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Spillover Effects of Trade Policy in the Presence of a Third Country*

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Abstract

Using a simple monopoly model, we show that the number of markets and the shape of marginal revenue curves are crucial to evaluate trade policies when the marginal cost is not constant. It is shown that the effects of a tariff-change in a three-country model are in contrast with those in a two-country model. The effects also depend on what trade policy the other importing country adopts. When both importing countries simultaneously change their tariffs, the Metzler paradox may arise.

JEL Classification Numbers: F12, F13, F15

Keywords: tariffs, spillover effects, a third country, Metzler paradox, economic integration

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1 Introduction

Since the beginning of 1980s, various trade policies have extensively been analyzed under imperfect competition.[1] One of the characteristics observed from the existing literature is that in the segmented-markets models, marginal cost (MC) is usually assumed to be constant. The assumption of constant MC is imposed to eliminate the complication that firm's choices in different markets are connected through the dependence of MC on the total output. That is, the assumption of constant MC plays a role to shut the spillover effects among markets. Even when non-constant MC is introduced into the model, the number of markets are at most two.[2]

The purpose of this paper is to show that the number of markets could be crucial to evaluate trade policies when MC is not constant. To accomplish this purpose, using a simple monopoly model, we examine the effects of changes in tariffs on economies when MC is increasing.[3] We first present a two-country model where the monopolist, which is located in country 1, serves the two markets (i.e., countries 1 and 2). Then we consider a three-country model (countries 1, 2 and 3) where the monopolist serves all the markets and only country 2 or both countries 2 and 3 change their tariffs.

We show that in the three-country model, the effects of tariff-changes could be different from those in the two-country model. For example, in the two-country model, the tariff-reduction in country 2 benefits the consumers in country 2 but harms those in country 1 when MC is increasing. In the three-country model, however, this may not hold. The consumers in country 1 could gain from country 2's tariff-reduction. As far as we know, the differences obtained in our study have not been pointed out in the existing literature. Moreover, we show that the effects of country 2's tariff-reduction depend on trade policies adopted by country 3.

The point of our analysis is the spillover effects that stem from the increasing MC. In particular, the presence of a third country alters the spillover effects obtained in the two-country model. Furthermore, not only the presence of the third country but also the shape of the demand curves (or, the marginal revenue (MR) curves) is the key to our results. The upward-sloping MR curve particularly plays a crucial role. As we see later, the upward-sloping MR curve magnifies the spillover effects.

Although one may think that the increasing MR is peculiar, the possibility of upward-sloping MR curve is recognized by Robinson (1933). She points out that possibility is important. However, it was in 1980's when the analysis of upward-sloping MR curve was actually developed.[4] In particular, using the elasticity of the slope of the demand curve, Coughlin (1984) shows that the MR function is increasing with respect to quantity if and only if the value of the elasticity is

[1] The literature is surveyed in Helpman and Krugman (1989) and Brander (1995), among others.

[2] Although Krugman (1984) uses a multi-market model to show that import protection may promote exports with decreasing MCs, two markets (i.e., the domestic and foreign markets) suffice for his result.

[3] To make our point as clearly as possible, we present a monopoly model. We can obtain the similar results even in the framework of oligopoly.

[4] See Formby et al. (1982), Coughlin (1984), Narahata et al. (1990), and Beckman and Smith (1993), for example.

greater than two.

Using a three-country, partial-equilibrium model, Ikema (1984) considers the spillover effect of a tariff under perfect competition. He points out that by reducing the world price, an increase in the tariff by an importing country affects the third country as well as the exporting country. His point is that an increase in the tariff in an importing country may lead other importing countries to raise their tariffs. In contrast to his model, an increase in the tariff by an importing country may NOT lower the prices of the exporting country and the third country. Moreover, the presence of the third country is crucial to our result in the sense that it may reverse the effects on the exporting country.

We also show that when both importing countries increase their tariffs, the consumer price in one of these importing countries may fall. That is, the Metzler paradox may arise in our analysis. There are only a few studies that explore the Metzler paradox in the presence of imperfect competition.[5] Moreover, those existing literature focuses on the imperfect competition in the *importing* country. Our analysis provides another possibility. That is, the Metzler paradox could arise when there is a monopolist in the exporting country.

The rest of the paper is organized as follows. Section 2 provides our bench mark. We examine the effects of tariff-changes in a two-country model. The analysis in this section is basically the same as Ishikawa (2000b) which investigates various trade policies when the MC of the monopolist is not constant. Section 3 extends the analysis into a three-country model. We examine the effects of a change in the tariff set by one of the importing countries. Section 4 considers the case where both importing countries change their tariffs. Section 5 analyzes the case of quotas. Section 6 concludes the paper.

2 A Two-country Model

We consider a world where there exist two countries (countries 1 and 2) or where the good in question is traded between only two countries. The good is produced and supplied to both countries by a monopolist located in country 1. The demand function in country i ($i = 1, 2$) is given by

$$x_i = D_i(p_i); \quad D_i' < 0, \tag{1}$$

where x_i and p_i are, respectively, the demand and consumer price of the good in country i. We define the elasticity of the slope of the inverse demand function for the following analysis:

$$\epsilon_i \equiv \frac{D_i D_i''}{(D_i')^2}.$$

The (inverse) demand curve is concave if $\epsilon_i \leq 0$ and convex if $\epsilon_i \geq 0$. We assume that the markets are segmented.

[5] Panagariya (1982) shows in a general equilibrium model that the existence of monopoly in the domestic import competing industry increases the likelihood of the Mezler paradox. Benston and Hartigan (1983) show that an import tariff may induce the domestic firm to lower its price in a spatial duopoly model.

There exist tariffs. Letting t_{ji} denote a specific tariff when the good is exported from country j to country i,[6] the profit function of the monopolist is defined by

$$\Pi(P;T) = \sum_{i=1}^{n}(p_i - t_{1i})D_i(p_i) - C(\sum_{i=1}^{n} D_i(p_i)), \tag{2}$$

where P and T, respectively, denote the vectors of consumer prices and tariffs; and n is the number of countries. In this section, $P = (p_1, p_2)$, $T = (t_{11}, t_{12}, t_{21}, t_{22})$ and n=2.[7] $C(\cdot)$ is the cost function with $C^{'} > 0$ and $C^{''} > 0$.[8]

The first-order conditions of the profit maximization are $(i = 1, 2)$

$$\frac{\partial \Pi}{\partial p_i} = D_i + (p_i - t_{1i} - C^{'})D_i^{\prime} = 0. \tag{3}$$

We assume that the second-order sufficient conditions are satisfied $(i, j = 1, 2)$:

$$D_i^{\prime}(2 - \epsilon_i) - C^{''}(D_i^{\prime})^2 < 0, \tag{4}$$

$$\begin{aligned} & [D_i^{\prime}(2-\epsilon_i) - C^{''}(D_i^{\prime})^2][D_j^{\prime}(2-\epsilon_j) - C^{''}(D_j^{\prime})^2] - (C^{''}D_i^{\prime}D_j^{\prime})^2 \\ = & \left[D_i^{\prime}(2-\epsilon_i) - C^{\prime\prime}(D_i^{\prime})^2\right] D_j^{\prime}(2-\epsilon_j) - (2-\epsilon_i)C^{\prime\prime}D_i^{\prime}(D_j^{\prime})^2 > 0 \quad (i \neq j). \end{aligned} \tag{5}$$

Solving the first-order conditions, we have

$$p_i = \frac{\theta_i(p_i)}{\theta_i(p_i) - 1}[C^{'}(\cdot) + t_{1i}],$$

where θ_i denotes the price elasticity in country i.[9] Substituting these prices into the demand functions, the supply to each market can be obtained.

