論　説

The Timing of Trade Policy Implementation in a Third Market Model

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Abstract

This paper examines how the difference in the timing of trade policy implementation affects the welfare of the exporting and importing countries, and world welfare, using a third market model. The paper shows that when the importing government (resp. the exporting governments) first move(s), the welfare of the importing country and the world is the highest (resp. lowest). Further, we compare the equilibrium results under free trade, the unilateral interventions, and bilateral interventions. When the exporting governments implement the subsidy policy strategically, the import tariff policy implemented by the importing government in advance of setting the subsidy can be justified from the viewpoint of the third country's welfare and also world welfare.

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1 Introduction

In the mainstream theory of international trade, strategic trade theory has provided various fruitful results by clarifying the reason why governments might intervene in firms with several instructions in their trade policy in imperfectly competitive markets, using the framework of international oligopoly. In particular, many articles deal with a "third market model," in which firms that produce goods in different countries compete in a third market. Seminal works among these are Brander and Spencer (1985) and Eaton and Grossman (1986). Brander and Spencer (1985) show that export subsidies by governments shift part of the profits from foreign firms and clarify that a highly competitive subsidy race exaggerates the welfare levels of both countries. Eaton and Grossman (1986) show that the outcome of a strategic export policy depends on whether firms choose prices or quantities.[1] Their analyses have been extended in a number of directions, and examples of typical extensions include the incorporation of incomplete information (Cooper and Riezman 1989; Maggi 1999; Grossman and Maggi 1999) and the endogeneity of market competition (Horstmann and Markusen 1992; Maggi 1996).

In a third market model, in which all quantities of the good must be supplied by exporting firms, the exporting governments have often adopted the export subsidy policy as a trade policy instrument to support their exporting firms, and lending their industries a competitive edge. The existing literature on the strategic export subsidy in a third market model has examined the subsidy race by the exporting governments, under which the optimal level of export subsidy is strategically determined by considering market competition between firms. Much of the existing literature usually assumes that the importing country with a third market plays no active role. In other words, there is no active player such as the government who protects the domestic welfare of the country within a market. One reason for such a simplified assumption is because it is essential for the importing country with no domestic firms to export the good from the foreign firms. The rationale is that if the foreign firms are indispensable in supplying the good, it is unlikely that the importing country itself chooses to restrict the supply of the good. However, even if the good must be fully imported, the government of the importing country may be able to improve domestic welfare by properly implementing the trade policy. Once the importing government is explicitly introduced into the model, the strategic interaction between the trade policies implemented not only by the exporting governments but also by the importing government can be delineated in a clearer

[1] For an excellent survey on strategic trade policies in a third market model, see Brander (1995) and Helpman and Krugman (1989).

manner.

Another reason for introducing this assumption is the simplification of the model. Abstracting away from additional players in the third country allows us to pay attention to the strategic interaction of the export subsidies between both exporting governments. However, in a realistic trade environment, exporting countries and importing countries will have experienced conflicts over trade policies. As seen in trade practices in non-WTO members, the importing government sets the import tariff as an instrument to shift the rent from the foreign firms to the domestic consumer. If the interaction between exporting and importing countries should be explicitly taken into consideration, an active role must be taken in the policy making of the importing country's government. In a realistic situation, a lot of manufactured products are produced in the developed countries, and these are imported by the developing countries. When the above simplified assumption is satisfied, it implies that while the exporting developed countries can execute foreign export subsidies effectively, the importing developing countries do not have any trade policy instruments in place to protect the domestic consumers. Such a situation seems to be quite unrealistic. A more realistic situation is that in which not only can the exporting countries set foreign export subsidies but the importing country can also appropriately implement an import tariff. By allowing the importing country to implement the import tariff on the exporting firms, this paper examines the effect of trade policies on welfare in a third market model when the government of the importing country plays an active role.

As opposed to the framework of a third market model, in a two-country model in which the home firms and foreign firms compete in the home market, there are several articles on strategic trade policy that have dealt with the interaction of trade policies between the home government and the foreign government, since the home government chooses the import tariff and the foreign government chooses the export subsidy (Dixit 1984; Cheng 1988; among others). In contrast, as stated above, due to the complexity of calculation, only few articles on strategic export subsidies in a third market model have allowed market intervention by the government of the third country. Therefore, this paper contributes to the literature on strategic trade theory by allowing the government with a third market to choose an import tariff in a third market model. Moreover, our paper is concerned with how the implementation of trade policies at different times by the exporting country and the importing country affects the welfare of each country. In this respect, this paper is similar to those articles that have analyzed the outcome of policies implemented at different times. Collie (1994) explores a two-country model in which the domestic and foreign governments choose when to set the trade policy, and endogenizes the timing of trade policy implementation. Ohkawa et al. (2002) extend the result of Brander and Spencer (1985) to the situation of oligopolistic competition with multiple firms, and clarify the relationship between the number of firms and the order of trade policy implementation. Supasri and Tawada (2007) examine how the order of decision-making by governments is endogenously determined when the number of firms in the importing and exporting countries differs.

A recent article that has dealt with the endogenous timing of trade policies in a third market model, Nomura (2005), explores the third market model in which an importing government and two exporting governments set an import tariff and export subsidies, respectively, and presents the comprehensive conclusions about the endogenous policy timing.[2] His paper allows the exporting governments to move in a different order, such as a Stackelberg-like leader and follower situation, and endogenizes the timing of trade policies by considering the government's choice of the order that maximizes national welfare. Although Nomura (2005) presents relatively comprehensive conclusions about the timing of trade policy implementation, he focuses on analyzing the effect of the Free Trade Agreement (FTA) between two countries and its endogenous formation. Thus, unlike our paper, Nomura (2005) does not pay attention to how the difference per se in the timing of trade policy implementation between the importing government and the exporting government affects the welfare of the country and the world. Our paper investigates the relationship between the timing of trade policy implementation and the extent of welfare clarifying the order under which policy implementation obtains higher welfare; the endogeneity of the policy timing is not argued in order to avoid analytical complexity.

By comparing the different scenarios relating to policy implementation, this paper sheds light on several results that seem to be counterintuitive at first glance. To cite a well-known result since Brander and Spencer (1985), in the absence of an import tariff, show that the welfare of the exporting countries under the subsidy race by the exporting governments is less than that under free trade. We show that as a result of severe competition between the exporting firms in terms of subsidization, higher world welfare is obtained under export subsidization than under free trade (Proposition 1). By comparing the effect of the export subsidy with that of the import tariff, we show that the welfare of the importing

[2] After completing this paper, we became aware of Nomura's (2005) study. Although his paper presents more comprehensive and general results than ours, the main concern is on the commitment to trade policy by two countries, which is executed by the FTA formation. Our paper focuses on how the different timings of trade policies affects welfare, and attempts to present some interesting results attributed to the difference in timing.

country and the world is higher when the exporting governments engage in the subsidy race when no import tariff is in place than when the importing government imposes the tariff in the absence of an export subsidy (Proposition 2). When we consider the simultaneous-move game in which governments determine whether or not to implement the trade policy, the unique Nash equilibrium states that only the importing government should impose a tariff policy and that neither exporting government should subsidize the firm (Proposition 3). In a sequential-move situation in which the importing government first moves and the exporting governments follow, the equilibrium tariff countervails the equilibrium subsidy thoroughly, and the equilibrium output, profit, and world welfare are the same as that under free trade (Proposition 4). In a sequential-move situation in which the exporting governments first move, followed by the importing government, the equilibrium subsidy is negative (Proposition 5). Finally, we show that in all bilateral interventions that differ in the timing of trade policies, the welfare of the third country and the world is highest in a sequential-move situation in which the importing government first moves (Proposition 6). These results suggest that in order to ensure the effectiveness of the trade policy, the decision timing of trade policies must be considered. Moreover, they suggest that from the viewpoint of the welfare of the importing country and also the world, the imposition of import tariff before subsidizing the export firms can be justified.

The remainder of the paper is organized as follows. Section 2 presents the basic model of the strategic trade policy. Section 3 presents the equilibrium results under different timing of trade policy implementation. Section 4 compares the equilibrium results and presents several results. Section 5 concludes the paper.

