

## STRATEGIC TRADE POLICIES IN INTERNATIONAL RIVALRY WHEN COMPETITION MODE IS ENDOGENOUS\*

KANGSIK CHOI

*Graduate School of International Studies, Pusan National University  
Busan 46241, Republic of Korea  
choipnu@pusan.ac.kr*

KI-DONG LEE\*\*

*Department of International Commerce Keimyung University  
Daegu 42601, Republic of Korea  
kdlee@kmu.ac.kr*

SEONYOUNG LIM

*Investment Promotion Division, Busan Metropolitan City  
Busan 47545, Republic of Korea  
syylim220@gmail.com*

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### *Abstract*

We investigate government subsidy policy where a domestic and a foreign firm can choose either price or quantity in a third-country market. We demonstrate that even though firms can earn higher profits under Cournot competition than under Bertrand competition regardless of nature of goods, choosing Bertrand competition is the dominant strategy for firms. This leads firms to face prisoners' dilemma. However, trade liberalization brings about a change from Bertrand to Cournot and increases equilibrium profits if goods are substitutes. If goods are complements, Bertrand competition prevails in spite of the government non-intervention. Hence, a move toward free trade increases not only firms' profits, but also social welfare of both countries irrespective of the nature of goods.

*Keywords:* subsidy, Cournot, Bertrand, social welfare, prisoners' dilemma

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\*\* Corresponding Author

## I. *Introduction*

Strategic trade policy analysis has attracted much attention since the beginning of the 1980s. The theory of strategic export policy for oligopolies started with pioneering work by Brander and Spencer (1985). In their model, a domestic government first decides upon an export subsidy and then a home firm and a foreign firm compete in a third-country market. They show that an export subsidy is optimal under Cournot competition, whereas Eaton and Grossman (1986) demonstrate that an export tax is optimal under Bertrand competition in the third market<sup>1</sup>. Main stream economists have focused on extensions and generalizations of the work by Brander and Spencer (1985) and Eaton and Grossman (1986). Among them are de Meza (1986), Bandyopadhyay (1997), Neary and Leahy (2000), Collie and de Meza (2003), and Clarke and Collie (2006, 2008).

However, the theory of strategic trade policy has faced criticisms that the predictions of the theory are very sensitive to the nature of market structure, in particular, the mode of competition. In fact, some studies show that the appropriate export policy depends on the number of competitors (Dixit, 1984) and the extent to which there are barriers to entry (Etro, 2011). Reflecting the criticism, a number of theoretical studies have examined the relationship between competition mode and optimal trade policies in the strategic trade policy framework. Among them are Cheng (1988), Bagwell and Staiger (1994), Kikuchi (1998), Schroeder and Tremblay (2015) and Ghosh and Pal (2014).

Cheng (1988) derives optimal tariffs and production subsidies under Cournot and Bertrand competition with differentiated products and shows that the optimal tariff is lower under Bertrand competition than under Cournot competition. Bagwell and Staiger (1994) indicate that R&D subsidies are the best policy under both Cournot and Bertrand competition. Schroeder and Tremblay (2015) investigates the welfare effect of an export subsidy or tax in the third market trade model by allowing firms to compete in a heterogeneous contract mode, where one firm competes in output while the other competes in prices.<sup>2</sup> Ghosh and Pal (2014) analyze strategic trade policy for differentiated network goods oligopolies by comparing only Cournot versus Bertrand competition modes. On the other hand, using capacity-constrained price model Maggi (1996) shows that, under strategic export policy, a capacity subsidy is generally a welfare-improving policy regardless of the competition mode.

What should be noted in the above studies, however, is that although they focus on the importance of competition mode in the optimal trade policy, they do not consider the endogenous choice of competition mode except for Maggie (1996). In effect, the existing literature on strategic trade policy has paid relatively little attention to the endogenous choice of strategic variables for prices or quantities in a context that includes a government subsidy or tax

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<sup>1</sup> For more detailed discussion of subsidy policy, see Dixit and Kyle (1985), Horstmann and Markusen (1986), Cooper and Riezman (1989), Brainard and Martimort (1997), Hwang and Mai (2007), and Brander (1995) and references therein.

<sup>2</sup> As will be mentioned later, we consider a standard third-country model, where two exporting firms each located in two different countries sell their products to the third country market. However, unlike Schroeder and Tremblay (2015), where competition mode (i.e., one firm competes in output and the other competes in price) is exogenous, this paper allows firms to choose their strategic variables, price or quantity, in an export rivalry model. Therefore, in our model, the competition mode is determined endogenously by the firms' choice of strategic variables.

regime<sup>3</sup>. As Singh and Vives (1984) and Klemperer and Meyer (1986) pointed out, firms often choose whether to adopt a price contract or a quantity contract. And this is true in international trade context. In this respect, it is important to analyze how firms endogenously choose their strategic variable between quantities and prices in international trade.

Given the above discussion, this paper addresses how the endogenous choice of strategic variables for prices or quantities affects firms' profits and social welfare when a home firm and a foreign firm compete in a third market, by comparing strategic trade policies with laissez-faire equilibrium, which arises from a commitment to non-intervention on the part of the governments. A key paper in this area is Singh and Vives (1984). They are the first to demonstrate, from the standpoints of consumer surplus and social welfare, that Bertrand competition is more efficient than Cournot competition regardless of the nature of goods. They also have shown that when goods are substitutes, Cournot equilibrium profits are higher than Bertrand equilibrium profits, and vice versa, when goods are complements. Considering the industrial organization context, various strands of the literature have produced extensions and generalizations of work by Singh and Vives (1984)<sup>4</sup>.

The main results of our paper are as follows. First, we show that Prisoner's Dilemma situation arises in the determination of competition mode. That is, even though each firm can earn higher profits under Cournot competition than under Bertrand competition regardless of the nature of goods, choosing Bertrand competition is the dominant strategy for both firms when they export their output to a third country market with strategic trade policy. Second, if the optimal trade policies are implemented by the governments, Cournot competition is more socially desirable than Bertrand competition when goods are substitutes, and vice versa when goods are complements. Additionally, we demonstrate that the government's commitment to non-intervention in international trade, such as formation of free trade agreements, brings about a shift in the competition mode from Bertrand competition to Cournot competition and subsequently increases equilibrium profits, if the goods are substitutes. If the goods are complements, Bertrand competition prevails in the market in spite of the government non-intervention policy in international trade. Hence, an exogenous move toward free trade increases not only a firm's profits but also the social welfare of both countries irrespective of the nature of goods.