Next we consider the effects of a change in t_{12} on profits, consumer prices, trade flows, and welfare. To find the effects, we totally differentiate (3) and obtain:

$$\begin{pmatrix} D_1^{\prime}(2-\epsilon_1) - C^{''}(D_1^{\prime})^2 & -C^{''}D_1^{\prime}D_2^{\prime} \\ -C^{''}D_1^{\prime}D_2^{\prime} & D_2^{\prime}(2-\epsilon_2) - C^{''}(D_2^{\prime})^2 \end{pmatrix} \begin{pmatrix} \frac{dp_1}{dt_{12}} \\ \frac{dp_2}{dt_{12}} \end{pmatrix} = \begin{pmatrix} 0 \\ D_2^{\prime} \end{pmatrix}$$

with the solution

$$\begin{pmatrix} \frac{dp_1}{dt_{12}} \\ \frac{dp_2}{dt_{12}} \end{pmatrix} = \frac{1}{\Omega} \begin{pmatrix} D_2^{\prime}(2-\epsilon_2) - C^{''}(D_2^{\prime})^2 & C^{''}D_1^{\prime}D_2^{\prime} \\ C^{''}D_1^{\prime}D_2^{\prime} & D_1^{\prime}(2-\epsilon_1) - C^{''}(D_1^{\prime})^2 \end{pmatrix} \begin{pmatrix} 0 \\ D_2^{\prime} \end{pmatrix},$$

where $\Omega \equiv [D_1^{\prime}(2-\epsilon_1) - C^{''}(D_1^{\prime})^2][D_2^{\prime}(2-\epsilon_2) - C^{''}(D_2^{\prime})^2] - (C^{''}D_1^{\prime}D_2^{\prime})^2 > 0$ from (5).

In view of (4), therefore, the effects of a change in t_{12} on consumer price in each market are given by

$$\frac{dp_1}{dt_{12}} = \frac{C^{''}D_1^{\prime}(D_2^{\prime})^2}{\Omega} < 0, \quad \frac{dp_2}{dt_{12}} = \frac{[D_1^{\prime}(2-\epsilon_1) - C^{''}(D_1^{\prime})^2]D_2^{\prime}}{\Omega} > 0. \tag{6}$$

[6] Even if the tariffs are an ad valorem type, the essence of our results would not change.

[7] $t_{ii} = 0$ holds.

[8] Ishikawa (2000b) analyzes the case with $C^{\prime\prime} < 0$, too. In our analysis, we focus on the case with $C^{\prime\prime} < 0$, because our purpose is not to exaine all possible cases but to make our point clearly.

[9] θ_i is not necessarily assumed constant in our analysis. If it is constant, however, $\epsilon_i = 1 + 1/\theta_i$ holds.

Noting $C^{''} > 0$, a decrease in t_{12} lowers the consumer price in country 2; and raises the price in country 1. Thus, a decrease in t_{12} benefits the consumers in country 2 but harms those in country 1.[10] Obviously, the volume of trade increases.

The effect of a decrease in t_{12} can be seen with the aid of Figure 1. In the figures, panel (a) shows the MC curve, whereas panel (b) shows the MR curve in country 1, MR_1. Since the slope of the MR curve is given by $D_i'(2 - \epsilon_i)$, the following lemma (Couglin (1984)) is straightforward:

Lemma 1 *The MR curve in country i is downward-sloping if and only if $\epsilon_i < 2$.*

It can be seen from the second-order conditions (4) and (5) that if $\epsilon_j \geq 2$, then $\epsilon_i < 2$ $(i \neq j)$ is necessary and vice versa. Thus, we obtain the following lemma.

Lemma 2 *The MR curve can be upward-sloping or horizontal at most in one country.*

Since $C^{''} > 0$, the MC rises if and only if the total supply rises. The effect of a decrease in t_{12} on the total supply $X(\equiv \sum_{i=1}^{n} x_i)$ is given by

$$\frac{dX}{dt_{12}} = D_1' \frac{dp_1}{dt_{12}} + D_2' \frac{dp_2}{dt_{12}} = \frac{D_1'(D_2')^2(2 - \epsilon_1)}{\Omega}. \tag{7}$$

A reduction of t_{12} increases the total supply and hence the MC if and only if $\epsilon_1 < 2$. We can easily verify that a decrease in t_{12} lowers the supply to country 1 in both cases in Figure 1.

The following should be noted. The decrease in the supply to country 1 caused by a decrease in t_{12} in turn generates another spillover effect. That is, the decrease in the supply to country 1 lowers the MC and hence the supply to country 2 rises. The above equation shows that the original spillover effect dominates the second one if and only if $\epsilon_1 < 2$.

The reason why $\epsilon_1 = 2$ is critical can be seen from Figure 1. In panel (b), an increase in MC due to a tariff-reduction corresponds to a shift of the MC curve from MC to MC'. We can easily confirm that the effect of the shift of the MC curve on the supply in country 1 is mitigated when the MR curve is downward-sloping, but is magnified when the MR curve is upward-sloping. Thus, even if the change in the MC is small, its effect on country 1's supply could be large when $\epsilon_1 > 2$. The following lemma is useful to analyze a three-country model.

Lemma 3 *The effect of a change in the MC on the supply to country i is mitigated if $\epsilon_i < 2$ but is magnified if $\epsilon_i > 2$.*

The effect of a decrease in t_{12} on profits can be obtained by using the envelop theorem:

$$\frac{d\Pi}{dt_{12}} = \frac{\partial \Pi}{\partial t_{12}} = -D_2 < 0. \tag{8}$$

The monopolist gains from a decrease in t_{12}. Thus, the effect on the welfare of country 1, which is measured by the sum of the profits and consumers' surplus:

$$W_1 \equiv \Pi(P;T) + \int_{p_1}^{\infty} D_1(z)dz \tag{9}$$

[10] We can verify that a decrease in t_{12} does not affect the price in country 1 (i.e., there is no spillover effect) if $C^{''} = 0$.

is generally ambiguous.[11]

The effect on the welfare of country 2, which is measured by the sum of consumers' surplus and tariff revenue:

$$W_2 \equiv \int_{p_2}^{\infty} D_2(z)dz + t_{12}D_2(p_2) \tag{10}$$

is also ambiguous. As shown by Brander and Spencer (1984), using a tariff, the country 2 could extract some of the monopoly rent and hence raise welfare. That is, there exists the optimal level of the tariff. A small decrease in the tariff raises welfare if the initial tariff is higher than the optimal level but reduces welfare if it is lower than the optimal level. Differentiating (10) with respect to t_{12} and evaluating it at $t = 0$, we obtain

$$\left.\frac{dW_2}{dt_{12}}\right|_{t_{12}=0} = D_2(1 - \frac{dp_2}{dt_{12}}) \tag{11}$$

Thus, the optimal tariff is positive if and only if $(dp_2/dt_{12})|_{t_{12}=0} < 1$ (that is, an increase in the consumer price caused by a tariff is less than the size of the tariff). Since we have

$$1 - \frac{dp_2}{dt_{12}} \equiv \widetilde{\Gamma} = \frac{D_2' D_1' [(1-\epsilon_2)\,\Psi_1 - (2-\epsilon_1)\,C'' D_2']}{\Omega} \tag{12}$$

where $\Psi_i \equiv (2-\epsilon_i) - C^{''} D_i'$ which is positive from (4), a sufficient condition for welfare of country 2 to improve is $\epsilon_1 < 2$ and $\epsilon_2 < 1$.[12]

Therefore, we can summarize the effects of a tariff-reduction in our two-country model as follows: the monopolist and the consumers in country 2 gain; the consumers in country 1 lose; and welfare of each country may or may not improve. It is possible that both countries lose.

3 A Three-Country Model: Tariff-Changes in One of the Importing Countries

In this section, we show that the effects of a change in the tariff could be different in the presence of a third country. To this end, we consider a model where there exist three countries (countries 1, 2, and 3).

The demand function of country i $(i = 1, 2, 3)$ is given by (1). A monopolist based in country 1 serves all the countries. The profit function (2) and the first-order conditions (3) remain unchanged. However, the second-order conditions require another condition in addition to (4) and (5). Defining the following matrix:

$$A \equiv \begin{pmatrix} D_1'(2-\epsilon_1) - C^{''}(D_1')^2 & -C^{''} D_1' D_2' & -C^{''} D_1' D_3' \\ -C^{''} D_2' D_1' & D_2'(2-\epsilon_2) - C^{''}(D_2')^2 & -C^{''} D_2' D_3' \\ -C^{''} D_3' D_1' & -C^{''} D_3' D_2' & D_3'(2-\epsilon_3) - C^{''}(D_3')^2 \end{pmatrix},$$

[11] For details, see Ishikawa (2000b).

[12] This condition is the same with the condition obtained in Brander and Spencer (1984). However, the value of $[1 - (dp/dt)]$ in our model is different from theirs, because the monopolist in their model serves only country 2. See Ishikawa (2000b), for details.

the condition is $|A| < 0$.