2 The model

Consider the Cournot duopoly with one firm in country 1 and another firm in country 2, which are indexed; firm $i = 1,2$. Firms produce a homogeneous good which is sold in a third market in country 3. There is no consumption in country i and no production in country 3. The output of firm i is denoted by q_i and the total output by $Q = q_1 + q_2$. Both firms have the constant-return-to-scale technology with a constant marginal cost c_i. The utility of the representative consumer in the third market is defined by $U(Q) = aQ - \frac{b}{2}Q^2$. Thus, the inverse demand function is linear, given by $p(Q) = a - bQ$. We assume that $a > \max\{c_1, c_2\}$ and $b > 0$. As a trade policy instrument, government i, which is the government of the exporting country i, can subsidize a per unit export subsidy s_i to its exporting firm. Government 3, which is the importing government with a third market, can impose a per unit import tariff t_i to the firms. The profit of firm i is as follows:

$$\pi_i(q_i, q_j) = (a - b(q_i + q_j) - \widehat{c}_i)q_i, \tag{1}$$

where $i, j = 1, 2; j \neq i$ and $\widehat{c}_i \equiv c_i - s_i + t_i$ is defined as a “virtual cost,” including the export subsidy minus import tariff. Both exporting firms engage in quantity competition in a Cournot fashion.

The welfare of the exporting country i is the profit of the exporting firm minus the cost of the subsidy as follows:

$$G_i = \pi_i - s_i q_i. \tag{2}$$

Government $i = 1, 2$, which has an exporting firm in country i, sets the export subsidy in order to maximize G_i. The welfare of the importing country 3 is the consumer surplus plus the revenue from import tariff, given as follows:

$$G_3 = U(Q) - p(Q)Q + t_1 q_1 + t_2 q_2 = \frac{b}{2}Q^2 + t_1 q_1 + t_2 q_2. \tag{3}$$

Government 3, which has the third market, imposes the import tariff on the exporting firms in order to maximize G_3.

This paper focuses on how the different timing of trade policy implementation affects welfare, and presents some interesting results by comparing the welfare observed under different cases. For this purpose, we classify six cases according to the different timing of implementing trade policy, as follows: Case 1 is that without any trade policy. This case is a benchmark under free trade. Cases 2 and 3 are those of unilateral interventions by either the exporting governments or the importing government. Case 2 has only a subsidy, but no tariff. Conversely, Case 3 has only a tariff, but no subsidy. Cases 4, 5, and 6 are bilateral interventions by the exporting and importing governments. Although both subsidy and tariff are implemented in Cases 4, 5, and 6, the three cases differ in the timing of trade policy implementation. In Case 4, both the exporting and importing governments simultaneously execute the subsidy and tariff, respectively. Thus, Case 4 is the simultaneous-move game with respect to the order of choices of trade policy. In Case 5, the importing government first determines the tariff level, and the exporting governments then set the subsidy after observing the tariff level. Case 5 is the sequential-move game in which the importing government first moves and the exporting governments follow. Finally, in Case 6, in contrast to Case 5, the exporting governments first determine the subsidy levels and then the importing government imposes the tariff. Case 6 is the sequential-move game in which the exporting governments first move, followed by the importing government. Throughout this paper, we assume that both exporting governments act simultaneously and noncooperatively at the same time. Although the analysis can be extended in a more generalized manner by allowing the exporting governments to move at different times, we abstract such an extension from the analysis in order to avoid increased analytical complexity.[3]

The timing of the game is as follows: In Case 1, in which there is no trade policy, the two exporting firms decide their quantity levels simultaneously and noncooperatively. In Cases 2, 3, and 4, in the first stage, as applicable, the importing government and the exporting governments determine the tariff level and the subsidy levels simultaneously and noncooperatively, respectively. In the second stage, given the determined subsidy and tariff levels, the two exporting firms decide their quantity levels simultaneously and noncooperatively. In Case 5, in the first stage, the importing government determines the tariff level. In the second stage, after observing the tariff level, the exporting governments set the subsidy levels simultaneously and noncooperatively. In the third stage, given the determined subsidy and tariff levels, the two exporting firms decide their quantity levels simultaneously and noncooperatively. Finally, in Case 6, in the first stage, the exporting governments set the subsidy levels simultaneously and noncooperatively. In the second stage, after observing the subsidy levels, the importing government imposes the tariff level. In the third stage, given the determined subsidy and tariff levels, the two exporting firms decide their quantity levels simultaneously and noncooperatively.

The solution concept follows the subgame perfect Nash equilibrium. We derive and compare the equilibrium of all six cases in the following section.

3 The equilibrium result

We derive the equilibrium outcome by backward induction. In the production stage, that is, the final stage, the exporting firms maximize their profits π_i. The first-order condition (FOC) for profit maximiza-

[3] Nomura (2005) deals with a more generalized setting than ours, including the cases in which both the exporting governments choose the subsidy at different timings.

tion is as follows:

$$\frac{\partial \pi_i(q_i, q_j)}{\partial q_i} = a - 2bq_i - bq_j - \widehat{c}_i = 0. \tag{4}$$

By (4), the reaction function of firm i is obtained as $q_i = R(q_j) \equiv \frac{a-\widehat{c}_i-bq_j}{2b}$. By solving the intersection of the reaction functions, we obtain the equilibrium output as follows:

$$(q_1, q_2) = (\frac{a-2\widehat{c}_1+\widehat{c}_2}{3b}, \frac{a-2\widehat{c}_2+\widehat{c}_1}{3b}). \tag{5}$$

We assume that in all six cases, the equilibrium output is positive.[4] Total output, price, and profit margin are $Q = q_1 + q_2 = \frac{2a-\widehat{c}_1-\widehat{c}_2}{3b}$, $p(Q) = \frac{a+\widehat{c}_1+\widehat{c}_2}{3}$, and $p(Q) - \widehat{c}_i = \frac{a-2\widehat{c}_i+\widehat{c}_j}{3} = bq_i$, respectively. Note that the firm's profit is $\pi_i = bq_i^2$.

By differentiating (5) with regard to the level of subsidy or tariff, we obtain the comparative statics result as $\frac{\partial q_i}{\partial s_i} = -\frac{\partial q_i}{\partial t_i} = \frac{2}{3b}$ and $\frac{\partial q_j}{\partial s_i} = -\frac{\partial q_j}{\partial t_i} = -\frac{1}{3b}$. In the following, we derive the equilibrium in the six cases in turn.

3.1 Case 1: free trade

This case is a benchmark case under free trade without any trade policy. Since $(s_1, s_2) = (0, 0)$ and $(t_1, t_2) = (0, 0)$, $\widehat{c}_i = c_i$ holds. In the equilibrium, the output is $q_i = \frac{a-2c_i+c_j}{3b}$, the profit, which is equal to the welfare of the exporting country, is $\pi_i = G_i = \frac{(a-2c_i+c_j)^2}{9b}$, and the welfare of the third country is $G_3 = \frac{(2a-c_1-c_2)^2}{18b}$.

3.2 Case 2: subsidy only

Case 2 is the case in which there is only subsidy, but no tariff. In the first stage, the exporting governments set the subsidy levels in order to maximize $G_i = \pi_i - s_i q_i$, subject to (5). The FOC is as follows:

$$\frac{\partial G_i}{\partial s_i} = \frac{\partial \pi_i}{\partial s_i} - q_i - s_i \frac{\partial q_i}{\partial s_i} = 2bq_i \frac{\partial q_i}{\partial s_i} - q_i - s_i \frac{\partial q_i}{\partial s_i} = 0. \tag{6}$$

By substituting $\frac{\partial q_i}{\partial s_i} = \frac{2}{3b}$ into (6), we obtain $s_i = \frac{b}{2} q_i$. Under the subsidy race, the reaction function of government i is $s_i = R_i(s_j) \equiv \frac{a-2c_i+c_j-s_j}{4}$. By solving the intersection of both reaction functions, we obtain the equilibrium subsidy, $(s_1, s_2) = (\frac{a-3c_1+2c_2}{5}, \frac{a-3c_2+2c_1}{5})$. In the equilibrium, the output is

[4] By the following calculation, it is shown that for the output to be positive, $a - 3c_i + 2c_j > 0$ is a sufficient condition. We assume $a - c_i > 2(c_i - c_j)$ throughout the following analysis.

$q_i = \frac{2(a-3c_i+2c_j)}{5b}$, the profit is $\pi_i = \frac{4(a-3c_i+2c_j)^2}{25b}$, the welfare of the exporting country is $G_i = \pi_i - s_i q_i = \frac{2(a-3c_i+2c_j)^2}{25b}$, and the welfare of the third country is $G_3 = \frac{2(2a-c_1-c_2)^2}{25b}$.