The main contributions of this paper to the literature are as follows. First, unlike traditional models of strategic trade policy, the mode of competition is determined by the endogenous choice of a strategic variable (quantity or price) for an oligopolistic competition where home and foreign firms compete in the third country market. We adopt a standard export rivalry model with a linear demand for differentiated goods. We find that if optimal trade policies are implemented by the governments, firms choose the price contract. Thus, Bertrand competition occurs regardless of whether goods are substitutes or complements.

Second, we need to clarify the differences of this paper to the study of Maggie (1996), which examines the trade policies with endogenous mode of competition. Using a capacity-

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<sup>3</sup> In reality, it is often observed that firms choose different variables (Cournot-Bertrand competition) in one market. For example, Scion dealers act as price competition while Honda dealers act as quantity competition in the US small car market (Tremblay *et al.*, 2013).

<sup>4</sup> For example, one strand that focuses on extensions and generalizations of their study, Dastidar (1997), Qiu (1997), Lambertini (1997), Hackner (2000), and Zanchettin (2006) reveals counter-results based on the original framework by allowing for a wider range of cost and demand asymmetries.

price competition model, Maggie (1996) found that the equilibrium outcome is somewhere in between the Bertrand and Cournot outcomes, moving gradually towards the Cournot equilibrium as the significance of the capacity increases. Thus, the competition mode is said to be endogenous in the sense that the equilibrium outcome ranges from the Bertrand to the Cournot outcome depending on the significance of capacity constraints<sup>5</sup>. However, in our model, oligopolistic firms simultaneously choose their strategic variable, price or quantity, in an export rivalry model, and thus, the mode of competition is endogenously determined by the strategic interactions of firms. Thus, this paper contributes to the literature on strategic trade policy by firstly considering endogenous choice of strategic variables<sup>6</sup>. Unlike Maggie (1996), there is neither capacity constraint nor the capacity subsidy as a government policy in our model.

The paper is organized as follows. Section 2 outlines the third-market model. Section 3 analyzes market equilibrium with competition modes under a subsidy regime. Section 4 determines the logic behind the choice of competition mode under a subsidy regime. Section 5 analyzes the effect of free trade with a subsidy regime in place. Section 6 concludes.

## II. *The Third-Market Model*

Following Brander and Spencer (1985), we use the third-market model of international trade under oligopolistic competition. We analyze the market for a differentiated good that is produced by two firms (firm 1 and 2), each located in a different country (country 1 and 2, respectively). These firms compete in a third-country market, in other words their total outputs are exported to a third-country market<sup>7</sup>. The inverse demand functions for good  $i$  can be written as follows:

$$p_i = 1 - x_i - bx_j; \quad i, j = 1, 2 \text{ and } i \neq j, \quad (1a)$$

where  $p_i$  and  $q_i$  refer the market price and the output level of firm  $i$ , respectively. The parameter  $b$  ( $\in (-1, 1)$ ) denotes the type of interaction (substitutability or complementarity) between good  $i$  and good  $j$ . That is, the goods are substitutes, independent, or complements according to whether  $b$  is positive, zero, or negative, respectively. The corresponding direct demand function is given by

$$x_i = \frac{1 - b - p_i + bp_j}{1 - b^2}; \quad i, j = 1, 2, \quad i \neq j. \quad (1b)$$

<sup>5</sup> Maggie (1996) also studies how government could use strategic trade policy under different information constraints. In our paper, we do not consider information issues and capacity constraint price model, which differs from previous work.

<sup>6</sup> In international trade, subsidies come in a variety of methods such as low-interest loans, government-financed international advertisement etc. Thus, the subsidies may cause trade disputes since direct subsidies are prohibited under WTO. There are over 100 trade disputes for subsidies and countervailing duties in international trade such as Mexico government complaint about China government subsidy to its firm where Mexico and China firms compete in the US markets for apparel and textile products. For more details, refer to the website (<http://www.wto.org>).

<sup>7</sup> The third-country market assumption implies that consumer surplus does not enter the domestic country's welfare function, which allows us to focus on the strategic interaction between firms under oligopolistic competition.

Without loss of generality, we assume zero marginal production costs. Let  $s_i$  be the exports subsidy received per unit of output by firm  $i$ . The firm's profits are given by

$$\pi_i = (p_i + s_i)x_i; \quad i, j = 1, 2. \quad (2)$$

Since there is no domestic consumption, the welfare of country  $i$ , denoted  $W_i$ , consists only of the profits of the firm minus the subsidy:

$$W_i = \pi_i - s_i x_i; \quad i, j = 1, 2. \quad (3)$$

This study considers the case where each firm can make two types of binding contracts with consumers, the price contract and the quantity contract, as described by Singh and Vives (1984). In order to endogenize whether firms choose price or quantity contracts, we consider a three-stage game. In the first stage, each firm determines whether to adopt the price or quantity contract as a strategic variable. Since each firm has two possible strategic variables, there are three possible subgames: both choose quantity contracts (quantity-quantity game), both choose price contracts (price-price game), or firm  $i$  chooses the price contract while the other firm  $j$  chooses the quantity contract (price-quantity game)<sup>8</sup>. In the second stage, after observing the mode of competition determined in the first stage, two governments simultaneously set the optimal subsidy or tax levels to maximize their countries' respective social welfare<sup>9</sup>. In the third stage, each firm simultaneously chooses its price or quantity in order to maximize its profits.

### III. Market Equilibrium in the Second and Third Stages

Following the backward induction method, we first solve the firms' profit maximization problems under each subgame.

#### 1. Quantity-quantity Game

This is a simultaneous-move Cournot game. In this case, the profit maximization problem of firm  $i$  ( $i=1, 2$ ) in the third stage is  $\max_{x_i} \pi_i(x_i, x_j; s_i)$ , which yields its quantity reaction function as  $R_i^C(x_j; s_i) = (1 - bx_j + s_i)/2$ , where the superscript "C" denotes Cournot competition. We find that  $R_i^C(x_j; s_i)$  is negatively (positively) related to  $x_j$  in the quantity space, if  $b$  is positive (negative). By solving the system of the two reaction functions, we get equilibrium prices, quantities, and profits under Cournot competition as a function of  $s_i$  and  $s_j$

<sup>8</sup> Because firms  $i$  and  $j$  are symmetric in terms of their cost structures, both the price-quantity game and quantity-price games produce the same results.