We now examine the effects of changes in tariffs. Totally differentiating (3), we obtain:

$$\begin{pmatrix} dp_1 \\ dp_2 \\ dp_3 \end{pmatrix} = A^{-1} \begin{pmatrix} 0 \\ D_2' dt_{12} \\ D_3' dt_{13} \end{pmatrix}.$$

We first analyze the effects of a change in t_{12} on p_i $(i = 1, 3)$ and p_2. They are given by

$$\frac{dp_2}{dt_{12}} = \frac{D_2'\{[D_1'(2-\epsilon_1) - C''(D_1')^2][D_3'(2-\epsilon_3) - C''(D_3')^2] - (C''D_1'D_3')^2\}}{|A|} > 0, \tag{13}$$

$$\frac{dp_i}{dt_{12}} = \frac{C''(D_2')^2 D_1' D_3'(2-\epsilon_k)}{|A|}; \quad (i, k = 1, 3; : i \neq k). \tag{14}$$

Thus, we have

$$\frac{dp_i}{dt_{12}} \gtreqless 0 \iff 2 - \epsilon_j \gtreqless 0;\ (i, k = 1, 3; : i \neq k). \tag{15}$$

A decrease in t_{12} necessarily lowers the consumer price in country 2, but may NOT raise the consumer price in country 1. The consumer price in country 1 rises if and only if $\epsilon_3 < 2$. The effect of a decrease in t_{12} on the consumer price in country 1 is in contrast to that in the two-country model. The presence of the third country could drastically change the effect on country 1. Similarly, the consumer price in country 3 rises if and only if $\epsilon_1 < 2$. We should note that Lemma 2 is still valid and hence $\epsilon_1 > 2$ and $\epsilon_3 > 2$ do not hold at the same time.

An interesting feature is that the change in the consumer price in country 1 (resp. country 3) depends on the shape of the MR curve in country 3 (resp. country 1). To see why, we need to clearly recognize that there are two kinds of spillover effects in the three-country model and how they work. The first spillover effect is caused by a change in the supply to country 2 due to a change in the tariff. When the tariff in country 2 lowers, the supply to country 2 and hence the MC rise. This decreases the supply to both countries 1 and 3. The magnitude of the decrease in country i $(i = 1, 3)$ depends on ϵ_i. The decrease is relatively small if $\epsilon_i < 2$, but is relatively large if $\epsilon_i > 2$ (recall Lemma 3). The supply changes in countries 1 and 3 in turn generate the second spillover effects. The decrease in the supply to country 3 increases that to country 1. Obviously, the second spillover effect on country 1 becomes larger as the change in the supply to country 3 which is caused by the first spillover effect becomes larger. Thus, the first spillover effect on country 1 depends on ϵ_1, while the second one on country 1 depends on ϵ_3. If $\epsilon_3 > 2$ (which implies $\epsilon_1 < 2$ and $\epsilon_2 < 2$ from Lemma 2), the second spillover effect dominates the first one and hence the supply to country 1 actually rises. In the two-country model, the spillover effect from country 3 to country 1 does not exist. Thus, a decrease in t_{12} necessarily reduces the supply to country 1.

We can confirm the above result with the aid of Figure 2. The figures, respectively, show the case where $\epsilon_1 < 2$ and $\epsilon_3 < 2$, the case where $\epsilon_1 < 2$ and $\epsilon_3 > 2$, and the case where $\epsilon_1 > 2$ and $\epsilon_3 < 2$. In the figures, panels (a), (b) and (c), respectively, show the MC curve, the MR curve in country 1, and the MR curve in country 3. Recall that the MR curve in country i is downward-sloping if and only if $\epsilon_i < 2$ (Lemma 1).

As in the two-country model, the MC rises if and only if the total output rises. We first examine the condition under which the total output increases. The effect of a decrease in t_{12} on the total supply is given by

$$\frac{dX}{dt_{12}} = D_1' \frac{dp_1}{dt_{12}} + D_2' \frac{dp_2}{dt_{12}} + D_3' \frac{dp_3}{dt_{12}} = \frac{(D_2')^2 \{D_1' D_3' (2-\epsilon_1)(2-\epsilon_3)\}}{|A|}. \tag{16}$$

A decrease in t_{12} increases the total supply if and only if $(2-\epsilon_1)(2-\epsilon_3) > 0$. Thus, a decrease in t_{12} increases the MC in Case 1 but decreases it in Cases 2 and 3. Noting that a decrease in t_{12} shifts the equilibrium from E to E' in the figures, we can easily verify the changes in the prices in countries 1 and 3 in each case. In Case 2, for example, the MC decreases due to the smaller total output. Since MR_1 is downward-sloping but MR_3 is upward-sloping, p_1 falls but p_3 rises.

Thus, we can obtain the following proposition.

Proposition 1 *A decrease in the tariff imposed by country 2 necessarily benefits the monopolist in country 1 and the consumers in country 2. The consumers in country 1 gain if and only if* $\epsilon_3 > 2$; *country 1 gains if* $\epsilon_3 > 2$; *and the consumers in country 3 as well as country 3 gain if and only if* $\epsilon_1 > 2$.

We next examine how the presence of a third country affects the optimal tariff. To make a comparison between the two models, we assume $t_{13} = 0$. Since (10) is not affected by the presence of other countries, (11) remains valid in the three-country model. Thus, we investigate under what condition $dp_2/dt_{12} < 1$ holds. In the three-country model where $t_{13} = 0$, we have

$$1 - \frac{dp_2}{dt_{12}} \equiv \widehat{\Gamma} = \frac{D_1' D_2' D_3' [(1-\epsilon_2)(2-\epsilon_3)\Psi_1 - (2-\epsilon_3)(2-\epsilon_1) C'' D_2' - (1-\epsilon_2)(2-\epsilon_1) C'' D_3']}{|A|}. \tag{17}$$

A sufficient condition for welfare of country 2 to improve is $\epsilon_1 < 2$, $\epsilon_2 < 1$ and $\epsilon_3 < 2$.

Comparing $\widetilde{\Gamma}$ and $\widehat{\Gamma}$, we have

$$\widetilde{\Gamma} - \widehat{\Gamma} = \frac{D_2' [(2-\epsilon_1) D_1' D_2' D_3' C'']^2}{\Omega |A|} > 0. \tag{18}$$

This implies that the increase in p_2 caused by a tariff is greater in three-country model than in two-country model. Thus, a small import tariff is more likely to improve welfare of country 2 in the two-country model.

We should note that (8) remains to hold. Thus, if $\epsilon_3 > 2$, a decrease in t_{12} benefits country 1 because the monopolist as well as the consumers in countries 1 and 2. In addition, if the initial tariff in country 2 is greater than the optimal level, the tariff-reduction enhances welfare of both countries 1 and 2. In this case, however, country 3 loses because $\epsilon_3 > 2$ implies $\epsilon_1 < 2$ (recall Lemma 2).

4 A Three-Country Model: Tariff-Changes in Both Importing Countries

In Section 3, we have examined the case where only county 2 changes her tariff. This section analyzes the case where both countries 2 and 3 change their tariffs. We first consider simultaneous tariff changes, i.e., the case where both countries 2 and 3 simultaneously change their tariffs. For simplicity, we assume $t \equiv t_{12} = t_{13}/\alpha$ (where $\alpha(>0)$ is a parameter) and examine the effects of a change in t. A small α implies that country 2's tariff is higher than country 3's; and $\alpha = 1$ implies that the tariffs imposed by both countries are the same. Without loss of generality, we assume $\alpha \leq 1$ (i.e., $t_{12} \geq t_{13}$).

The effects of changes in t on Π and p_i $(i = 1, 2, 3)$ are given by

$$\frac{d\Pi}{dt} = \frac{\partial \Pi}{\partial t} = -(D_2 + \alpha D_3) < 0, \tag{19}$$

$$\frac{dp_1}{dt} = \frac{C'' D_1' D_2' D_3' [\alpha D_3'(2-\epsilon_2) + D_2'(2-\epsilon_3)]}{|A|}, \tag{20}$$

$$\begin{aligned}\frac{dp_2}{dt} &= \frac{D_1' D_2' D_3' \left[(2-\epsilon_3)\Psi_1 + (\alpha - 1)(2-\epsilon_1) C'' D_3'\right]}{|A|} \\ &= \frac{D_2' \left[\Omega_{13} + \alpha(2-\epsilon_1) C'' D_1' \left(D_3'\right)^2\right]}{|A|},\end{aligned} \tag{21}$$

$$\begin{aligned}\frac{dp_3}{dt} &= \frac{D_1' D_2' D_3' \left[(\alpha - 1)(2-\epsilon_1)\Psi_2 + D_2' D_3' (2-\epsilon_2)\Psi_1\right]}{|A|} \\ &= \frac{D_3' \left[\alpha \Omega_{12} + (2-\epsilon_1) C'' D_1' \left(D_2'\right)^2\right]}{|A|},\end{aligned} \tag{22}$$

$$\frac{dX}{dt} = D_1' \frac{dp_1}{dt} + D_2' \frac{dp_2}{dt} + D_3' \frac{dp_3}{dt} = \frac{D_1' D_2' D_3' (2-\epsilon_1)\{D_2'(2-\epsilon_3) + \alpha D_3'(2-\epsilon_2)\}}{|A|}, \tag{23}$$

where $\Psi_i = 2 - \epsilon_i - C'' D_i'$ $(i = 1, 2)$, which is positive from the second-order condition, and $\Omega_{1j} = \left[\Psi_1 \Psi_j - (C'')^2 D_1 D_j'\right] D_1' D_j' > 0$ $(j = 2, 3)$.