3.3 Case 3: tariff only

Case 3 is the case in which there is only tariff, but no subsidy. In the first stage, the importing government imposes the tariff levels (t_1, t_2) in order to maximize $G_3 = \frac{b}{2}Q^2 + t_1 q_1 + t_2 q_2$, subject to (5). The FOC is as follows:

$$\frac{\partial G_3}{t_i} = bQ(\frac{\partial q_i}{\partial t_i} + \frac{\partial q_j}{\partial t_i}) + q_i + t_i \frac{\partial q_i}{\partial t_i} + t_j \frac{\partial q_j}{\partial t_i} = 0. \quad (7)$$

By substituting $\frac{\partial q_i}{\partial t_i} = -\frac{2}{3b}$ and $\frac{\partial q_j}{\partial t_i} = \frac{1}{3b}$ into (7), we obtain $t_i = bq_i$, which is arranged as $t_i = \frac{a-5c_i+4c_j+7t_j}{11}$. We obtain the equilibrium tariff $(t_1, t_2) = (\frac{2a-3c_1+c_2}{8}, \frac{2a-3c_2+c_1}{8})$. In the equilibrium, the output is $q_i = \frac{2a-3c_i+c_j}{8b}$, the profit, which is equal to the welfare of the exporting country, is $\pi_i = G_i = \frac{(2a-3c_i+c_j)^2}{64b}$, and the welfare of the third country is $G_3 = \frac{(2a-c_1-c_2)^2+2(c_1-c_2)^2}{16b}$.

3.4 Case 4: the simultaneous-move game

In Case 4, both the exporting and importing governments simultaneously execute a subsidy and tariff, respectively. In the first stage, the exporting governments set the subsidy level in order to maximize $G_i = \pi_i - s_i q_i$, subject to (5). The FOC is the same as that in Case 2, that is, (6). By substituting $\frac{\partial q_i}{\partial s_i} = \frac{2}{3b}$ into (6), we obtain $s_i = \frac{b}{2} q_i$. Simultaneously, the importing government sets the tariff level (t_1, t_2) in order to maximize $G_3 = \frac{b}{2}Q^2 + t_1 q_1 + t_2 q_2$, subject to (5). The FOC is the same as that in Case 3, that is, (7). By substituting $\frac{\partial q_i}{\partial t_i} = -\frac{2}{3b}$ and $\frac{\partial q_j}{\partial t_i} = \frac{1}{3b}$ into (7), we obtain $t_i = bq_i$. By arranging $t_i = 2s_i = bq_i$, we obtain $s_i(t_i, t_j) = \frac{a-3c_i+2c_j-3t_i+2t_j}{5}$ and $t_i(s_i, s_j) = \frac{2a-3c_i+c_j+3s_i-s_j}{8}$. By solving the above simultaneous equations, we obtain the subsidy and tariff levels in equilibrium as follows: $(s_1, s_2) = (\frac{3a-5c_1+2c_2}{21}, \frac{3a-5c_2+2c_1}{21})$ and $(t_1, t_2) = (\frac{2(3a-5c_1+2c_2)}{21}, \frac{2(3a-5c_2+2c_1)}{21})$. In the equilibrium, the output is $q_i = \frac{2(3a-5c_i+2c_j)}{21b}$, the profit is $\pi_i = \frac{4(3a-5c_i+2c_j)^2}{441b}$, the welfare of the exporting country is $G_i = \frac{b}{2}q_i^2 = \frac{2(3a-5c_i+2c_j)^2}{441b}$, and the welfare of the third country is calculated as $G_3 = \frac{4(72(a-c_1)(a-c_2)+67(c_1-c_2)^2)}{882b}$.

3.5 Case 5: the sequential-move game in which tariffs are first imposed

Case 5 is a sequential-move game in which the importing government first moves and the exporting governments follow. In the second stage, the exporting governments set the subsidy levels in order to maximize $G_i = \pi_i - s_i q_i$, subject to (5). The FOC is the same as that in Cases 2 and 4, that is, (6). By substituting $\frac{\partial q_i}{\partial s_i} = \frac{2}{3b}$ into (6), we obtain $s_i = \frac{b}{2} q_i$. The reaction function of s_i with respect to (t_i, t_j) is $s_i(t_i, t_j) = \frac{a-3c_i+2c_j-3t_i+2t_j}{5}$. Note that $\frac{\partial s_i(t_i,t_j)}{\partial t_i} = -\frac{3}{5}$ and $\frac{\partial s_i(t_i,t_j)}{\partial t_j} = \frac{2}{5}$.

In the first stage, the importing government imposes the tariff levels (t_1, t_2) in order to maximize $G_3 = \frac{b}{2} Q^2 + t_1 q_1 + t_2 q_2$, subject to (5) and $s_i(t_i, t_j) = \frac{a-3c_i+2c_j-3t_i+2t_j}{5}$. The FOC is as follows:

$$\frac{\partial G_3}{t_i} = bQ\left(\frac{\partial q_i}{\partial t_i} + \frac{\partial q_i}{\partial s_i}\frac{\partial s_i}{\partial t_i} + \frac{\partial q_i}{\partial s_j}\frac{\partial s_j}{\partial t_i} + \frac{\partial q_j}{\partial t_i} + \frac{\partial q_j}{\partial s_i}\frac{\partial s_i}{\partial t_i} + \frac{\partial q_j}{\partial s_j}\frac{\partial s_j}{\partial t_i}\right)$$
$$+ q_i + t_i\left(\frac{\partial q_i}{\partial t_i} + \frac{\partial q_i}{\partial s_i}\frac{\partial s_i}{\partial t_i} + \frac{\partial q_i}{\partial s_j}\frac{\partial s_j}{\partial t_i}\right) + t_j\left(\frac{\partial q_j}{\partial t_i} + \frac{\partial q_j}{\partial s_i}\frac{\partial s_i}{\partial t_i} + \frac{\partial q_j}{\partial s_j}\frac{\partial s_j}{\partial t_i}\right) = 0, \quad (8)$$

where $\frac{\partial q_i}{\partial s_i} = -\frac{\partial q_i}{\partial t_i} = \frac{2}{3b}$, $\frac{\partial q_j}{\partial s_i} = -\frac{\partial q_j}{\partial t_i} = -\frac{1}{3b}$, $\frac{\partial s_i}{\partial t_i} = -\frac{3}{5}$, and $\frac{\partial s_i}{\partial t_j} = \frac{2}{5}$. By substituting the partial derivatives into (8), we obtain $t_i = \frac{b}{2} q_i$, which is arranged as $t_i = \frac{a-3c_i+2c_j+2t_j}{8}$. By arranging the above simultaneous equations and noting that $s_i = t_i = \frac{b}{2} q_i$, we obtain the subsidy and tariff levels in this equilibrium as follows: $(s_1, s_2) = (\frac{a-2c_1+c_2}{6}, \frac{a-2c_2+c_1}{6})$ and $(t_1, t_2) = (\frac{a-2c_1+c_2}{6}, \frac{a-2c_2+c_1}{6})$. In the equilibrium, the output is $q_i = \frac{a-2c_i+c_j}{3b}$, the profit is $\pi_i = \frac{(a-2c_i+c_j)^2}{9b}$, the welfare of the exporting country is $G_i = \frac{b}{2} q_i^2 = \frac{(a-2c_i+c_j)^2}{18b}$, and the welfare of the third country is $G_3 = \frac{(a-c_1)(a-c_2)+(c_1-c_2)^2}{3b}$.

3.6 Case 6: the sequential-move game in which subsidies are first imposed

Case 6 is a sequential-move game in which the exporting governments first move and the importing government follows. In the second stage, the importing government imposes the tariff levels (t_1, t_2) in order to maximize $G_3 = \frac{b}{2} Q^2 + t_1 q_1 + t_2 q_2$, subject to (5). The FOC is the same as that in Cases 3 and 4, that is, (7). By substituting $\frac{\partial q_i}{\partial t_i} = -\frac{2}{3b}$ and $\frac{\partial q_j}{\partial t_i} = \frac{1}{3b}$ into (7), we obtain $t_i = bq_i$. The reaction function of t_i with respect to (s_i, s_j) is $t_i(s_i, s_j) = \frac{2a-3c_i+c_j+3s_i-s_j}{8}$. Note that $\frac{\partial t_i(s_i,s_j)}{\partial s_i} = \frac{3}{8}$ and $\frac{\partial t_i(s_i,s_j)}{\partial s_j} = -\frac{1}{8}$.