<sup>9</sup> In the strategic trade policy literature, firms are assumed to choose a strategic variable before the policy of the government. See Brander and Spencer (1987), Blonigen and Ohno (1998), Konishi *et al.* (1999), among others who adopted the game stages where firms first move before decision of government policy in strategic trade policy. If governments move first before firms' choice of strategic variable, governments induce firms to choose the strategic variable from the welfare viewpoint. That is, governments do not necessarily set the optimal tax or subsidy in some case. For instance, if choice of quantity variable is more efficient for social welfare, governments set the optimal subsidy under Cournot competition and set the extremely high tax under Bertrand competition. Thus, this implies that firms are rendered the choice of their strategic variable by governments.

$$p_i^c = \frac{2-b-(2-b^2)s_i-bs_j}{4-b^2}, \quad x_i^c = \frac{2-b-bs_j+2s_i}{4-b^2} \quad (4)$$

$$\pi_i^c = \pi_i[x_i^c(s_i, s_j), x_j^c(s_i, s_j); s_i] = [x_i^c(s_i, s_j)]^2. \quad (5)$$

By substituting these equilibrium prices and quantities into the welfare expression we get

$$W_i^c(s_i, s_j) = \pi_i[x_i^c(s_i, s_j), x_j^c(s_i, s_j); s_i] - s_i x_i^c(s_i, s_j). \quad (6)$$

Therefore, in the second stage, the problem of each government can be written as  $\max_{s_i} W_i^c(s_i, s_j)$ . More formally, by the envelope theorem, the optimal  $s_i$  solves:

$$\frac{\partial W_i^c}{\partial s_i} = \frac{\partial \pi_i}{\partial x_j} \frac{\partial x_j^c}{\partial s_i} - s_i \frac{\partial x_i^c}{\partial s_i} = \frac{b^2}{4-b^2} x_i^c - \frac{2s_i}{4-b^2} (>0 \text{ when } s_i=0), \quad (7)$$

where the first equation is derived from (1a) and (2) with the envelope theorem (since  $\pi_i$  is maximized already by  $x_i$ ) and the second one directly derived from (3). Thus, the term  $\partial \pi_i / \partial x_j$  in the second part of the equation represents the effects of the rival firm's market action (here, it is quantity change) on the home firm's profits and is the equilibrium output change of the rival firm caused by an export subsidy, while the second term  $s_i(\partial x_i^c / \partial s_i)$  represents the subsidy payments increase due to the home firm's output change caused by the export subsidy. The key finding is that, irrespective of whether goods are substitutes or complements, the combined term  $(\partial \pi_i / \partial x_j)(\partial x_j^c / \partial s_i)$ , the cross effect of an export subsidy on profits via the rival's output change, is positive. This implies that, in the context of free trade ( $s_i=0$ ), the cross effects of an export subsidy are greater than the subsidy payments, and thus; a marginal increase in a subsidy increases social welfare. Setting  $\partial W_i^c / \partial s_i = 0$  to obtain the reaction function of the government yields  $s_i(s_j) = [b^2(2-b) - b^3 s_j] / 4(2-b^2)$ . Given  $s_i = s_j$ , the optimal subsidy level under Cournot competition is determined by

$$s_i^c = s_j^c = s^c = \frac{b^2}{4+2b-b^2} > 0. \quad (8)$$

By substituting the equilibrium value of the export subsidy from Eq. (8) into Eqs. (4) to (6) we get the equilibrium prices, quantities, profits, and social welfare under Cournot competition. The following lemma is immediate:

**Lemma 1:** *Suppose that both firms engage in Cournot competition in a third-country market. Nash subsidy equilibrium is characterized by positive export subsidies in both exporting countries. The equilibrium outputs, prices, firms' profits, and social welfare are, respectively, as follows.*

$$x_i^c = \frac{2}{4+2b-b^2}, \quad p_i^c = \frac{2-b^2}{4+2b-b^2}, \quad (9a)$$

$$\pi_i^c = \frac{4}{(4+2b-b^2)^2}, \quad W_i^c = \frac{2(2-b^2)}{(4+2b-b^2)^2}. \quad (9b)$$

## 2. Price-price Game

We now turn to the case of Bertrand competition in the third-country market. Given Bertrand competition determined in the first stage of this subgame, each government in the second stage chooses an optimal export subsidy or tax as the strategic variable, and then each firm in the third stage engages in simultaneous price competition to maximize its profits.

The profit maximization of firm  $i$  in the third stage is  $\max_{p_i} \pi_i(p_i, p_j; s_i)$ , which yields firm  $i$ 's price response function as  $R_i^B(p_j; s_i) = (1-b+bp_j-s_i)/2$  where the superscript "B" denotes Bertrand competition. The response function  $R_i^B(p_j; s_i)$  is upward (downward) sloping in the price space, if  $b$  is positive (negative). By solving the system of the two reaction functions, we obtain equilibrium prices, quantities, and profits under Bertrand competition as a function of  $s_i$  and  $s_j$

$$p_i^B = \frac{(2+b)(1-b)-2s_i-bs_j}{4-b^2}, \quad x_i^B = \frac{(2+b)(1-b)+s_j(2-b^2)-bs_i}{(1-b^2)(4-b^2)}, \quad (10)$$

$$\pi_i^B(s_i, s_j) = \pi_i[p_i^B(s_i, s_j), p_j^B(s_i, s_j); s_i] = (1-b^2)[x_i^B(s_i, s_j)]^2, \quad (11)$$

$$W_i^B(s_i, s_j) = \pi_i[p_i^B(s_i, s_j), p_j^B(s_i, s_j); s_i] - s_i x_i^B(s_i, s_j). \quad (12)$$

Analogously to the case of Cournot competition, each government in the second stage chooses  $s_i$  to maximize its social welfare  $W_i^B(s_i, s_j)$ . Differentiating  $W_i^B(s_i, s_j)$  with respect to  $s_i$  gives

$$\frac{\partial W_i^B}{\partial s_i} = \frac{\partial \pi_i}{\partial p_j} \frac{\partial p_j^B}{\partial s_i} - s_i \frac{\partial x_i^B}{\partial s_i} = \frac{-b^2(p_j^B + s_i)}{(1-b^2)(4-b^2)} - s_i \frac{2-b^2}{(1-b^2)(4-b^2)} (< 0 \text{ when } s_i=0), \quad (13)$$

where the first term  $(\partial \pi_i / \partial p_j)(\partial p_j^B / \partial s_i)$  in the second part of the equation represents the cross effect of the export subsidy on profits via the rival firm's price change, and the second term  $s_i(\partial x_i^B / \partial s_i)$  represents the subsidy payments increase due to the home firm's output change caused by the export subsidy. Regardless of the nature of goods, the cross effect of the export subsidy on profits is negative under Bertrand competition.