From (20), a decrease in t could lower p_1. p_1 falls if and only if $[\alpha D_3'(2-\epsilon_2) + D_2'(2-\epsilon_3)] > 0$. As we see below, p_1 lowers only if $\epsilon_3 > 2$ holds.[13] Whereas $\alpha D_3'$ (resp. D_2') is related to the spillover effect due to a change in t_{13} (resp. t_{12}), $(2-\epsilon_2)$ (resp. $(2-\epsilon_3)$) is related to the spillover effect from county 2 (resp. country 3) to country 1. For countries 2 and 3, the effects are more complicated, because they have the direct effect of their own tariff reduction as well as the spillover effects from the other two countries.

When $\epsilon_1 \geq 2$ (which implies $\epsilon_2 < 2$ and $\epsilon_3 < 2$), we have $dp_1/dt < 0$, $dp_2/dt > 0$, and $dp_3/dt > 0$ from (20)-(22). When $\epsilon_1 < 2$, on the other hand, we obtain

$$\frac{dp_1}{dt} \gtrless 0 \quad \begin{array}{ll} \Longleftrightarrow \alpha \lesseqgtr \widetilde{\alpha}_1(\epsilon_2, \epsilon_3) \equiv -\frac{D_2'(2-\epsilon_3)}{D_3'(2-\epsilon_2)} & \text{if} \quad 2 > \epsilon_2 \\ \Longleftrightarrow \alpha \gtreqless \widetilde{\alpha}_1(\epsilon_2, \epsilon_3) \equiv -\frac{D_2'(2-\epsilon_3)}{D_3'(2-\epsilon_2)} & \text{if} \quad 2 < \epsilon_2 \end{array} \tag{24}$$

[13] If $\alpha > 1$, then p_1 may fall when $\epsilon_2 > 2$.

$$\frac{dp_2}{dt} \gtrless 0 \Longleftrightarrow \alpha \lesseqgtr \widetilde{\alpha}_2(\epsilon_1,\epsilon_3) \equiv -\frac{\Omega_{13}}{(2-\epsilon_1)C''D_1'(D_3')^2} = 1 - \frac{(2-\epsilon_3)\Psi_1}{(2-\epsilon_1)C''D_3'} > 0, \tag{25}$$

$$\frac{dp_3}{dt} \gtrless 0 \Longleftrightarrow \alpha \gtrless \widetilde{\alpha}_3(\epsilon_1,\epsilon_2) \equiv -\frac{(2-\epsilon_1)C''D_1'(D_2')^2}{\Omega_{12}} = 1 - \frac{(2-\epsilon_2)D_1'D_2'\Psi_1}{\Omega_{12}} > 0. \tag{26}$$

We also have

$$\frac{\partial\widetilde{\alpha}_2(\epsilon_1,\epsilon_3)}{\partial\epsilon_3} = \frac{\Psi_1}{(2-\epsilon_1)C''D_3'} < 0,$$

$$\frac{\partial\widetilde{\alpha}_3(\epsilon_1,\epsilon_2)}{\partial\epsilon_2} = -\frac{(2-\epsilon_1)\Psi_1 C''(D_1')^2(D_2')^3}{(\Omega_{12})^2} > 0.$$

$dp_i/dt < 0$ $(i = 2, 3)$ implies the Metzler paradox in country i. That is, when an importing country increases (resp. decreases) her tariff, her consumer price falls (resp. rises). We should note that the Metzler paradox arises only if both importing countries simultaneously change their tariffs. To explore this possibility further, we check the ranking among $\widetilde{\alpha}_1(\epsilon_2,\epsilon_3)$, $\widetilde{\alpha}_2(\epsilon_1,\epsilon_3)$, and $\widetilde{\alpha}_3(\epsilon_1,\epsilon_2)$:

$$\widetilde{\alpha}_1(\epsilon_2,\epsilon_3) - \widetilde{\alpha}_2(\epsilon_1,\epsilon_3) = \frac{|A|}{(2-\epsilon_2)(2-\epsilon_1)C''D_1'D_2'(D_3')^2} \gtrless 0 \Longleftrightarrow 2 \lesseqgtr \epsilon_2, \tag{27}$$

$$\widetilde{\alpha}_1(\epsilon_2,\epsilon_3) - \widetilde{\alpha}_3(\epsilon_1,\epsilon_2) = -\frac{|A|\,D_2'}{\Omega_{12}(2-\epsilon_2)(D_3')^2} \gtrless 0 \Longleftrightarrow 2 \lesseqgtr \epsilon_2, \tag{28}$$

$$\widetilde{\alpha}_2(\epsilon_1,\epsilon_3) - \widetilde{\alpha}_3(\epsilon_1,\epsilon_2) = -\frac{\Psi_1|A|}{\Omega_{12}(2-\epsilon_1)C''(D_3')^2} > 0. \tag{29}$$

It can be seen from (25), (26) and (29) that if $dp_i/dt < 0$, then $dp_j/dt > 0$ $(i, j = 2, 3;\ i \neq j)$. That is, $dp_2/dt < 0$ and $dp_3/dt < 0$ do not hold simultaneously.

There are three cases when $\epsilon_1 < 2$. In view of (27)- (29), we can verify the sign of dp_i/dt $(i = 1, 2, 3)$ in each case (see also Table 1):

(i) $\epsilon_1 < 2$, $\epsilon_2 < 2$, and $\epsilon_3 < 2$ (i.e., all countries have downward-sloping MR curves): In this case, $\widetilde{\alpha}_1(\epsilon_2,\epsilon_3) < 0 < \widetilde{\alpha}_3(\epsilon_1,\epsilon_2) < 1 < \widetilde{\alpha}_2(\epsilon_1,\epsilon_3)$ holds. Thus, there are two subcases, depending on the size of α: (i) $dp_1/dt < 0$, $dp_2/dt > 0$ and $dp_3/dt < 0$ if $\alpha < \widetilde{\alpha}_3(\epsilon_1,\epsilon_2)$; and (ii) $dp_1/dt < 0$, $dp_2/dt > 0$ and $dp_3/dt > 0$ if $\widetilde{\alpha}_3(\epsilon_1,\epsilon_2) < \alpha$.

(ii) $\epsilon_1 < 2$, $\epsilon_2 > 2$, and $\epsilon_3 < 2$ (i.e., country 2's MR curve is upward-sloping): In this case, $\alpha \leq 1 < \widetilde{\alpha}_3(\epsilon_1,\epsilon_2) < \widetilde{\alpha}_2(\epsilon_1,\epsilon_3) < \widetilde{\alpha}_1(\epsilon_2,\epsilon_3)$. Thus, we have $dp_1/dt < 0$, $dp_2/dt > 0$, and $dp_3/dt > 0$.

(iii) $\epsilon_1 < 2$, $\epsilon_2 < 2$, and $\epsilon_3 > 2$ (i.e., country 3's MR curve is upward-sloping): In this case, $0 \leq \widetilde{\alpha}_1(\epsilon_2,\epsilon_3) < \widetilde{\alpha}_3(\epsilon_1,\epsilon_2) < \widetilde{\alpha}_2(\epsilon_1,\epsilon_3) < 1$. Thus, there are four subcases, depending on the size of α: (i) $dp_1/dt > 0$, $dp_2/dt > 0$ and $dp_3/dt < 0$ if $\alpha < \widetilde{\alpha}_1(\epsilon_2,\epsilon_3)$; (ii) $dp_1/dt < 0$, $dp_2/dt > 0$ and $dp_3/dt < 0$ if $\widetilde{\alpha}_1(\epsilon_2,\epsilon_3) < \alpha < \widetilde{\alpha}_3(\epsilon_1,\epsilon_2)$; (iii) $dp_1/dt < 0$, $dp_2/dt > 0$ and $dp_3/dt > 0$ if $\widetilde{\alpha}_3(\epsilon_1,\epsilon_2) < \alpha < \widetilde{\alpha}_2(\epsilon_1,\epsilon_3)$; (iv) $dp_1/dt < 0$, $dp_2/dt < 0$ and $dp_3/dt > 0$ if $\widetilde{\alpha}_2(\epsilon_1,\epsilon_3) < \alpha$.