In the first stage, the exporting governments noncooperatively set the subsidy levels (s_1, s_2) in order to maximize $G_i = \pi_i - s_i q_i$, subject to (5) and $t_i(s_i, s_j) = \frac{2a-3c_i+c_j+3s_i-s_j}{8}$. The FOC is as follows:

$$\frac{\partial G_i}{\partial s_i} = 2bq_i\left(\frac{\partial q_i}{\partial s_i} + \frac{\partial q_i}{\partial t_i}\frac{\partial t_i}{\partial s_i} + \frac{\partial q_i}{\partial t_j}\frac{\partial t_j}{\partial s_i}\right) - q_i - s_i\left(\frac{\partial q_i}{\partial s_i} + \frac{\partial q_i}{\partial t_i}\frac{\partial t_i}{\partial s_i} + \frac{\partial q_i}{\partial t_j}\frac{\partial t_j}{\partial s_i}\right) = 0, \quad (9)$$

where $\frac{\partial q_i}{\partial s_i} = -\frac{\partial q_i}{\partial t_i} = \frac{2}{3b}$, $\frac{\partial q_j}{\partial s_i} = -\frac{\partial q_j}{\partial t_i} = -\frac{1}{3b}$, $\frac{\partial t_i}{\partial s_i} = \frac{3}{8}$, and $\frac{\partial t_i}{\partial s_j} = -\frac{1}{8}$. By substituting the partial derivatives into (9), we obtain $s_i = -\frac{2b}{3} q_i < 0$, which is arranged as $s_i = -\frac{6a-9c_i+3c_j-s_j}{45}$. By arranging the above simultaneous equations and noting that $t_i = -\frac{3}{2} s_i = bq_i$, we obtain the subsidy and tariff levels in this equilibrium as follows: $(s_1, s_2) = (-\frac{8a-11c_1+3c_2}{56}, -\frac{8a-11c_2+3c_1}{56})$ and $(t_1, t_2) = (\frac{3(8a-11c_1+3c_2)}{112}, \frac{3(8a-11c_2+3c_1)}{112})$.

In the equilibrium, the output is $q_i = \frac{3(8a-11c_i+3c_j)}{112b}$, the profit is $\pi_i = \frac{9(8a-11c_i+3c_j)^2}{12544b}$, the welfare of the exporting country is $G_i = \frac{5b}{3}q_i^2 = \frac{15(8a-11c_i+3c_j)^2}{12544b}$, and the welfare of the third country is $G_3 = \frac{18(128(a-c_1)(a-c_2)+81(c_1-c_2)^2)}{12544b}$.

In Case 6, it should be noted that the equilibrium subsidy is negative. If the negative subsidy is not allowed, the optimal subsidy level is $s_i = 0$. In other words, there is a corner solution. As $t_i(0,0) = \frac{2a-3c_i+c_j}{8}$, when the negative subsidy is not allowed, the equilibrium solution corresponds to that in Case 3. In the following analysis, we assume that the negative subsidy (the export tariff) is allowed.

We summarize the equilibrium results in all the six cases in Table 1.

Table 1: The equilibrium results

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
s_i	0	$\frac{a-3c_i+2c_j}{5}$	0	$\frac{3a-5c_i+2c_j}{21}$	$\frac{a-2c_i+c_j}{6}$	$-\frac{8a-11c_i+3c_j}{56}$
t_i	0	0	$\frac{2a-3c_i+c_j}{8}$	$\frac{2(3a-5c_i+2c_j)}{21}$	$\frac{a-2c_i+c_j}{6}$	$\frac{3(8a-11c_i+3c_j)}{112}$
q_i	$\frac{a-2c_i+c_j}{3b}$	$\frac{2(a-3c_i+2c_j)}{5b}$	$\frac{2a-3c_i+c_j}{8b}$	$\frac{2(3a-5c_i+2c_j)}{21b}$	$\frac{a-2c_i+c_j}{3b}$	$\frac{3(8a-11c_i+3c_j)}{112b}$
Q	$\frac{2a-c_1-c_2}{3b}$	$\frac{2(2a-c_1-c_2)}{5b}$	$\frac{2a-c_1-c_2}{4b}$	$\frac{2(2a-c_1-c_2)}{7b}$	$\frac{2a-c_1-c_2}{3b}$	$\frac{3(2a-c_1-c_2)}{14b}$
p	$\frac{a+c_1+c_2}{3}$	$\frac{a+2c_1+2c_2}{5}$	$\frac{2a+c_1+c_2}{4}$	$\frac{3a+2c_1+2c_2}{7}$	$\frac{a+c_1+c_2}{3}$	$\frac{8a+3c_1+3c_2}{14}$
π_i	$\frac{(a-2c_i+c_j)^2}{9b}$	$\frac{4(a-3c_i+2c_j)^2}{25b}$	$\frac{(2a-3c_i+c_j)^2}{64b}$	$\frac{4(3a-5c_i+2c_j)^2}{441b}$	$\frac{(a-2c_i+c_j)^2}{9b}$	$\frac{9(8a-11c_i+3c_j)^2}{12544b}$
G_i	$\frac{(a-2c_i+c_j)^2}{9b}$	$\frac{2(a-3c_i+2c_j)^2}{25b}$	$\frac{(2a-3c_i+c_j)^2}{64b}$	$\frac{2(3a-5c_i+2c_j)^2}{441b}$	$\frac{(a-2c_i+c_j)^2}{18b}$	$\frac{15(8a-11c_i+3c_j)^2}{12544b}$
G_3	$\frac{(2a-c_1-c_2)^2}{18b}$	$\frac{2(2a-c_1-c_2)^2}{25b}$	$\frac{(2a-c_1-c_2)^2}{16b} + \frac{(c_1-c_2)^2}{8b}$	$\frac{16(a-c_1)(a-c_2)}{49b} + \frac{134(c_1-c_2)^2}{441b}$	$\frac{(a-c_1)(a-c_2)}{3b} + \frac{(c_1-c_2)^2}{3b}$	$\frac{9(a-c_1)(a-c_2)}{49b} + \frac{729(c_1-c_2)^2}{6272b}$
W	$\frac{4(a-c_1)(a-c_2)}{9b} + \frac{11(c_1-c_2)^2}{18b}$	$\frac{12(a-c_1)(a-c_2)}{25b} + \frac{28(c_1-c_2)^2}{25b}$	$\frac{3(a-c_1)(a-c_2)}{8b} + \frac{11(c_1-c_2)^2}{32b}$	$\frac{20(a-c_1)(a-c_2)}{49b} + \frac{64(c_1-c_2)^2}{147b}$	$\frac{4(a-c_1)(a-c_2)}{9b} + \frac{11(c_1-c_2)^2}{18b}$	$\frac{33(a-c_1)(a-c_2)}{98b} + \frac{213(c_1-c_2)^2}{784b}$

The calculation in Table 1 includes the situation in which the exporting firms have different marginal costs. If both the exporting firms are identical, the calculation can be described in a more simplified manner. In order to recognize the relative profit sizes and the extent of welfare, suppose that both firms are identical, that is, $c_1 = c_2 \equiv c$. As the parameters of the demand function, a and b, and the marginal cost c can be normalized by properly transforming the unit of measure, we normalize $a - c = 1$ and $b = 1$ without loss of generality. We summarize the profit and welfare under $a - c = 1$ and $b = 1$ in Table 2.

Table 2: The equilibrium profit and welfares (normalized as $a - c = 1$ and $b = 1$)

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
π_i	$\frac{1}{9} \approx 0.1111$	$\frac{4}{25} = 0.1600$	$\frac{1}{16} = 0.0625$	$\frac{4}{49} \approx 0.0816$	$\frac{1}{9} \approx 0.1111$	$\frac{9}{196} \approx 0.0459$
G_i	$\frac{1}{9} \approx 0.1111$	$\frac{2}{25} = 0.0800$	$\frac{1}{16} = 0.0625$	$\frac{2}{49} \approx 0.0408$	$\frac{1}{18} \approx 0.0555$	$\frac{15}{196} \approx 0.0765$
G_3	$\frac{2}{9} \approx 0.2222$	$\frac{8}{25} = 0.3200$	$\frac{1}{4} = 0.2500$	$\frac{16}{49} \approx 0.3265$	$\frac{1}{3} \approx 0.3333$	$\frac{9}{49} \approx 0.1837$
W	$\frac{4}{9} \approx 0.4444$	$\frac{12}{25} = 0.4800$	$\frac{3}{8} = 0.3750$	$\frac{20}{49} \approx 0.4082$	$\frac{4}{9} \approx 0.4444$	$\frac{33}{98} \approx 0.3367$

4 Comparison

In this section, we compare the cases that differ in the timing of trade policies and present some interesting results, among other observations.