The social welfare of country  $i$  is decreasing with export subsidies  $s_i$  in place under free trade, understood as  $[\partial W_i^B / \partial s_i]_{s_i=0} < 0$ , indicating that a marginal decrease in the subsidy (marginal increase in the export tax) will increase welfare. The first-order conditions for both governments define the two reaction functions in the policy space, understood as  $s_i(s_j) = -[b^2(1-b)(2+b)+b^3s_j]/4(2-b^2)$ ,  $i, j=1, 2, i \neq j$ . Solving these two reaction functions simultaneously yields

$$s_i^B = s_j^B = s^B = \frac{-b^2(1-b)}{4-2b-b^2} < 0, \quad (14)$$

which is consistent with the finding of Eaton and Grossman (1986) that implementation of an export tax is the optimal trade policy under Bertrand competition.

Clearly, Cournot and Bertrand competition differ in their incentives. Outputs are typically strategic substitutes under Cournot competition, giving rise to an incentive to subsidize. Prices are typically strategic complements under Bertrand competition, giving rise to an incentive to tax exports. We confirm that the above results hold true irrespective of whether goods are

substitutes or complements.

Substituting  $s^B$  of Eq. (14) into Eqs. (10) to (12), we can obtain the equilibrium prices, quantities and firms' profits and welfare under Bertrand competition when optimal trade policies are introduced by both governments. The following lemma is immediate.

**Lemma 2:** *Suppose that both firms engage in Bertrand competition in a third-country market. The Nash equilibrium in a strategic trade policy game is characterized by the choice of export tax in both countries. The equilibrium outputs, prices, firms' profits and social welfare are given by*

$$x_i^B = \frac{2-b^2}{(1+b)(4-2b-b^2)}, p_i^B = \frac{2(1-b)}{4-2b-b^2}, \quad (15a)$$

$$\pi_i^B = (1-b^2)(x_i^B)^2 = \frac{(1-b)(2-b^2)^2}{(1+b)(4-2b-b^2)^2}, W_i^B = x_i^B p_i^B = \frac{2(1-b)(2-b^2)}{(1+b)(4-2b-b^2)^2}. \quad (15b)$$

### 3. Quantity-price Game

Now we turn to the case where, in the first stage, firm  $i$  chooses quantity while firm  $j$  chooses price as their respective strategic variables for competition in a third-country market. In this case, the modes of competition are asymmetric. Although there are two possible games, the quantity-price game and price-quantity game, in this case, it is sufficient to analyze either of them, because the firms are assumed to be otherwise identical. In the quantity-price game, the demand functions of the firm  $i$  and firm  $j$  are given by  $p_i = 1 - b + bp_j - (1 - b^2)x_i$  and  $x_j = 1 - bx_i - p_j$ , respectively. We can rewrite the profit maximization problem of firm  $i$  in the third stage as  $\max_{x_i} \pi_i(x_i, p_j; s_i)$  while that of firm  $j$  as  $\max_{p_j} \pi_j(x_i, p_j; s_j)$ <sup>10</sup>.

From the first-order conditions,  $\partial \pi_i / \partial x_i = 0$  and  $\partial \pi_j / \partial p_j = 0$ , we get the reaction function  $R_i^Q(p_j, s_i) = (1 - b + bp_j + s_i) / 2(1 - b^2)$  for firm  $i$  and  $R_j^P(x_i, s_j) = (1 - bx_i - s_j) / 2$  for firm  $j$ . Clearly, it holds that  $\partial R_i^Q / \partial p_j > 0 (< 0)$  and  $\partial R_j^P / \partial x_i < 0 (> 0)$  if  $b > 0 (b < 0)$ . Therefore, under asymmetric competition, the quantity-setting firm  $i$  perceives that  $x_i$  and  $p_j$  are strategic complements, while the price-setting firm  $j$  perceives those variables to be strategic substitutes if  $b > 0$ , and vice versa if  $b < 0$ . Solving the system of the two reaction functions under asymmetric competition, we obtain the third stage equilibrium outputs, prices, and profits and welfare as functions of  $s_i$  and  $s_j$ :

$$x_i^Q(s_i, s_j) = \frac{2-b+2s_i-bs_j}{4-3b^2}, p_i^Q(s_i, s_j) = \frac{(2-b)(1-b^2)-bs_j(1-b^2)-s_i(2-b^2)}{4-3b^2}, \quad (16)$$

$$x_j^P(s_i, s_j) = \frac{(2+b)(1-b)+s_j(2-b^2)-bs_i}{4-3b^2}, p_j^P(s_i, s_j) = \frac{(2+b)(1-b)-2s_j(1-b^2)-bs_i}{4-3b^2}, \quad (17)$$

<sup>10</sup> Note that the profit maximization functions of firm  $i$  and firm  $j$  are asymmetric depending on the control variable that each firm chooses. The profit function of quantity-setting firm  $i$  is given by  $\pi_i(x_i, p_j; s_i) = (p_i + s_i)x_i$  where  $p_i = p_i(x_i, p_j)$  is firm  $i$ 's indirect demand function, and firm  $i$  chooses  $x_i$  for any given  $p_j$  to maximize  $\pi_i$ . The profit function of price-setting firm  $j$  is  $\pi_j(x_i, p_j; s_j) = (p_j + s_j)x_j$ , where  $x_j = x_j(p_j, x_i)$  is firm  $j$ 's direct demand function, and firm  $j$  determines  $p_j$  given  $x_i$  to maximize  $\pi_j$ .

$$\pi_i^Q(s_i, s_j) = \pi_i[x_i^Q(s_i, s_j), p_j^P(s_i, s_j); s_i], \quad \pi_j^P(s_i, s_j) = \pi_j[p_j^P(s_i, s_j), x_i^Q(s_i, s_j); s_j] \quad (18)$$

$$W_i^Q(s_i, s_j) = \pi_i^Q(s_i, s_j) - s_i x_i^Q(s_i, s_j), \quad W_j^P(s_i, s_j) = \pi_j^P(s_i, s_j) - s_j x_j^P(s_i, s_j), \quad (19)$$

where superscripts “P” and “Q” denote the price-setting firm and quantity-setting firm, respectively, under asymmetric competition.