Therefore, the following proposition is immediate.

Proposition 2 *Suppose that $t_{12} \geq t_{13}$ and that countries 2 and 3 simultaneously decrease their tariffs by the same proportion. If $\epsilon_3 > 2$, the consumers in country 1 could gain and those in country 2 could lose. The consumers in country 3 could lose unless $\epsilon_1 \geq 2$. It is possible that the consumers in country 1 benefit and those in country 3 hurt at the same time, but it is not possible that the consumers in country 1 benefit and those in country 2 hurt at the same time. It is also impossible that the consumers in countries 2 and 3 lose at the same time. The monopolist in country 1 gains.*

The following should be noted. The Metzler paradox could arise even if all countries have downward-sloping MR curves. In this case, the simultaneous tariff-reduction necessarily harms the consumers in the exporting country and benefits the consumers in the importing country whose tariff is higher. However, the consumers in the importing country whose tariff is lower lose if the tariff gap is large enough (i.e., α is small).

We next compare the sequential tariff-reduction with the simultaneous one. Since there are many cases depending on the size of α, here we focus on the case where $\alpha = 1$ (that is, the tariffs imposed by countries 2 and 3 are the same) and both countries change their tariffs by the same amount.[14] Without the loss of generality, we assume that country 2 moves first and then country 3 if the tariff cut is sequential.

It is obvious that the sequential tariff decreases and the simultaneous tariff decreases eventually lead to the same effects on the prices. However, the paths of price changes could be different between them. Figure 3 summarizes the paths. The panels (a), (b) and (c) show the paths of price changes in countries 1, 2 and 3, respectively. For example, in case 1 where all countries have the downward-sloping MR curves, a decrease in t_{12} raises p_1 and p_3 and lowers p_2 and then a decrease in t_{13} raises p_1 and p_2 and lowers p_3. Comparing the final levels with the initial ones, p_1 becomes higher but p_2 and p_3 become lower. The figures show that the paths are the same only if country 1 has the upward-sloping MR curve; and that if either $\epsilon_2 > 2$ or $\epsilon_3 > 2$ holds, the directions of price changes are reversed in all countries.[15]

Next we examine the optimal tariff when the importing countries set a common tariff. We denote $W \equiv W_2 + W_3$ as the joint welfare of the importing countries, and $t(\equiv t_{12} = t_{13})$ as the common import tariff. Differentiating the joint welfare with respect to t and evaluating it at $t = 0$, we obtain

$$\left.\frac{dW}{dt}\right|_{t=0} = \sum_{i=2,3} D_i \left(1 - \frac{dp_i}{dt}\right)$$
$$= \sum_{i=2,3} \frac{D_i D_1' D_2' D_3' \left[(1-\epsilon_i)(2-\epsilon_j)\Psi_1 - (2-\epsilon_1)\left\{(2-\epsilon_3) D_2' + (2-\epsilon_2) D_3'\right\} C''\right]}{|A|} \quad (30)$$

[14] For example, this is the case where countries 2 and 3 form a costoms union and set a common external tariff.
[15] Whn either $\epsilon_2 > 2$ or $\epsilon_3 > 2$ holds, the final level of p_1 may or may not be higher than the initial level.

Thus, the joint welfare of importing countries may be raised by imposing a small common tariff: $\epsilon_1 < 2$, $\epsilon_2 < 1$ and $\epsilon_3 < 1$ is a sufficient condition.

5 Tariffs vs. Quotas

We have been focusing on tariffs as trade policy. This section investigates the case in which the importing countries set import quotas or the exporting country sets country-specific export quotas (i.e., voluntary export restraints).[16]

We let q_i denote the quota level of country i $(= 2, 3)$. We first consider the case where one importing country sets a quota and the other sets a tariff. Without loss of generality, we assume that country 2 sets a quota whose level is q_2 and country 3 sets a tariff. We also assume that the quota is initially binding. The profit function of the monopolist becomes

$$\Pi(P; q_2; t_{13}) = p_1 D_1(p_1) + p_2^q q_2 + (p_3 - t_{13}) D_3(p_3) - C(D_1(p_3) + q_2 + D_3(p_3)), \tag{31}$$

where $p_i^q \equiv D_i^{-1}(q_i)$.

The effects of a change in q_2 is as follows. Differentiating (31) with respect to q_2 and using the envelope theorem, we obtain

$$\frac{d\Pi}{dq_2} = \frac{\partial \Pi}{\partial q_2} = p_2^q - \frac{q_2}{D_2'} - C' \geq 0,$$

where equality holds when the quota is set at the free-trade level. Totally differentiating the first-order conditions with respect to q_2, we have the effects of a change in the quota level:

$$\frac{dp_i}{dq_2} = \frac{D_1' D_3' C'' (2 - \epsilon_j)}{\Omega_{13}}; \quad (i, j = 1, 3; i \neq j).$$

Therefore,

$$\frac{dp_i}{dq_2} \gtreqless 0 \Longleftrightarrow 2 - \epsilon_j \gtreqless 0\,. \tag{32}$$

This condition is similar to (15) which is obtained in the case of the tariff-change. Obviously, $dp_2/dq_2 < 0$. Thus, as long as country 3 employs a tariff, the effects of strengthening (resp. weakening) country 2's quota on prices are the same as those of increasing (resp. decreasing) country 2's tariff.

When country 2 employs a quota, however, the effects of a change in t_{13} may be different from those in section 3. We have two cases. The quota remains binding in one case and it becomes unbinding in the other. In the former case, it is obvious that a change in t_{13} has no effect on p_2. Thus, the effects of a change in t_{13} are the same as those in the two-country model.

From Proposition 1, an increase (resp. a decrease) in t_{13} lowers the profit-maximizing level of the supply to country 2 lowers if and only if $\epsilon_1 > 2$ (resp. $\epsilon_1 < 2$). In this case, the initially binding quota q_2 may no longer be binding. If the quota becomes unbinding as t_{13} rises (resp. falls), $dp_2/dt_{13} > 0$ (resp. $dp_2/dt_{13} < 0$) holds.

[16] As was pointed out by Shibata (1968), export quotas and import quotas set at the same levels are equivalent under segmented markets.

We can establish the following proposition (see Table 2).

Proposition 3 *Suppose that country 3 decreases her tariff when country 2 is imposing a quota. When the quota remains binding, the consumers in countries 1 lose, those in country 2, are indifferent, and those in country 3 gain. When the quota becomes unbinding, however, the consumers in countries 1 may gain if $\epsilon_2 > 2$, those in country 2 lose, and those in country 3 gain.*

Proof. We let $\widetilde{p}_k$ and $\widetilde{x}_k$ denote the optimal price and supply in country k ($k = 1, 2, 3$) in the absence of the quota (i.e., $\widetilde{x}_k \equiv D_k(\widetilde{p}_k)$). We also let x_k denote the actual level of supply to country k. Suppose that country 2's quota is initially binding (i.e., $\widetilde{x}_2 \geq x_2 = q_2$) but a change in t_{13} makes it unbinding. Since $\Delta\widetilde{x}_2 = (D_2')^{-1}(d\widetilde{p}_2/dt_{13})\Delta t_{13}$ and $d\widetilde{p}_2/dt_{13} \gtreqless 0 \iff \epsilon_1 \gtreqless 2$ from (15), the quota becomes unbinding (i.e., $\Delta\widetilde{x}_2 < 0$) only if $\epsilon_1 < 2$ and $\Delta t_{13} < 0$ or only if $\epsilon_1 > 2$ and $\Delta t_{13} > 0$. Since the quota is initially binding, we have $d\widetilde{x}_2/dt_{13} \leq dx_2/dt_{13} \leq 0$ or $0 \leq dx_2/dt_{13} \leq d\widetilde{x}_2/dt_{13}$. We define $\beta \equiv (dx_2/dt_{13})/(d\widetilde{x}_2/dt_{13})$, where $\beta \in [0, 1]$, $\beta = 0$ if the quota remains binding, and $\beta = 1$ if the quota is initially set at the free-trade level. We have

$$\frac{dp_1}{dt_{13}} = \beta\frac{d\widetilde{p}_1}{dt_{13}} + (1-\beta)\frac{D_1'(D_3')^2 C''}{\Omega_{13}}.$$