First, by comparing the welfare of the importing country and the world between Case 1 and Case 2, we obtain the following proposition. All proofs are presented in the Appendix.

PROPOSITION 1. *In the absence of a tariff policy, the welfare of the importing country and the world under the subsidy race is higher than the case under free trade. That is,* $G_3^{Case2} > G_3^{Case1}$ *and* $W^{Case2} > W^{Case1}$.

Since Brander and Spencer (1985), it is well-known that with the highly competitive subsidy race among the exporting governments, the exporting countries experience decreased welfare, compared to the no-subsidy case, as was also shown in Table 1. This result is a kind of prisoner's dilemma that occurs in the subsidy choice game that the exporting governments play. However, there is another player in a third-market model, that is, the consumer in the importing country, although this player is inactive in these cases. Proposition 1 implies that due to the severe subsidy competition by both the exporting governments, the importing country obtains higher welfare under the subsidy race than without a subsidy policy. Although Brander and Spencer (1985) show that the exporting countries fall into excessive subsidization, they do not explicitly mention the possibility that the importing country improves the social welfare. Moreover, world welfare also increases when there is a subsidy race. This paper clarifies that the increase in the consumer's surplus in the third market owing to intensified competition under the subsidy race always exceeds the sum of the decrease in the producer's surplus of the exporting firms. Therefore, this proposition suggests that if the subsidy race results in severe competition in a third market, the export subsidization policy by the exporting governments is justified from the viewpoint of both the welfare of the exporting country and world welfare.

Second, we focus on two unilateral interventions, one by the exporting governments and the other by the importing government. We compare the welfare of the importing country and the world welfare in Case 2 with that in Case 3. By comparing the unilateral intervention by the exporting governments with the one by the importing government, we clarify which of the trade policies, subsidy or tariff, has a stronger impact on welfare. We obtain the following proposition.

PROPOSITION 2. *The welfare of the importing country and the world under the unilateral intervention by the exporting governments is higher than that under the unilateral intervention by the importing government. If firm i is not less efficient than firm j, the welfare of the exporting government i under the unilateral intervention by the exporting governments is higher than that under the unilateral intervention by the importing government. That is,* $G_3^{Case2} > G_3^{Case3}$ *and* $W^{Case2} > W^{Case3}$*. If* $c_i \leq c_j$*, then* $G_i^{Case2} > G_i^{Case3}$.

Proposition 2 compares the effect of the unilateral trade policy on the welfare. It shows that the welfare of the importing country under the unilateral intervention by the exporting governments is higher than that under the unilateral intervention by the importing government itself. Moreover, world welfare under the subsidy race with no tariff is shown to exceed that under the tariff imposition with no subsidy. At first glance, it appears that the trade policy chosen by the importing government itself brings about higher welfare for the importing country than when the exporting governments in other countries choose the subsidy policy. However, this proposition suggests that the welfare-improving effect, which promotes competition between firms induced by the subsidy race, exceeds the rent-extracting effect by directly imposing the tariff on the firms. As regards the welfare of the exporting government, when the firm's technology is not less efficient than that of the rival firm, the exporting government obtains higher welfare under the subsidy race without tariff imposition than under the tariff imposition without subsidy race. In particular, if both exporting firms are identical, that is, $c_i = c_j$, the welfare of all countries (and therefore, world welfare) in Case 2 is higher than that in Case 3.

Although this proposition is only a comparison between two different regimes, it suggests that in terms of the impact on the importing country's welfare, the country with a third market prefers promoting competition by exporting countries rather than imposing the tariff by the domestic government itself. From the viewpoint of world welfare and also the importing country's welfare, this proposition supports the justification of the competition policy for the exporting governments to protect exporting industries when there is no domestic firm in the third country's market. If the importing government incurs any administrative costs to implement the tariff policy, it will become more desirable to allow the exporting governments to subsidize firms.

Third, we consider the simultaneous-move game in which both of the exporting and importing governments determine whether or not to implement a trade policy. We examine whether the exporting governments and the importing government implement the export subsidy and the import tariff, respectively, in the simultaneous-move game. By comparing the welfare of the three countries across Cases 1–4, the decision-making of governments about the implementation of a trade policy is derived in equilibrium. The Nash equilibrium for the trade policy choice is summarized in the following proposition.

Proposition 3. *In the simultaneous-move game in which governments determine whether or not to implement a trade policy simultaneously and noncooperatively, the unique Nash equilibrium states that only the importing government should impose a tariff policy and that neither exporting governments should subsidize the firm. That is, Case 3 is the unique Nash equilibrium.*

From Proposition 3, when the three governments determine whether or not to implement a trade policy simultaneously and noncooperatively, the obtained result is Case 3, in which only the importing government imposes a tariff and both exporting governments do not subsidize firms. As shown in Proposition 2, the welfare of the third country and the world in Case 2 is higher than in Case 3, and if both the firms are identical, the welfare of all countries is higher in Case 2 than in Case 3. Moreover, among Cases 1–4, Case 2 presents the highest world welfare. However, in Proposition 3, the players cannot choose Case 2 in the simultaneous-move game in terms of the decision-making regarding the trade policy. Case 3 is chosen in the equilibrium and in this case, the lowest world welfare is obtained of all four cases, Cases 1–4. This result suggests that the noncooperative choice of trade policy by governments causes an undesirable outcome from the viewpoint of world welfare. Therefore, as the WTO has insisted, the import tariff must be eliminated by the binding trade agreements because its elimination leads to higher welfare for the importing country and the world.

Indeed, as shown in the normal-form game representation in Appendix A.3 (Table 3), the tariff imposition is the dominant strategy for the importing government in this game, because in any case the tariff shifts part of profits from the exporting firms to the importing country. When the importing government always chooses to impose the tariff, the exporting governments refrain from granting their firms a subsidy in order to circumvent the excessive competition from the subsidy race and avoid being deprived of their profits. Although the subsidy race promotes competition and provides significant benefits to the third market consumers, the subsidy policy is not implemented by both the exporting governments and only the tariff policy is implemented by the importing government. The tariff imposition restricts competition and leads to a decrease in the consumer's surplus of the third country.

In the previous analysis, we investigated the unilateral interventions by either the exporting governments or the importing government and the simultaneous move bilateral interventions by governments. Next, focusing on the bilateral interventions by both the exporting and importing governments, we proceed to examine the effect that the difference in the policy timing has on the welfare. In the following, the analytical results are presented with regard to three bilateral interventions, namely, Cases 4–6.

First, we consider Case 5, that is, a sequential-move case in which the importing government first moves followed by the exporting governments. By comparing Case 5 with Case 1, we obtain the following proposition.

PROPOSITION 4. *In Case 5, the equilibrium tariff countervails the equilibrium subsidy thoroughly. The equilibrium output, profit, and world welfare in Case 5 are the same as those in Case 1. The welfare of the exporting government in Case 5 is lower than that in Case 1. On the other hand, the welfare of the importing government in Case 5 is higher than that in Case 1. That is,* $s_i^{Case5} = t_i^{Case5}$, $q_i^{Case5} = q_i^{Case1}$, $\pi_i^{Case5} = \pi_i^{Case1}$, $W^{Case5} = W^{Case1}$, $G_i^{Case5} < G_i^{Case1}$, *and* $G_3^{Case5} > G_3^{Case1}$

Proposition 4 implies that in the sequential timing of Case 5, the same equilibrium result as that under free trade is obtained. The tariff set by the importing government at the first stage completely countervails the subsidy that the exporting governments follows with at the second stage, and the subsidy is completely nullified by the tariff. As a result, in this sequential timing, world welfare in equilibrium is the same as that under free trade without any trade policy. Therefore, if the importing government in a country with a third market can choose the tariff level in advance of the exporting governments, after which the exporting governments must determine the subsidy level upon observing the tariff level, then the importing government recovers the same competitive position as in the case of free trade. However, Case 5 is different from Case 1 in terms of the welfare of governments. Although the equilibrium output and profit under sequential timing are the same as under free trade, the importing government as the first-mover decision-maker obtains higher welfare than under free trade. This is because the subsidy race takes place in Case 5, which is different from Case 1, and the importing government can acquire the increase in profits that is caused by promoting competition by means of the import tariff.[5] On the other hand, as part of the profit is diminished by the tariff, the exporting governments obtain less welfare. If the importing government can set the tariff first, it can acquire the first-mover advantage.