In the second stage of the game, the optimization problems of the respective governments are  $\max_{s_i} W_i^Q(s_i, s_j)$  for country  $i$  and  $\max_{s_j} W_j^P(s_i, s_j)$  for country  $j$ . Differentiating  $W_i^Q(W_j^P)$  with respect to  $s_i(s_j)$  gives:

$$\frac{\partial W_i^Q}{\partial s_i} = \frac{\partial \pi_i}{\partial p_j} \frac{\partial p_j^P}{\partial s_i} - s_i \frac{\partial x_i^Q}{\partial s_i} = \frac{-b^2}{4-3b^2} x_i^Q - s_i \frac{2}{4-3b^2} (<0 \text{ when } s_i=0), \quad (20a)$$

$$\frac{\partial W_j^P}{\partial s_j} = \frac{\partial \pi_j}{\partial x_i} \frac{\partial x_i^Q}{\partial s_j} - s_j \frac{\partial x_j^P}{\partial s_j} = \frac{b^2}{4-3b^2} x_j^P - s_j \frac{2-b^2}{4-3b^2} (>0 \text{ when } s_j=0). \quad (20b)$$

It is noteworthy that the cross effect of the export subsidy on profits, the term  $(\partial \pi_i / \partial p_j) (\partial p_j^P / \partial s_i)$  in Eq. (20a), is negative if the firm competes in terms of quantity and takes the rival's price as given, while the cross effect, the term  $(\partial \pi_j / \partial x_i) (\partial x_i^Q / \partial s_j)$  in Eq. (20b), is positive if the firm competes in terms of price and takes the rival's quantity as given. This holds true irrespective of the nature of goods.

Note that  $[\partial W_i^Q / \partial s_i]_{s_i=0} < 0$  and  $[\partial W_j^P / \partial s_j]_{s_j=0} > 0$ , which implies that under asymmetric competition, it is optimal for the government to induce the price-setting (quantity-setting) firm to be more (less) aggressive in the third-country market by providing subsidies (imposing tax on) exports. If the price-setting firm acts aggressively by, for example, price cutting, then the quantity-setting rival firm responds by producing less. For any given price level, lower output by the rival leads to higher profits for the price-setting firm. If the quantity-setting firm acts less aggressively by, for example, reducing the production, then the price-setting rival firm responds by charging a higher price. For any given output level, higher price setting by the rival firm leads to higher profits for the quantity-setting firm.

Simultaneously solving the two profit maximization problems  $\partial W_i^Q / \partial s_i = 0$  and  $\partial W_j^P / \partial s_j = 0$ , we get the optimal subsidy or tax level of each country under asymmetric competition as follows<sup>11</sup>.

$$s_i^Q = \frac{-b^2(1-b)(4+2b-b^2)}{16-20b^2+5b^4} < 0, \quad s_j^P = \frac{b^2(1-b)(4-2b-b^2)}{16-20b^2+5b^4} > 0. \quad (21)$$

By comparing  $s_i^Q$  and  $s_j^P$  in Eq. (21) with  $s^B$  in Eq. (14) and  $s^C$  in Eq. (8) respectively, we get

$$|s_i^Q| - |s^B| = \frac{4b^4(1-b)(2-b^2)}{(4-2b-b^2)(16-20b^2+5b^4)} > 0, \quad (22a)$$

$$s_j^P - s^C = \frac{4b^4(2-b^2)}{(4-2b-b^2)(16-20b^2+5b^4)} > 0. \quad (22b)$$

<sup>11</sup> From the respective first order condition, we can obtain the reaction function of each government in the policy space; i.e.,  $s_i(s_j) = -[b^2(2-b) + b^3 s_j] / 4(2-b^2)$  for country  $i$  and  $s_j(s_i) = [b^2(1-b)(2+b) - b^3 s_i] / 4(1-b^2)(2-b^2)$  for country  $j$ .

**Proposition 1:** *Suppose that a home firm and a foreign firm both export to a third-country market. The optimal trade policy under Cournot (Bertrand) competition is an export subsidy (tax); that is,  $s^C > 0$  and  $s^B < 0$ . Under asymmetric competition, the optimal trade policy for the price-setting firm  $j$  is an export subsidy while that for the quantity-setting firm  $i$  is an export tax; that is,  $s_i^Q < 0$  and  $s_j^P > 0$ . Furthermore, the magnitude of the export subsidy (tax) under asymmetric competition is greater than that under Cournot (Bertrand) competition; that is,  $s_j^P > s^C$  and  $|s_i^Q| > |s^B|$ .*

By substituting  $s_i^Q$  and  $s_j^P$  in Eq. (21) into Eqs. (16) to (19), we obtain the equilibrium prices, quantities, firms' profits, and social welfare under asymmetric competition when optimal trade policies are introduced by both governments. The following lemma is immediate:

**Lemma 3:** *Suppose that firms differ in terms of their choices of strategic variables; one firm chooses price and the other chooses quantity. Under asymmetric competition, if optimal trade policies as in Eq. (21) are introduced by both governments, then equilibrium outputs, prices, firms' profits, and social welfare are given by*

$$x_i^Q = \frac{2(1-b)(4+2b-b^2)}{16-20b^2+5b^4}, \quad x_j^P = \frac{(2-b^2)(4-2b-b^2)}{16-20b^2+5b^4}, \quad (23a)$$

$$p_i^Q = \frac{(1-b)(2-b^2)(4+2b-b^2)}{16-20b^2+5b^4}, \quad p_j^P = \frac{2(1-b^2)(4-2b-b^2)}{16-20b^2+5b^4}, \quad (23b)$$

$$\pi_i^Q = (1-b^2)(x_i^Q)^2 = \frac{4(1-b)^2(1-b^2)(4+2b-b^2)^2}{(16-20b^2+5b^4)^2}, \quad \pi_j^P = (x_j^P)^2 = \frac{(2-b^2)^2(4-2b-b^2)^2}{(16-20b^2+5b^4)^2}, \quad (24a)$$

$$W_i^Q = x_i^Q p_i^Q = \frac{2(1-b)^2(2-b^2)(4+2b-b^2)^2}{(16-20b^2+5b^4)^2}, \quad W_j^P = x_j^P p_j^P = \frac{2(1-b^2)(2-b^2)(4-2b-b^2)^2}{(16-20b^2+5b^4)^2}. \quad (24b)$$

By comparing the equilibrium outcomes under the three competition modes given in Lemmas 1, 2, and 3, we obtain the following lemma.