If q_2 remains binding, $dp_1/dt_{13} = D_1'(D_3')^2 C''/\Omega_{13} < 0$. If the quota becomes unbinding and $\epsilon_2 < 2$, $d\widetilde{p}_1/dt_{13} < 0$. If the quota becomes unbinding and $\epsilon_2 > 2$, on the other hand, $d\widetilde{p}_1/dt_{13} > 0$. In this case, dp_1/dt_{13} takes the minimum value at $\beta = 0$, which is negative, and maximum value at $\beta = 1$, which is positive. Hence, dp_1/dt_{13} has an ambiguous sign. As for p_2, we have

$$\frac{dp_2}{dt_{13}} = \beta\frac{d\widetilde{p}_2}{dt_{13}}.$$

Hence, $dp_2/dt_{13} = 0$ if the quota remains binding and $dp_2/dt_{13} \gtreqless 0 \iff \epsilon_1 \gtreqless 2$ if it becomes unbinding. Finally,

$$\frac{dp_3}{dt_{13}} = \beta\frac{d\widetilde{p}_3}{dt_{13}} + (1-\beta)\frac{D_3'\left[D_1'(2-\epsilon_1) - C''(D_1')^2\right]}{\Omega_{13}} > 0.$$

Note that $d\widetilde{p}_3/dt_{13} > 0$ by (13). Q.E.D. ■

Contrary to the tariff case, a quota shuts the spillover effects as long as the quota is binding. Hence, any policy change in country 3 that increases her imports never raises country 1's supply as long as the quota remains binding in country 2. Moreover, it is obvious that when both importing countries impose binding quotas, simultaneous changes in quota levels never lead to the Metzler paradox, which is contrast to the tariff case.

6 Concluding Remarks

We have examined the effects of tariff-changes in the framework of monopoly. It has been shown that the presence of a third country could drastically change the effects. In particular, it is possible that the consumer price falls not only in the country which lowers her tariff but also in another country; and that the consumers in the country which lowers her tariff lose. The increasing MC and MR are the key to our results. The increasing MC leads to spillover effects, while the increasing MR magnifies the spillover effects.

Although we have mainly confined ourselves to the case of tariffs in our analysis, similar results could hold with other trade policies. If the tariff is replaced by an export tax in country 1, for example, all the effects except for those on welfare are the same. In the case of quotas, however, we should note that the spillover effects are shut down. The effects of a tariff-change in an importing country differ if the other importing country employs a quota instead of a tariff.

Our analysis suggests that we should be careful when evaluating various trade policies. A good example is the evaluation of the effects of economic integration, because the tariff-reduction can be regarded as the process of economic integration. When we examine economic integration, therefore, the analysis confined to a two-country model may be unsatisfactory. First of all, our analysis suggests that a non-member country should be included in the analysis. Interpreting Proposition 1 in the context of economic integration, we can make various claims depending on the values of ϵ_i. In particular, three interesting claims are (i) economic integration between two countries (i.e., countries 1 and 2) may also benefit the non-member country (i.e., country 3); (ii) economic integration may benefit only non-member country; (iii) neither member nor non-member countries may gain from economic integration. Furthermore, the comparison between Propositions 1 and 2 implies that the effects of multilateral trade liberalization may be quite different from those of bilateral trade liberalization.

Although we have dealt with the case where both importing countries change their tariffs, we have not considered any strategic interactions between the governments. It is certainly worthwhile to examine this kind of strategic interactions. This is left for future research.

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Tables and Figures

Table 1 : Simultaneous tariff changes: asymmetric case

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[**Case 1 : All countries have downward-sloping MR curve**]

$\epsilon_1 < 2,\ \epsilon_2 < 2,\ \epsilon_3 < 2$			
	dp_1/dt	dp_2/dt	dp_3/dt
$\widetilde{\alpha}_3\left(\epsilon_1, \epsilon_2\right) < \alpha \leq 1$	$-$	$+$	$+$
$0 < \alpha < \widetilde{\alpha}_3\left(\epsilon_1, \epsilon_2\right)$	$-$	$+$	$-$

[**Case 2 : Exporting country has upward-sloping MR curve**]

$\epsilon_1 > 2,\ \epsilon_2 < 2,\ \epsilon_3 < 2$			
	dp_1/dt	dp_2/dt	dp_3/dt
$0 < \alpha \leq 1$	$-$	$+$	$+$

[**Case 3 : Country 2 has upward-sloping MR curve**]

$\epsilon_1 < 2,\ \epsilon_2 > 2,\ \epsilon_3 < 2$			
	dp_1/dt	dp_2/dt	dp_3/dt
$0 < \alpha \leq 1$	$-$	$+$	$-$

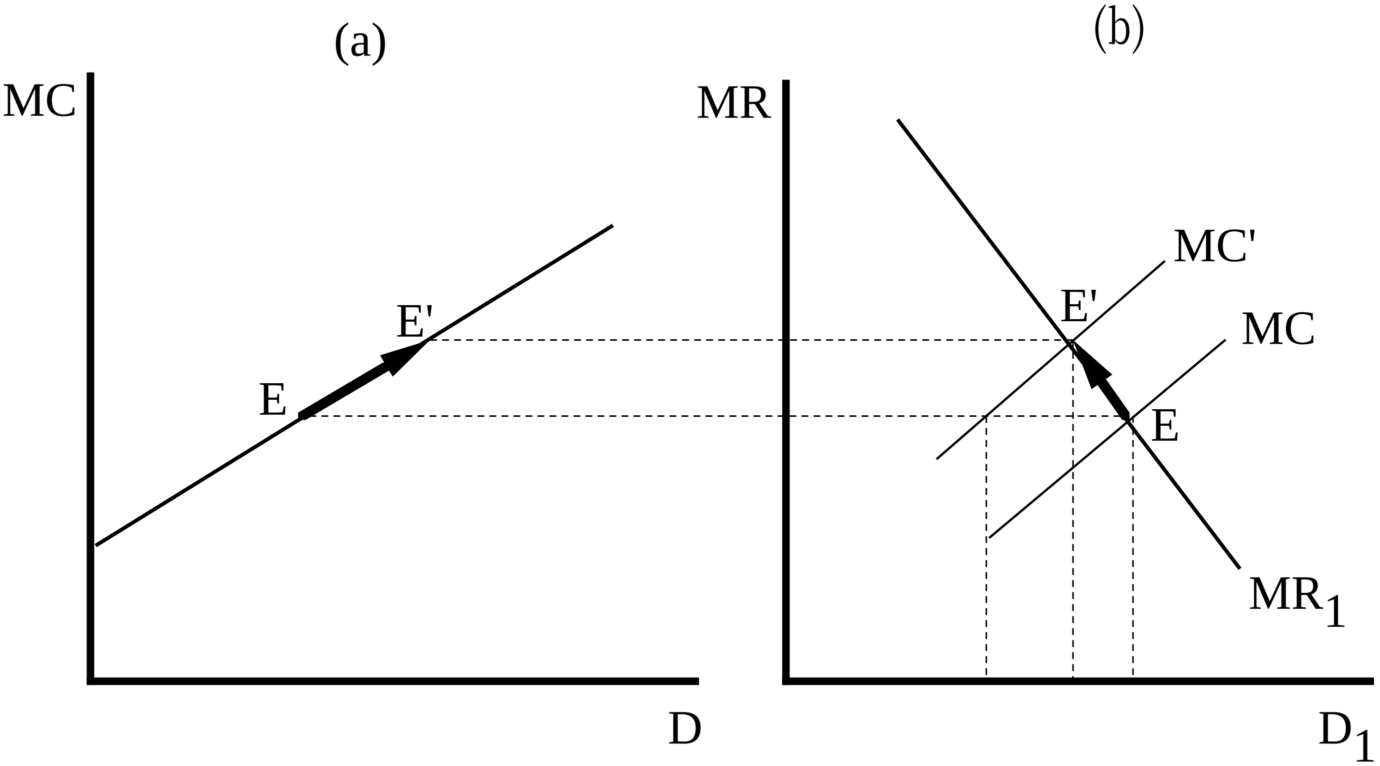
[**Case 4 : Country 3 has upward-sloping MR curve**]