Second, we consider Case 6, that is, the sequential-move case in which the exporting governments

[5] Further, it is shown that in all the cases, Cases 1–6, the welfare of the importing country in Case 5 is the highest.

make the first move and the importing government follows. We obtain the following proposition.

Proposition 5. *In Case 6, the equilibrium subsidy is negative. That is,* $s_i^{Case6} < 0$.

When the exporting governments first move, they impose a negative subsidy. That is, the exporting governments impose an export tariff on their exporting firm. Anticipating that the importing government deprives the exporting firms of profit by levying the tariff at the second stage, the exporting governments impose an export tax on the firms at the first stage in order to reduce the rent that is shifted to the importing country. Under this decision-making timing, the shrinking quantity results in the deterioration of social welfare.[6]

In Case 6, after the subsidy is granted, the importing government levies the tariff. The tariff has the same role as countervailing duties (CVDs). This proposition clarifies that CVDs reduce the importing country's welfare and also world welfare in particular. As CVDs shrink the quantity levels excessively, they do not function effectively in a third-market model. Therefore, Proposition 5 implies that if the importing government sets CVDs after the exporting governments set a subsidy, the CVDs shrink the market excessively. With this policy timing, the CVDs work in a direction to reduce the trade. This proposition suggests that some regulations on CVDs are required in order to avoid the excessive rent-shifting.

Finally, in order to examine how the different timing of trade policy affects welfare, we compare the equilibrium in a simultaneous-move game and two sequential-move games. The size relation of the equilibrium variables in Cases 4–6 is summarized in Table 4 in Appendix A.6. By comparing the welfare of the importing country and world welfare under three bilateral interventions, we summarize the main proposition as follows.

Proposition 6. *In all bilateral interventions in which the timing of trade policies differ, the welfare of the importing country and the world is the highest in Case 5 and the lowest in Case 6. Moreover, world welfare in Case 5 is equal to that under free trade. That is,* $G_3^{Case5} > G_3^{Case4} > G_3^{Case6}$ *and* $W^{Case5} = W^{Case1} > W^{Case4} > W^{Case6}$.

When the importing government first chooses the import tariff and then the exporting governments subsidizes the firms, the importing country obtains the highest welfare. In reality, in all the six cases, the

[6] As export tariffs are no longer levied in many countries nowadays, the result of Proposition 5 may not be realistic. However, if we interpret the negative subsidy in a broader sense, the situation that Proposition 5 implies might be interpreted as that in which various regulations to the exporting industry, such as voluntary export restraints (VERs) and trade restrictions, are set by the exporting government on the exporting industry in order to avoid the outflow of national wealth.

importing country's welfare is the highest in Case 5. Moreover, among all three bilateral interventions, the highest world welfare is obtained in Case 5, equal to world welfare under free trade. Thus, the timing of Case 5 is preferred from the viewpoint of world welfare. Even when an import tariff is levied by the importing government, if it is levied under a proper sequential timing in which the importing government first moves, then world welfare can be higher, as in the case of free trade. Proposition 6 suggests how it is important to ensure that trade policies are properly timed, and it justifies the import tariff from the point of view of the third country's welfare and also the world welfare. If the trade policies are timed properly, the appropriate combination of trade policies will not necessarily decrease the world welfare.

5 Conclusion

This paper examined how the difference in the timing of trade policy implementation affects the firm's profit and welfare in a third market model. We compared the outcome of trade policies implemented at different times, and obtained the following main results. First, the welfare of the importing country and the world under the subsidy race is higher than under free trade (Proposition 1). Second, the welfare of the importing country and the world under the unilateral intervention by the exporting governments is higher than under the unilateral intervention by the importing government (Proposition 2). Third, in the simultaneous-move game in which governments determine whether or not to implement trade policy, the unique Nash equilibrium states that only the importing government should impose a tariff policy and that neither of the exporting governments should subsidize the firm (Proposition 3). These results suggest that although the subsidy race by the exporting governments improves the third country's welfare and also world welfare, in the simultaneous-move game of the choice of trade policies, the subsidy policy is not chosen by both exporting governments in equilibrium.

The paper also examined the effect that the difference in the timing of trade policy implementation has on welfare. Fourth, in a sequential-move case in which the importing government first moves, the equilibrium tariff countervails the equilibrium subsidy thoroughly, and the equilibrium output, profit, and world welfare are the same as under free trade (Proposition 4). Fifth, in a sequential-move case in which the exporting governments move first, the equilibrium subsidy is negative and the equilibrium output shrinks (Proposition 5). Finally, the welfare of the third country and the world is highest when the importing government moves first and the lowest when the exporting governments move first (Proposition 6). As for the timing of trade policies, we should choose the timing in which case the importing government moves first in order to obtain higher world welfare, because in this case, severe competition between exporting firms is promoted through the subsidy race. This proposition suggests that in order to determine whether a trade policy improves the welfare effectively, we should be careful when the policy is implemented.

We conclude the paper with a set of possible extensions. Our paper treats the timing of trade policy implementation exogenously. One extension is to endogenize the timing of trade policy implementation by the governments and clarify the equilibrium choice in the game of the timing choice. Another extension concerns multiple importing countries. In the case of multiple market countries, competition between the importing governments to attract export goods might ensue. Although the tariff imposed may reduce here, how this reduction affects the importing country's welfare and world welfare is an open question.

References

[1] Brander, J. A. (1995) 'Strategic Trade Policy', in G. Grossman and K. Rogoff (eds), *Handbook of International Economics, Vol.3*. Amsterdam: North-Holland. 1395–1455.

[2] Brander, J. A. and B. J. Spencer (1985) 'Export Subsidies and Market Share Rivalry', *Journal of International Economics* 18, 83–100.

[3] Cheng, L. K. (1988) 'Assisting Domestic Industries under International Oligopoly: The Relevance of the Nature of Competition to Optimal Policies', *American Economic Review* 78, 746–758.

[4] Collie, D. R. (1994) 'Endogenous Timing in Trade Policy Games: Should Governments Use Countervailing Duties?', *Review of World Economics* 130, 191–209.

[5] Cooper, R. and R. Riezman (1989) 'Uncertainty and the Choice of Trade Policy in Oligopolistic Industries', *Review of Economic Studies* 56, 129–140.

[6] Dixit, A. (1984) 'International Trade Policy for Oligopolistic Industries', *Economic Journal* 94, 1–16.

[7] Eaton, J. and G. M. Grossman (1986) 'Optimal Trade and Industrial Policy under Oligopoly', *Quarterly Journal of Economics* 101, 383–406.

[8] Grossman, G. M. and G. Maggi (1999) 'Free Trade vs. Strategic Trade: A Peek into Pandora's Box', in R. Sato, R. V. Ramachandran and K. Mino (eds), *Global Competition and Integration*. Boston: Kluwer Academic Publishers. 9–32.

[9] Helpman, E. and P. R. Krugman (1989) *Trade Policy and Market Structure*. Cambridge: MIT Press.

[10] Horstmann, I. J. and J. R. Markusen (1992) 'Endogenous Market Structures in International Trade (Natura Facit Saltum)', *Journal of International Economics* 32, 109–129.

[11] Maggi, G. (1996) 'Strategic Trade Policies with Endogenous Mode of Competition', *American Economic Review* 86, 237–258.

[12] Maggi, G. (1999) 'Strategic Trade Policy under Incomplete Information', *International Economic Review* 40, 571–594.

[13] Nomura, R. (2005) 'Voluntary Formation of a Free Trade Area under Endogenous Policy Timing in a Three-country Model', *Ritsumeikan Economic Review* 54, 383–395.

[14] Ohkawa, T., M. Okamura and M. Tawada (2002) 'Endogenous Timing and Welfare in the Game of Trade Policies under International Oligopoly', in A. Woodland (ed), *Economic Theory and International Trade: Essays in Honor of Murray C. Kemp*. Cheltenham: Edward Elgar. 218–231.

[15] Supasri, Y. and M. Tawada (2007) 'Endogenous Timing in a Strategic Trade Policy Game: A Two-country Oligopoly Model with Multiple Firms', *Review of Development Economics* 11, 275–290.

