustrated in Figure 4, can be reversed; if $\bar{\bar{\gamma}}^F(\beta,\delta) > \bar{\gamma}^F(\beta)$, there exists a set of parameters (β,γ) in which, for $i = A, B$, $W_i^M < W_i^F$ holds under national standards but $W_i^M > W_i^F$ holds under harmonization.

Proposition 6. *If the degree of transboundary externalities is sufficiently high, regional harmonization of standards may induce the FTA member countries to choose more stringent standards than those under national standards and may reduce the gains from an FTA formation.*

[10]The left-hand side of this inequality comes from $15\alpha(4-15\delta) - \beta(1-15\delta) < 0$. The right-hand side comes from the constraint that $\bar{\bar{\gamma}}^F(\beta,\delta)$ should be a real number for given parameter values. Notice that if $\beta < \alpha/2$, it holds that $0 < (60\alpha-\beta)/[15(15\alpha-\beta)] < 1$.

6 Concluding Remarks

In this paper we considered a three-country model of international oligopoly with endogenous determination of tariffs and standards on products that cause negative consumption externalities in the presence of possible FTA. The main results that we obtained are as follows:

- Compared with the MFN, an FTA makes the member countries to choose more stringent standards.
- Compared with the MFN, the FTA member countries may or may be better off under the formation of an FTA, while the nonmember country becomes better off for the case of low degree of transboundary externalities.
- Harmonization of standards within an FTA will lead the member countries to choose less stringent standards and make the formation of the FTA more favorable, provided the degree of transboundary externalities is not so high.

These results will have implications for the recent movement towards regionalism that takes harmonization of domestic policies into consideration as well as liberalizing trade in goods.

Throughout this paper we have focused on FTAs as a form of preferential trade agreement, and have not considered the case of a customs union (CU), where member countries set a common external tariff, harmonizing their external trade policy. Our next task is to examine the effects of CU with endogenous determination of standards. Of another interest is the analysis of dynamic time-path problem that considers whether regional standards are stumbling blocks or building blocks toward multilateral harmonization. There are also a number of possible extensions of the basic model, e.g., difference in preferences and technologies among countries, generalization of demand functions, introduction of quality improving R&D, and sequential determination of trade and domestic policies.

Appendix

A.1 Simultaneous determination of tariffs and standards

In this Appendix, we show that when the governments simultaneously determine their tariffs and standards, the optimal policy mix is the same as that under the sequential policy choice.

Let us consider the policy game under MFN. The government in country i chooses t_i and s_i so as to maximize (4). If $s_i = s_H$, (4) is rewritten as

$$W_i = \frac{[3(\alpha-\gamma)-2t_i]^2}{32} + \frac{(\alpha-\gamma+2t_i)^2}{16} + t_i\frac{\alpha-\gamma-2t_i}{2} + \Pi_{-i}, \tag{A.1}$$

whereas it is rewritten as

$$W_i = \frac{(3\alpha-2t_i)^2}{32} + \frac{(\alpha+2t_i)^2}{16} + t_i\frac{\alpha-2t_i}{2} - \beta\frac{3\alpha-2t_i}{4} + \Pi_{-i} \tag{A.2}$$

if $s_i = s_L$, where $\Pi_{-i} \equiv \{[a(s_j)-2t_j]^2 + [a(s_k)-2t_k]^2\}/16$. A direct comparison between (A.1) and (A.2) reveals that it is optimal for country i to choose s_H (s_L) if and only if $t_i < (>)\ \gamma(2\alpha+11\gamma)/[4(3\gamma+4\beta)]$. In light of this fact, the relation between t_i and W_i can typically be illustrated as a curve with twin peaks (see Figure A.1).

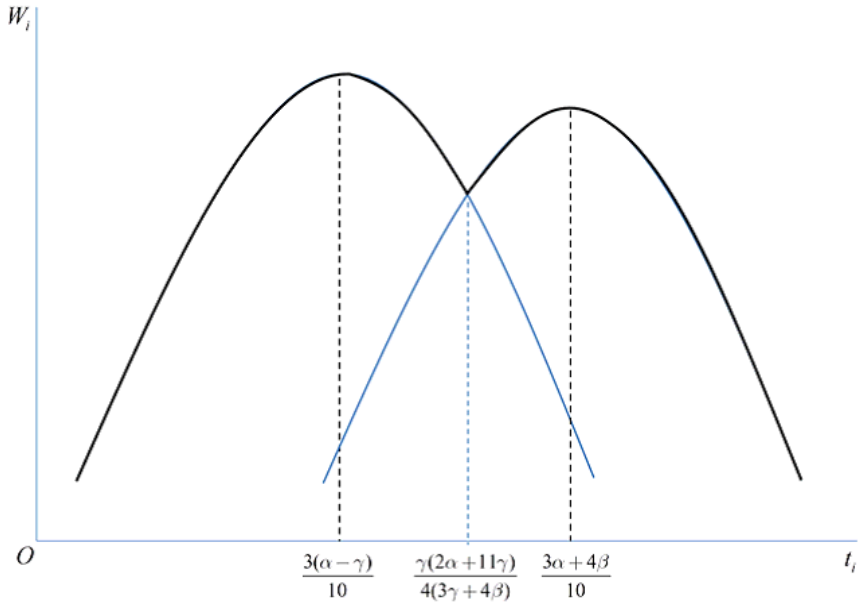

Figure A.1: Relation between t_i and W_i

From (A.1) and (A.2), the local maxima are attained at $t_i = 3(\alpha - \gamma)/10$ (when $s_i = s_H$) and $t_i = (3\alpha + 4\beta)/10$ (when $s_i = s_L$). Substituting $t_i = 3(\alpha - \gamma)/10$ into (A.1) and $t_i = (3\alpha + 4\beta)/10$ into (A.2) respectively yield

$$\max_{t_i} W_i = \begin{cases} \dfrac{2(\alpha-\gamma)^2}{5} + \Pi_{-i} & \text{if } s_i = s_H, \\ \dfrac{4\alpha^2 - 6\alpha\beta + \beta^2}{10} + \Pi_{-i} & \text{if } s_i = s_L. \end{cases} \tag{A.3}$$

It is clear from (A.3) and Figure A.1 that if $-8\alpha\gamma + 4\gamma^2 + 6\alpha\beta - \beta^2$ is positive (negative), s_H (s_L) achieves the maximum level of W_i. This means that the optimal policy mix, which is the dominant strategy, for each country under MFN is $(t^M, s^M) = \left(\frac{3(\alpha-\gamma}{10}, s_H\right)$ if $\gamma < \alpha - \sqrt{\alpha^2 - \frac{3}{2}\alpha\beta + \frac{\beta^2}{4}}$ and $(t^L, s^L) = \left(\frac{3\alpha+\beta}{10}, s_L\right)$ if $\gamma > \alpha - \sqrt{\alpha^2 - \frac{3}{2}\alpha\beta + \frac{\beta^2}{4}}$. However, the condition whether γ is higher or lower than $\alpha - \sqrt{\alpha^2 - \frac{3}{2}\alpha\beta + \frac{\beta^2}{4}}$ is equivalent to the condition imposed in Lemma 1. Therefore, the timing of the determination of policy instruments does not matter.

The above-mentioned equivalence between the simultaneous determination of policy instruments (i.e., tariffs and standards) and sequential determination of these policies also holds in the policy games under an FTA between countries A and B.

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