$\epsilon_1 < 2,\ \epsilon_2 < 2,\ \epsilon_3 > 2$			
	dp_1/dt	dp_2/dt	dp_3/dt
$\widetilde{\alpha}_2\left(\epsilon_1, \epsilon_3\right) < \alpha \leq 1$	$-$	$-$	$+$
$\widetilde{\alpha}_3\left(\epsilon_1, \epsilon_2\right) < \alpha < \widetilde{\alpha}_2\left(\epsilon_1, \epsilon_3\right)$	$-$	$+$	$+$
$\widetilde{\alpha}_1\left(\epsilon_2, \epsilon_3\right) < \alpha < \widetilde{\alpha}_3\left(\epsilon_1, \epsilon_2\right)$	$-$	$+$	$-$
$0 < \alpha < \widetilde{\alpha}_1\left(\epsilon_2, \epsilon_3\right)$	$+$	$+$	$-$

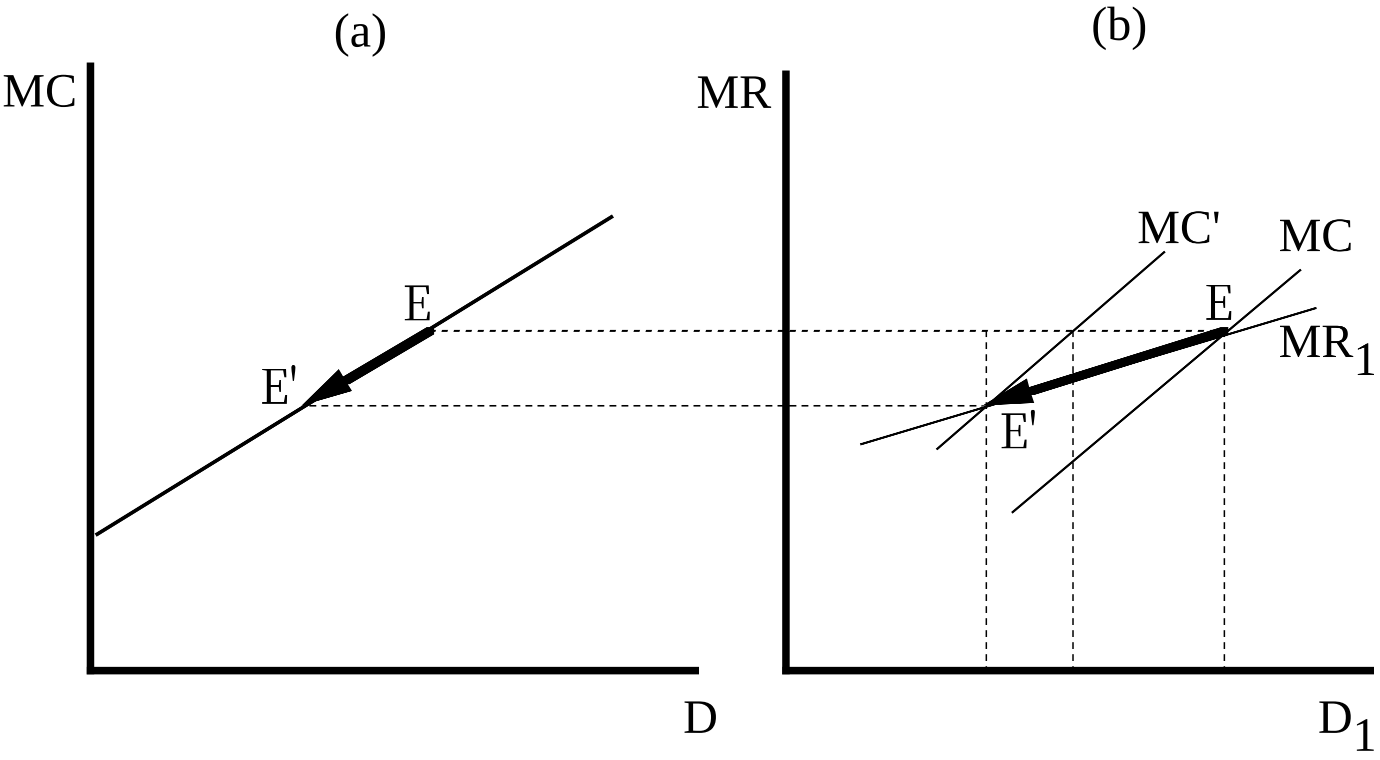
Table 2 : Country 3's tariff changes when country 2 employs a quota

	dp_1/dt_{13}	dp_2/dt_{13}	dp_3/dt_{13}
The quota remains binding	$-$	0	$+$
The quota becomes unbinding			
$\epsilon_k < 2$ $(k = 1, 2, 3)$ and $t_{13} \downarrow$	$-$	$-$	$+$
$\epsilon_1 > 2$ and $t_{13} \uparrow$	$-$	$+$	$+$
$\epsilon_2 > 2$ and $t_{13} \downarrow$	?	$-$	$+$
$\epsilon_3 > 2$ and $t_{13} \downarrow$	$-$	$-$	$+$