Appendix

A.1. *Proof of Proposition 1*

Proof. $G_3^{Case2} - G_3^{Case1} = \frac{11(2a-c_1-c_2)^2}{450b} > 0$. $W^{Case2} - W^{Case1} = \frac{8(a-c_1)(a-c_2)}{225b} + \frac{229(c_1-c_2)^2}{450b} > 0$. □

A.2. *Proof of Proposition 2*

Proof. $G_3^{Case2} - G_3^{Case3} = \frac{7(2a-c_1-c_2)^2-50(c_1-c_2)^2}{400b} = \frac{28(a-c_1)(a-c_2)-43(c_1-c_2)^2}{400b}$. For quantity to be positive, $a - c_i > 2(c_i - c_j)$ must be satisfied. Under this assumption, it is shown that the numerator of the above equation is positive, because $28(a-c_1)(a-c_2) - 43(c_1-c_2)^2 > 69(c_1-c_2)^2 \geq 0$. $W^{Case2} - W^{Case3} = \frac{21(a-c_1)(a-c_2)}{200b} + \frac{621(c_1-c_2)^2}{800b} > 0$. $G_i^{Case2} - G_i^{Case3} = \frac{28(a-3c_i+2c_j)^2-75(c_i-c_j)(4a-9c_i+5c_j)}{1600b} > 0$ if $c_i \leq c_j$. □

A.3. *Proof of Proposition 3*

Proof. Consider the simultaneous-move game for three players, two exporting governments, and an importing government. Depending on whether or not the government implements the trade policy, there are $2 \times 2 \times 2 = 8$ cases. The case in which all governments do not exercise any trade policies corresponds to Case 1. Likewise, the case in which only both exporting governments exercise subsidization is Case 2, the one in which the importing government imposes the tariff is Case 3, and the one in which all governments implement trade policy is Case 4. There are two other possible cases in the game. One is the case in which only an exporting government exercises subsidization, and the other is the case in which an exporting government and the importing government implement subsidy and tariff policy, respectively. In the former case, we obtain the subsidy, $(s_i, s_j) = (\frac{a-2c_i+c_j}{4}, 0)$. The output is $(q_i, q_j) = (\frac{a-2c_i+c_j}{2b}, \frac{a-3c_j+2c_i}{4b})$, and the profit is $(\pi_i, \pi_j) = (\frac{(a-2c_i+c_j)^2}{4b}, \frac{(a-3c_j+2c_i)^2}{16b})$. The welfare of the exporting country is $(G_i, G_j) = (\frac{(a-2c_i+c_j)^2}{8b}, \frac{(a-3c_j+2c_i)^2}{16b})$, and the welfare of the importing country is $G_3 = \frac{(3a-2c_i-c_j)^2}{32b}$.

In the latter case, the reaction functions of the exporting government and the importing government are the same as those in Case 4 except $s_j = 0$. As $s_i = \frac{b}{2}q_i$, $t_i = bq_i$, and $t_j = bq_j$ from the reaction functions, $t_i = 2s_i$ is satisfied. By solving the above simultaneous equations, we obtain the subsidy and tariffs, $(s_i, s_j) = (\frac{2a-3c_i+c_j}{13}, 0)$ and $(t_i, t_j) = (\frac{2(2a-3c_i+c_j)}{13}, \frac{3a-5c_j+2c_i}{13})$. The output is $(q_i, q_j) = (\frac{2(2a-3c_i+c_j)}{13b}, \frac{3a-5c_j+2c_i}{13b})$, and the profit is $(\pi_i, \pi_j) = (\frac{4(2a-3c_i+c_j)^2}{169b}, \frac{(3a-5c_j+2c_i)^2}{169b})$. The welfare of the exporting country is $(G_i, G_j) = (\frac{2(2a-3c_i+c_j)^2}{169b}, \frac{(3a-5c_j+2c_i)^2}{169b})$, and the welfare of the importing country is $G_3 = \frac{99(a-c_i)(a-c_j)-(c_i-c_j)(29(a-c_i)-67(c_i-c_j))}{338b}$.

By combining the above results with those in Cases 1–4, the normal-form representation of this game is depicted in Table 3.

Define the welfare of exporting country i as $G_i(s_i; s_j, s_3)$ and that of importing country 3 as $G_3(s_3; s_1, s_2)$, where s_i denotes the strategy of government i. Let us denote by N the choice for a government not to implement the trade policy, by S the subsidization, and by T the levy of the tariff. That is, $s_i = \{N, S\}$ for $i = 1, 2$, and $s_3 = \{N, T\}$. By simple calculation based on Table 3, $G_i(N; s_j, N) < G_i(S; s_j, N)$ and $G_i(N; s_j, T) > G_i(S; s_j, T)$ are satisfied for all $s_j = \{N, S\}$.[7] Concerning G_3, $G_3(N; s_1, s_2) < G_3(T; s_1, s_2)$ is satisfied for all $s_i, s_j = \{N, S\}$.[8] That is, T is the dominant strategy for the importing government. Therefore, $(s_1, s_2, s_3) = (N, N, T)$ is the unique Nash equilibrium. In other words, the unique Nash equilibrium in this three-player game is that both the exporting governments do not subsidize and only the

[7] $G_i(S;N,N) - G_i(N;N,N) = \frac{(a-2c_i+c_j)^2}{72b} > 0$, $G_i(S;S,N) - G_i(N;S,N) = \frac{7(a-3c_i+2c_j)^2}{400b} > 0$, $G_i(N;N,T) - G_i(S;N,T) = \frac{41(2a-3c_i+c_j)^2}{2^6 \times 13^2 b} > 0$, and $G_i(N;S,T) - G_i(S;S,T) = \frac{103(3a-5c_i+2c_j)^2}{3^2 \times 7^2 \times 13^2 b} > 0$.

[8] $G_3(T;N,N) - G_3(N;N,N) = \frac{(2a-c_1-c_2)^2}{144b} + \frac{(c_1-c_2)^2}{8b} > 0$ and $G_3(T;S,S) - G_3(N;S,S) = \frac{8(a-c_1)(a-c_2)}{5^2 \times 7^2 b} + \frac{4 \times 617(c_1-c_2)^2}{3^2 \times 5^2 \times 7^2 b} > 0$. When $(s_i, s_j) = (S, N)$, $G_3(T; s_i, s_j) - G_3(N; s_i, s_j) = \frac{(a-c_j)(20(a-c_i)+43(a-c_j))+860(c_i-c_j)^2}{2^5 * 13^2 b} > 0$.

Table 3: Normal-form representation of the three-player game

Gov. 1 \ Gov. 2	N	S
N	(Case 1) $\frac{(a-2c_1+c_2)^2}{9b}$ $\frac{(a-2c_2+c_1)^2}{9b}$ $\frac{(2a-c_1-c_2)^2}{18b}$	$\frac{(a-3c_1+2c_2)^2}{16b}$ $\frac{(a-2c_2+c_1)^2}{8b}$ * $\frac{(3a-2c_2-c_1)^2}{32b}$
S	$\frac{(a-2c_1+c_2)^2}{8b}$ * $\frac{(a-3c_2+2c_1)^2}{16b}$ $\frac{(3a-2c_1-c_2)^2}{32b}$	(Case 2) $\frac{2(a-3c_1+2c_2)^2}{25b}$ * $\frac{2(a-3c_2+2c_1)^2}{25b}$ * $\frac{2(2a-c_1-c_2)^2}{25b}$

when Gov. 3 chooses N

Gov. 1 \ Gov. 2	N	S
N	(Case 3) $\frac{(2a-3c_1+c_2)^2}{64b}$ * $\frac{(2a-3c_2+c_1)^2}{64b}$ * $\frac{(2a-c_1-c_2)^2+2(c_1-c_2)^2}{16b}$ *	$\frac{(3a-5c_1+2c_2)^2}{169b}$ * $\frac{2(2a-3c_2+c_1)^2}{169b}$ $\frac{99(a-c_1)(a-c_2)-(c_2-c_1)(29(a-c_2)-67(c_2-c_1))}{338b}$ *
S	$\frac{2(2a-3c_1+c_2)^2}{169b}$ $\frac{(3a-5c_2+2c_1)^2}{169b}$ * $\frac{99(a-c_1)(a-c_2)-(c_1-c_2)(29(a-c_1)-67(c_1-c_2))}{338b}$ *	(Case 4) $\frac{2(3a-5c_1+2c_2)^2}{441b}$ $\frac{2(3a-5c_2+2c_1)^2}{441b}$ $\frac{4(72(a-c_1)(a-c_2)+67(c_1-c_2)^2)}{882b}$ *

when Gov. 3 chooses T

Gov. 1 and Gov. 2 denote the exporting governments 1 and 2, respectively, and Gov. 3 denotes the importing government. Gov. 1 and Gov. 2 choose whether or not to subsidize and Gov. 3 chooses whether or not to impose a tariff. N denotes that the government does not implement the trade policy, S denotes subsidizing, and T denotes levying the tariff. The payoff matrix is placed in the order of (G_1, G_2, G_3). We put an asterisk into the maximum profit when a player chooses the best-response strategy given the strategies of other governments.