**Lemma 4:** *There are three different competition modes that depend on the choice of strategic variable: Cournot, Bertrand, and asymmetric competition. If optimal trade policies are introduced under each mode of competition, then the following relationships hold among equilibrium values:*

$$\begin{aligned} x_i^Q < x_i^C < x_i^B < x_i^P, \quad \text{and } p_i^B < p_i^P < p_i^Q < p_i^C \text{ if } b > 0, \\ x_i^C < x_i^Q < x_i^P < x_i^B, \quad \text{and } p_i^P < p_i^B < p_i^C < p_i^Q \text{ if } b < 0. \end{aligned} \quad (25)$$

With regard to the above rankings of equilibrium outputs and prices, two points are noteworthy. The first point is that Singh and Vives' (1984) ranking of equilibrium outputs and prices under Cournot and Bertrand competition hold true even if optimal trade policies are introduced by both countries, that is,  $x_i^C < x_i^B$  and  $p_i^B < p_i^C$ . Firms have less capacity to raise prices above marginal costs under Bertrand competition because, in a typical oligopolist context, firms perceive a higher elasticity of demand under Bertrand competition than under Cournot

competition. Although introduction of an optimal trade policy, such as an export subsidy (tax) under Cournot (Bertrand) competition, changes outputs and prices, the policy does not change the rankings of free trade equilibrium outputs and prices under Cournot and Bertrand competition, implying that quantities are lower and prices higher under Cournot than under Bertrand competition irrespective of the nature of goods.

The second point is that, comparing equilibrium outputs and prices under asymmetric competition with those under Cournot or Bertrand competition,  $x_i^C < x_i^P$  and  $p_i^P < p_i^C$  hold if the optimal trade policy is an export subsidy while  $x_i^Q < x_i^B$  and  $p_i^B < p_i^Q$  hold if the optimal trade policy is an export tax. The firm receives greater subsidies when it chooses price rather than quantity and takes the rival's quantity as given; that is,  $s_i^C < s_i^P$ , which leads to higher output and lower prices, that is,  $x_i^C < x_i^P$  and  $p_i^P < p_i^C$ . Higher export subsidies force the firm to be more aggressive in determining the output level. On the other hand, the firm is levied greater tax when it chooses quantity rather than price and takes the rival's price as given; that is,  $|s_i^B| < |s_i^Q|$ . This leads to less output and higher price when it chooses quantity under asymmetric competition compared with choosing price under Bertrand competition; that is,  $x_i^Q < x_i^B$  and  $p_i^B < p_i^Q$ .

For the analysis of the endogenous choice of contract mode in the next section, we define  $\Delta x_i^{P|Q}$  and  $\Delta x_i^{P|P}$  as follows:

$$\Delta x_i^{P|Q} (\equiv x_i^P - x_i^Q) = \frac{b^4(4-b^2)}{(4+2b-b^2)(16-20b^2+5b^4)} > 0, \quad (26a)$$

$$\Delta x_i^{P|P} (\equiv x_i^B - x_i^P) = \frac{b^4(4-3b^2)}{(1-b)(4+2b-b^2)(16-20b^2+5b^4)} > 0, \quad (26b)$$

where  $\Delta x_i^{P|Q}$  denotes firm  $i$ 's output change through shifting its strategic variable from quantity to price given that firm  $j$ , chooses quantity as its strategic variable. Similarly,  $\Delta x_i^{P|P}$  shows firm  $i$ 's output change through shifting its strategic variable from quantity to price given that firm  $j$  chooses price as its strategic variable. Both  $\Delta x_i^{P|Q}$  and  $\Delta x_i^{P|P}$  are positive based on Lemma 4. Because firms are assumed to be otherwise identical, it holds that  $\Delta x_i^{P|Q} = \Delta x_j^{Q|P}$  and  $\Delta x_i^{P|P} = \Delta x_j^{P|P}$ .

#### IV. *The Choice of Competition Mode in the First Stage*

We now turn to the choice of competition mode in the first stage of the three-stage game. By regarding firms' payoffs as their profits, Table 1 summarizes the potential choices in this stage, where both firms have two strategies with regard to their contract mode: quantity (Cournot) and price (Bertrand).

TABLE 1. THE FIRMS' CHOICE OF COMPETITION MODE

$i \setminus j$	Quantity	Price
Quantity	$\pi_i^C, \pi_j^C$	$\pi_i^Q, \pi_j^P$
Price	$\pi_i^P, \pi_j^Q$	$\pi_i^B, \pi_j^B$

Since firms are assumed to be identical, we can see that  $\pi_i^C = \pi_j^C$ ,  $\pi_i^B = \pi_j^B$ ,  $\pi_i^Q = \pi_j^Q$  and  $\pi_i^P = \pi_j^P$ . Based on Table 1, we have

$$\Delta\pi_i^{P|Q} (\equiv \pi_i^P - \pi_i^Q) = (x_i^P + x_i^Q)(x_i^P - x_i^Q) = (x_i^P + x_i^Q)\Delta x_i^{P|Q} > 0, \quad (27a)$$

$$\Delta\pi_i^{P|P} (\equiv \pi_i^B - \pi_i^Q) = (1 - b^2)(x_i^B + x_i^Q)(x_i^B - x_i^Q) = (1 - b^2)(x_i^B + x_i^Q)\Delta x_i^{P|P} > 0. \quad (27b)$$

where  $\Delta\pi_i^{P|Q}$  ( $\Delta\pi_i^{P|P}$ ) denotes the profit change of firm  $i$  ( $i=1, 2$ ) through shifting its strategic variable to price from quantity (quantity from price), given that firm  $j$  chooses quantity (price) as its strategic variable. Thus, the signs of both  $\Delta\pi_i^{P|Q}$  and  $\Delta\pi_i^{P|P}$  are positive based on Eqs. (26a) and (26b). From Eqs. (27a) and (27b), the following proposition is immediate.