Figure 1: The two-country model



Case 1: $\varepsilon_1 < 2$



Case 2: $\varepsilon_1 > 2$

Figure 2: The three-country model

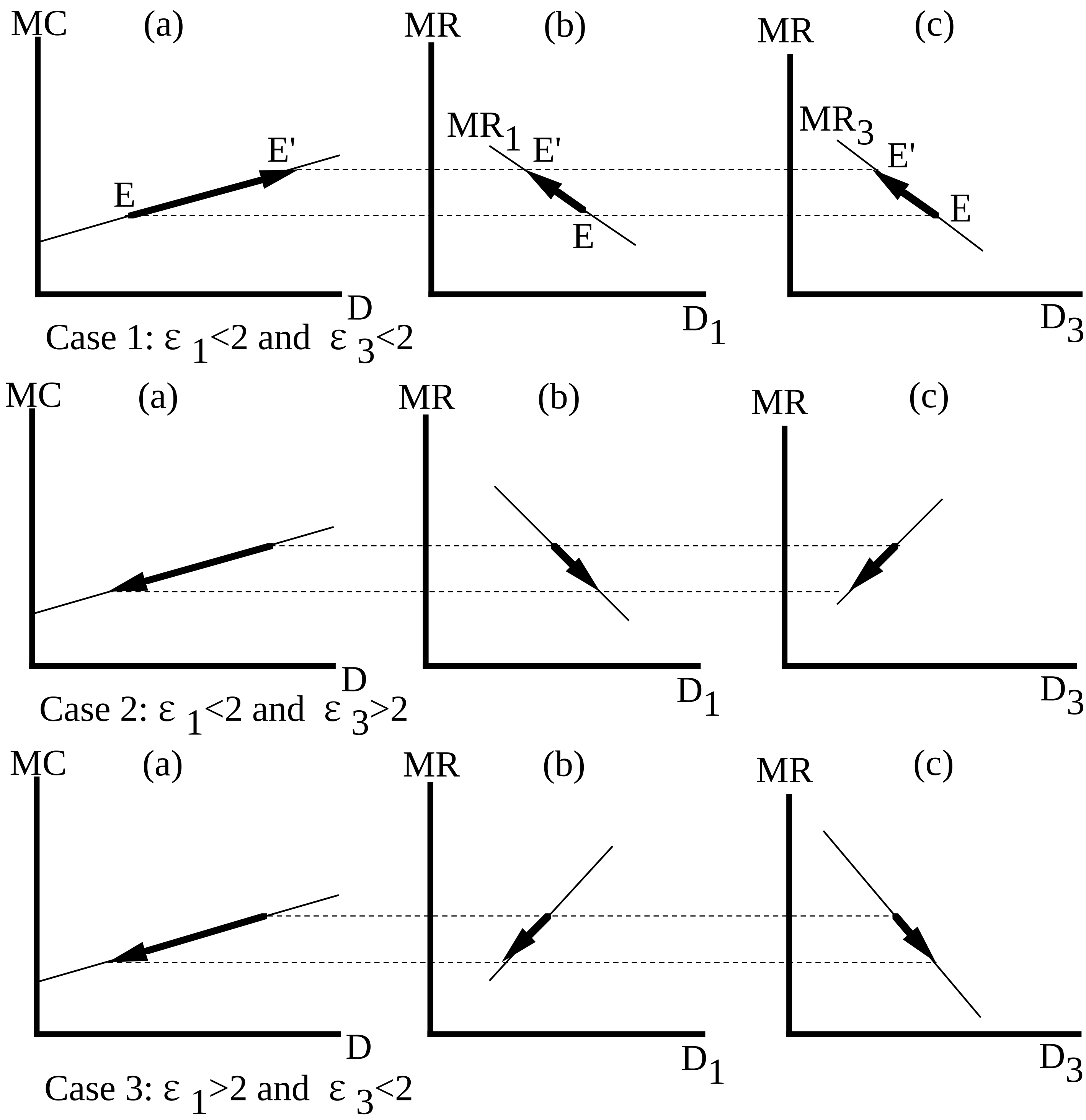
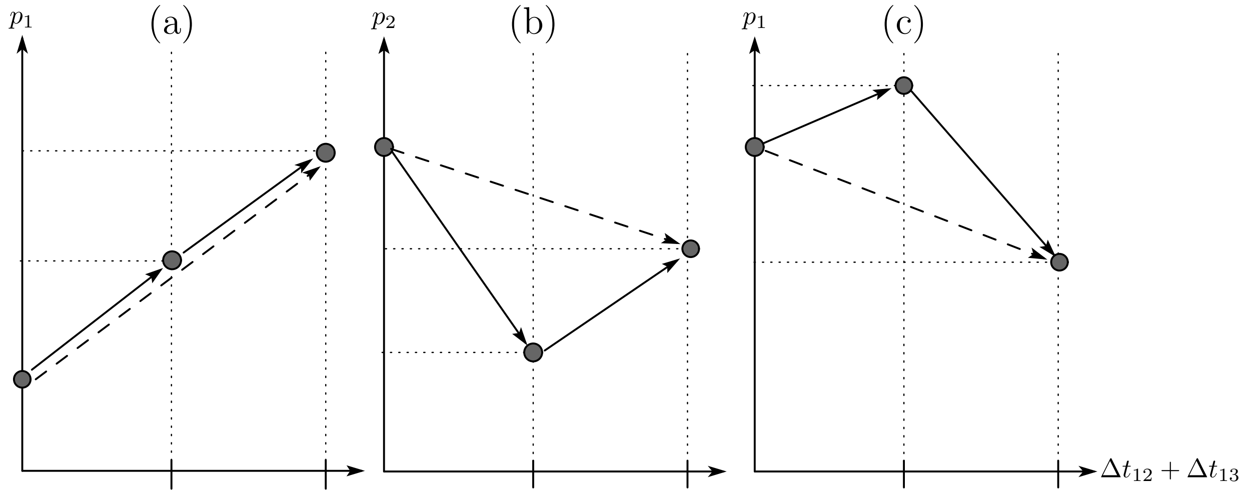
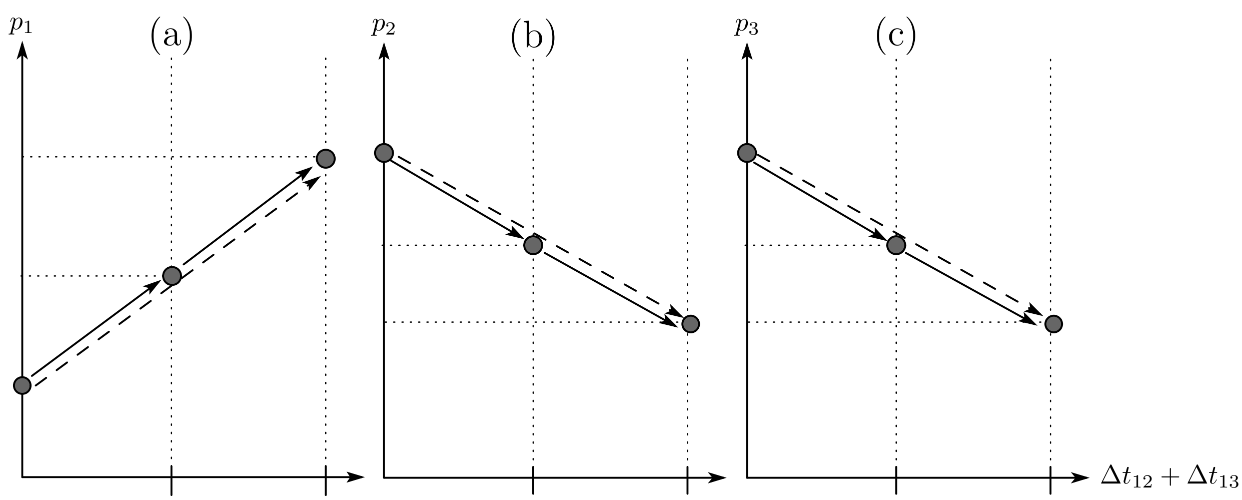


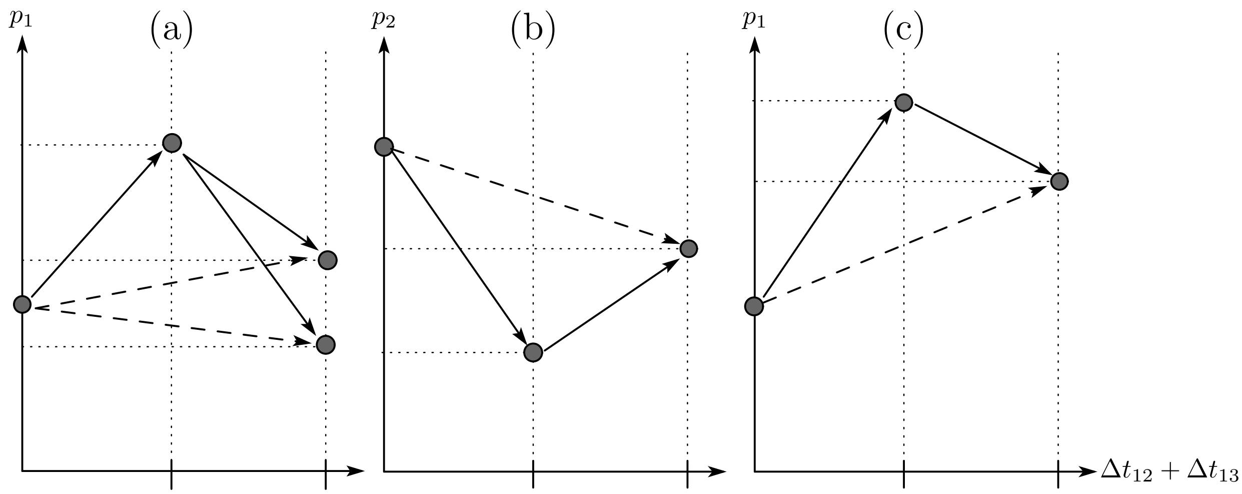
Figure 3 : Sequential tariff decreases



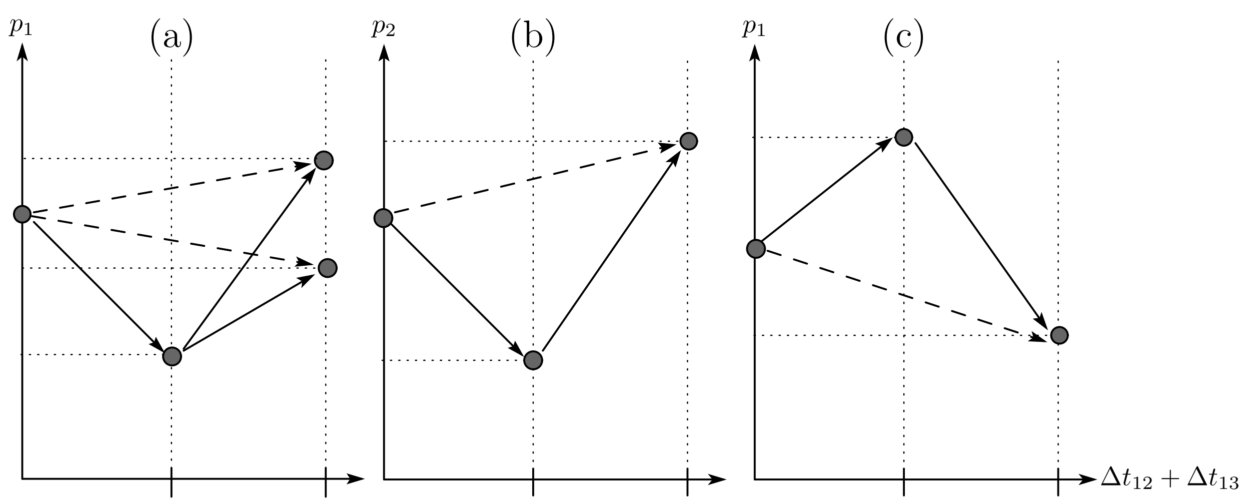
Case 1 : All countries have downward-sloping MR curve



Case 2 : Exporting country has upward-sloping MR curve



Case 3 : Country 2 has upward-sloping MR curve



Case 4 : Country 3 has upward-sloping MR curve