Table 4: Comparison of the equilibrium variables

s_i	$s_i^{Case5} > s_i^{Case4} > 0 > s_i^{Case6}$	if $a-c_i > 3(c_i-c_j)$
	$s_i^{Case4} > s_i^{Case5} > 0 > s_i^{Case6}$	if $a-c_i \in (2(c_i-c_j), 3(c_i-c_j))$
t_i	$t_i^{Case4} > t_i^{Case6} > t_i^{Case5}$	if $a-c_i > -\frac{29}{16}(c_i-c_j)$
	$t_i^{Case4} > t_i^{Case5} > t_i^{Case6}$	if $a-c_i < -\frac{29}{16}(c_i-c_j)$
q_i	$q_i^{Case5} > q_i^{Case4} > q_i^{Case6}$	if $a-c_i > 3(c_i-c_j)$
	$q_i^{Case4} > q_i^{Case5} > q_i^{Case6}$	if $a-c_i \in (\frac{85}{40}(c_i-c_j), 3(c_i-c_j))$
	$q_i^{Case4} > q_i^{Case6} > q_i^{Case5}$	if $a-c_i \in (2(c_i-c_j), \frac{85}{40}(c_i-c_j))$
Q	$Q^{Case5} > Q^{Case4} > Q^{Case6}$	
p	$p^{Case6} > p^{Case4} > p^{Case4}$	
π_i	$\pi_i^{Case5} > \pi_i^{Case4} > \pi_i^{Case6}$	if $a-c_i > 3(c_i-c_j)$
	$\pi_i^{Case4} > \pi_i^{Case5} > \pi_i^{Case6}$	if $a-c_i \in (\frac{85}{40}(c_i-c_j), 3(c_i-c_j))$
	$\pi_i^{Case4} > \pi_i^{Case6} > \pi_i^{Case5}$	if $a-c_i \in (2(c_i-c_j), \frac{85}{40}(c_i-c_j))$
G_i	$G_i^{Case6} > G_i^{Case5} > G_i^{Case4}$	if $a-c_i > 3(c_i-c_j)$
	$G_i^{Case6} > G_i^{Case4} > G_i^{Case5}$	if $a-c_i \in (-\frac{2\sqrt{30}-1}{24}(c_i-c_j), 3(c_i-c_j))$
	$G_i^{Case4} > G_i^{Case6} > G_i^{Case5}$	if $a-c_i \in (-\frac{105\sqrt{30}+379}{296}(c_i-c_j), -\frac{2\sqrt{30}-1}{24}(c_i-c_j))$
	$G_i^{Case4} > G_i^{Case5} > G_i^{Case6}$	if $a-c_i < -\frac{105\sqrt{30}+379}{296}(c_i-c_j)$
G_3	$G_3^{Case5} > G_3^{Case4} > G_3^{Case6}$	
W	$W^{Case5} > W^{Case4} > W^{Case6}$	

importing government implements the tariff policy. □

A.4. *Proof of Proposition 4*

Proof. As shown in Table 3, $s_i^{Case5} = t_i^{Case5} = \frac{a-2c_i+c_j}{6}$. $q_i^{Case5} = q_i^{Case1} = \frac{a-2c_i+c_j}{3b}$, $\pi_i^{Case5} = \pi_i^{Case1} = \frac{(a-2c_i+c_j)^2}{9b}$, $W^{Case5} = W^{Case1} = \frac{4(a-c_1)(a-c_2)}{9b} + \frac{11(c_1-c_2)^2}{18b}$, $G_i^{Case1} - G_i^{Case5} = \frac{(a-2c_i+c_j)^2}{18b} > 0$, and $G_3^{Case5} - G_3^{Case1} = \frac{2(a-c_1)(a-c_2)+5(c_1-c_2)^2}{18b} > 0$. □

A.5. *Proof of Proposition 5*

Proof. $s_i^{Case6} = -\frac{8a-11c_i+3c_j}{56} < 0$. □

A.6. *Comparison of the equilibrium variables under the bilateral interventions*

The comparison of the equilibrium variables is summarized in Table 4. $s_i^{Case5} - s_i^{Case4} = \frac{a-c_i-3(c_i-c_j)}{42} > 0$. $t_i^{Case4} - t_i^{Case5} = \frac{5(a-c_i)-(c_i-c_j)}{42} > 0$ because when $c_i \leq c_j$, the inequality obviously holds and when $c_i > c_j$, $a-c_i > 2(c_i-c_j)(> \frac{1}{5}(c_i-c_j))$ holds. Likewise, $t_i^{Case4} - t_i^{Case6} = \frac{24(a-c_i)-37(c_i-c_j)}{336} > 0$. $t_i^{Case6} - t_i^{Case5} = \frac{16(a-c_i)+29(c_i-c_j)}{336}$. When $c_i \geq c_j$, the difference is positive. When $c_i < c_j$, if $a-c_i > -\frac{29}{16}(c_i-c_j)$, $t_i^{Case6} > t_i^{Case5}$ and vice versa. $q_i^{Case5} - q_i^{Case4} = \frac{(a-c_i)-3(c_i-c_j)}{21b}$. $q_i^{Case4} - q_i^{Case6} = \frac{24(a-c_i)-37(c_i-c_j)}{336b} > 0$. $q_i^{Case5} - q_i^{Case6} = \frac{40(a-c_i)-85(c_i-c_j)}{336b} > 0$ if $a-c_i > \frac{85}{40}(c_i-c_j)$ and vice versa. $Q^{Case5} - Q^{Case4} = \frac{2a-c_1-c_2}{21b} >$

0. $Q^{Case4} - Q^{Case6} = \frac{2a-c_1-c_2}{14b} > 0$. As $Q^{Case5} > Q^{Case4} > Q^{Case6}$, $p^{Case6} > p^{Case4} > p^{Case5}$. As $\pi_i = bq_i^2$, the size of π_i corresponds to the size of q_i. In Cases 4 and 5, as $G_i = \frac{b}{2}q_i^2$, $q_i^{Case4} \gtreqless q_i^{Case5}$ if and only if $G_i^{Case4} \gtreqless G_i^{Case5}$. In Case 6, as $G_i^{Case6} = \frac{5b}{3}q_i^2$, $G_i^{Case6} \gtreqless G_i^{Casek}$ if and only if $q_i^{Case6} \gtreqless \frac{\sqrt{30}}{10}q_i^{Casek}$, $k = 4, 5$. $q_i^{Case6} > \frac{\sqrt{30}}{10}q_i^{Case4}$ if and only if $a - c_i > -\frac{2\sqrt{30}-1}{24}(c_i - c_j)$; $\frac{2\sqrt{30}-1}{24} \approx 0.4148$. $q_i^{Case6} > \frac{\sqrt{30}}{10}q_i^{Case5}$ if and only if $a - c_i > -\frac{105\sqrt{30}+379}{296}(c_i - c_j)$; $\frac{105\sqrt{30}+379}{296} \approx 3.223$. $G_3^{Case5} - G_3^{Case4} = \frac{3(a-c_1)(a-c_2)+13(c_1-c_2)^2}{441b} > 0$. $G_3^{Case4} - G_3^{Case6} = \frac{7(a-c_1)(a-c_2)}{49b} + \frac{1513(c_1-c_2)^2}{8064b} > 0$. $W^{Case5} - W^{Case4} = \frac{32(a-c_1)(a-c_2)+155(c_1-c_2)^2}{882b} > 0$. $W^{Case4} - W^{Case6} = \frac{24(a-c_1)(a-c_2)+55(c_1-c_2)^2}{336b} > 0$.

A.7. *Proof of Proposition 6*

Proof. $G_3^{Case5} - G_3^{Case4} = \frac{3(a-c_1)(a-c_2)+13(c_1-c_2)^2}{441b} > 0$. $G_3^{Case4} - G_3^{Case6} = \frac{7(a-c_1)(a-c_2)}{49b} + \frac{1513(c_1-c_2)^2}{8064b} > 0$. $W^{Case5} - W^{Case4} = \frac{32(a-c_1)(a-c_2)+155(c_1-c_2)^2}{882b} > 0$. $W^{Case4} - W^{Case6} = \frac{24(a-c_1)(a-c_2)+55(c_1-c_2)^2}{336b} > 0$. □