**Proposition 2:** *Suppose that a home firm and a foreign firm both export to a third-country market under either an export subsidy or tax regime. The choice of Bertrand competition is the dominant strategy for both firms irrespective of the nature of goods and thus the Nash equilibrium of firms' choice of competition mode is (price, price), that is, Bertrand competition.*

Proposition 2 is straightforward given Lemma 4. Suppose that the firm  $j$  chooses quantity as its strategic variable. In this case, firm  $i$  receives greater subsidies by choosing price rather than quantity like its rival; that is,  $s_i^C < s_i^P$ , which leads to higher output by firm  $i$  compared to the option of choosing quantity, that is,  $x_i^C < x_i^P$ . Since profits are positively related to output in equilibrium, this implies that  $\pi_i^C < \pi_i^P$ . Suppose that, on the contrary, firm  $j$  chooses price as its strategic variable. In this case, firm  $i$  can pay lower export tax by choosing price like its rival rather than quantity; that is,  $s_i^Q < s_i^B < 0$ , which leads to higher output by firm  $i$  compared to the option of choosing quantity, that is,  $x_i^Q < x_i^B$ . Since profits are positively related to output in equilibrium,  $\pi_i^Q < \pi_i^B$  holds. Thus, each firm prefers choosing price as its strategic variable to choosing quantity irrespective of whether goods are substitutes or complements.

In the context of a duopoly, Singh and Vives (1984) showed that choosing quantity (price) is the dominant strategy for each firm if goods are substitutes (complements). We obtain a different result from Singh and Vives (1984) when factoring into optimal trade policies that are introduced by both countries. In the third-market model, where both countries introduce optimal trade policies, the choice of a price contract is the dominant strategy for both firms irrespective of whether goods are substitutes or complements. As stated above, this is related to the magnitude of export tax/ subsidy. That is, given the rival firm's choosing quantity (price) as a strategic variable, firm  $i$  can obtain greater export subsidies (pay less export tax) by choosing price instead of quantity as its strategic variable. This implies that trade policies by government might change firms' behavior with respect to choice of strategic variable (price or quantity) and hence the mode of competition. And in our third-market model, active trade policies by governments change the competition mode from Cournot to Bertrand when goods are substitutes, and this suggests that the Bertrand competition mode should be used more in strategic trade policy analysis.

However, we should note that endogenously determined Bertrand competition is not Pareto superior compared to Cournot competition. From Eqs. (9b) and (15b), we get

$$\pi_i^C - \pi_i^B = \frac{b^2}{\Psi}(64 - 96b^2 + 8b^3 + 40b^4 - 4b^5 - 5b^6 + b^7) > (<) 0 \quad (28)$$

$$\Leftrightarrow b \in (-0.9732, 1) [b \in (-1, -0.9732)],$$

where  $\Psi \equiv (1+b)(4+2b-b^2)^2(4-2b-b^2)^2 > 0$ . Eq. (28) suggests that if goods are not sufficiently close complement, that is,  $b \in (-0.9732, 1)$ , then  $\pi_i^C > \pi_i^B$  holds. Consequently, from the firms' aspect Bertrand competition might be Pareto inferior regardless of the nature of goods. In other words, if  $b \in (-0.9732, 1)$ , both firms face a prisoners' dilemma irrespective of whether goods are substitutes or complements. However, if  $b \in (-1, -0.9732)$ , then  $\pi_i^C < \pi_i^B$ , implying that Bertrand competition is Pareto superior and a prisoners' dilemma does not occur. The following proposition is immediate.

**Proposition 3:** *Suppose that a home firm and a foreign firm produce differentiated goods and export to a third-country market under either an export subsidy or tax regime. In this case, the choice of Bertrand competition is the dominant strategy for both firms irrespective of the nature of goods and thus the Nash equilibrium of firms' choices of competition mode is (price, price), that is, Bertrand competition. If goods are not sufficiently close complements, that is,  $b \in (-0.9732, 1)$ , then a prisoners' dilemma situation arises. In this case, firms  $i$  and  $j$  are both better off if they choose Cournot competition instead of Bertrand competition. If goods are sufficiently close complements, that is,  $b \in (-1, -0.9732)$ , then Bertrand competition is Pareto superior and thus a prisoners' dilemma does not occur.*

Next, we consider the welfare effects of contract mode choice. Comparing the equilibrium outcomes under Bertrand competition with those under Cournot competition, from Eqs. (9b) and (15b), we get

$$W_i^C - W_i^B = 4b^5(2-b^2)\Psi^{-1} > (<) 0 \text{ if } b > (<) 0, \quad (29)$$

implying that social welfare is higher (lower) under Cournot competition than under Bertrand competition if goods are substitutes (complements). This is straightforward considering that social welfare equals firm's operating profits<sup>12</sup> in the absence of domestic consumption, that is,  $W_i = p_i x_i$ .

Suppose that goods are independent, that is,  $b=0$ . In this case, each firm has a monopoly position in the third market and thus no interaction occurs between firms. The pursuit of private profits by monopolistic firm coincides with welfare maximization, implying that the optimal trade policy is free trade. In the context of a monopoly, profit-maximizing prices are the same whether they are determined by setting price or quantity; that is,  $p_i^C = p_i^B$ , implying  $W_i^C = W_i^B$ .

Now suppose that goods are not independent. We confirmed from Eq. (25) that  $p_i^C > p_i^B$  holds irrespective of the nature of goods. For firms, if goods are substitutes (i.e.,  $b > 0$ ) low prices mean low profitability, and Cournot profits are higher than Bertrand profits, implying that  $W_i^C > W_i^B$ . However, if goods are complements (i.e.,  $b < 0$ ), the story differs. Since lower prices expand the size of the market, a firm's operating profits could be higher under Bertrand competition than under Cournot competition, implying that  $W_i^C < W_i^B$ .

Combining Eq. (29) and Proposition 3 results in Table 2, which summarizes the

<sup>12</sup> Typically, operating profits refer to sales revenue net of production costs. However, in the third-market model, since marginal production costs are assumed to be zero, a firm's operating costs equal its revenue.

TABLE 2. THE RELATIONSHIPS AMONG THE NATURE OF GOODS, COMPETITION MODE, PROFITS, AND WELFARE

Nature of goods	Endogenous competition mode	Optimal trade policy	Firms' profits	Social welfare
$b \in (0, 1)$ substitutes	Bertrand	Export subsidy	$\pi_i^B < \pi_i^C$ Prisoners' dilemma	$W_i^C > W_i^B$
$b \in (-0.9732, 0)$ complements	Bertrand	Export tax	$\pi_i^B < \pi_i^C$ Prisoners' dilemma	$W_i^C < W_i^B$
$b \in (-1, -0.9732)$ highly complementary	Bertrand	Export tax	$\pi_i^B > \pi_i^C$	$W_i^C < W_i^B$

relationship among the nature of goods, the endogenously determined competition mode, firms' profits, and social welfare.

V. *The Effects of Government Non-intervention Policies*

The laissez-faire equilibrium, where both countries do not employ trade policies, can be thought of as arising from a commitment to non-intervention on the part of governments. We consider a case where both governments commit not to intervene the market; perhaps by signing a free trade agreement in order to remove trade barriers among member countries. In this case, the second stage of the game, i.e., choosing an optimal trade policy by both governments, is eliminated from the original model and thus the three-stage game becomes a two-stage game. In the first stage, each firm simultaneously decides whether to compete in terms of price or quantity, and in the final stage, depending on the mode of competition chosen in the first stage, firms engage in competition in the third market to maximize their respective profits. Except for social welfare, this model coincides with that used by Singh and Vives (1984), where social welfare consists of consumer surplus as well as producer surplus.

By substituting  $s_i = s_j = 0$  into Eqs. (4) to (6) for Cournot competition, Eqs. (10) to (12) for Bertrand competition, and Eqs. (16) to (19) for asymmetric competition, we obtain the laissez-faire equilibrium outcomes (i.e., absence of government intervention in international trade) under each competition mode. Table 3 presents the equilibrium values under each competition mode. The laissez-faire equilibrium is distinguished by “^”.

TABLE 3. EQUILIBRIUM VALUES UNDER GOVERNMENT NON-INTERVENTION ( $s_i = s_j = 0$ )

Cournot	Bertrand	Asymmetric Competition
$\hat{x}_i^c = \hat{p}_i^c = \frac{1}{2+b}$	$\hat{x}_i^B = \frac{1-b}{2-b}, \hat{p}_i^B = \frac{1}{(1+b)(2-b)}$	$\hat{x}_i^A = \frac{2-b}{4-3b^2}, \hat{x}_j^A = \frac{(1-b)(2+b)}{4-3b^2}$ $\hat{p}_i^A = \frac{(2-b)(1-b^2)}{4-3b^2}, \hat{p}_j^A = \frac{(1-b)(2+b)}{4-3b^2}$
$\hat{\pi}_i^c = \hat{W}_i^c = (\hat{x}_i^c)^2 = \frac{1}{(2+b)^2}$	$\hat{\pi}_i^B = \hat{W}_i^B = (1-b^2)(\hat{x}_i^B)^2 = \frac{1-b}{(1+b)(2-b)^2}$	$\hat{\pi}_i^A = \hat{W}_i^A = (1-b^2)(\hat{x}_i^A)^2 = \frac{(1-b^2)(2-b)^2}{(4-3b^2)^2}$ $\hat{\pi}_j^A = \hat{W}_j^A = (\hat{x}_j^A)^2 = \frac{(1-b)^2(2+b)^2}{(4-3b^2)^2}$

We can confirm Singh and Vives' (1984) well-known rankings of equilibrium outcomes under different competition modes. From the free trade equilibrium outcomes, we obtain the following lemma.

**Lemma 5:** *Suppose that two countries reach an agreement about government non-intervention in international trade. It follows from Table 3 that  $\hat{\pi}_i^P < \hat{\pi}_i^B < \hat{\pi}_i^O < \hat{\pi}_i^C$  and  $\hat{W}_i^P < \hat{W}_i^B < \hat{W}_i^O < \hat{W}_i^C$  hold if goods are substitutes ( $b > 0$ ), while  $\hat{\pi}_i^O < \hat{\pi}_i^C < \hat{\pi}_i^P < \hat{\pi}_i^B$  and  $\hat{W}_i^O < \hat{W}_i^C < \hat{W}_i^P < \hat{W}_i^B$  hold if goods are complements ( $b < 0$ ). In the two-stage game, the dominant strategy for firm  $i$  is to choose the quantity (price) contract if goods are substitutes (complements).*

Lemma 5 implies that, under laissez-faire, Cournot competition is the dominant strategy if the goods are substitutes, while Bertrand competition is the dominant strategy if the goods are complements. We confirmed in Proposition 2 that if optimal trade policies are introduced by both governments, firms choose Bertrand competition market regardless of the nature of goods. Considering the above arguments, exogenous trade liberalization (i.e., the acceptance of trade liberalization commitment within regional preferential trade agreements) might bring about a shift in the competition mode chosen by firms depending on the nature of goods. The following proposition is immediate:

**Proposition 4:** *Exogenous trade liberalization such as that via free trade agreements brings about a change in the competition mode from Bertrand competition to Cournot competition if goods are substitutes. However, if goods are complements, Bertrand competition prevails in the market.*

Proposition 4 implies that exogenous trade liberalization among countries may cause a shift in the competition mode from Bertrand-type to Cournot-type competition especially when goods are substitutes and that Bertrand competition mode is likely to prevail in spite of exogenous trade liberalization when goods are complements.

Next, we turn to the welfare effects of each trade policy. By comparing the equilibrium outcomes with optimal trade policies in place with those under laissez-faire (i.e., absence of government intervention), we obtain the following proposition:

**Proposition 5:** *Exogenous trade liberalization increases not only a firm's profits but also the welfare of both countries irrespective of the nature of goods. That is,*

$$\hat{\pi}_i^C > \pi_i^B \text{ and } \hat{W}_i^C > W_i^B \text{ if } b > 0,$$

$$\hat{\pi}_i^B > \pi_i^B \text{ and } \hat{W}_i^B > W_i^B \text{ if } b < 0.$$

**Proof:** It follows from Eq. (15b) and Table 3 that

$$\hat{\pi}_i^C - \pi_i^B = \frac{b^2(8 + 4b - 11b^2 - 3b^3 + 3b^4 + b^5)}{(1+b)(2+b)^2(4-2b-b^2)^2}, \quad \hat{W}_i^C - W_i^B = \frac{(4-b-b^2)^2}{(1+b)(2+b)^2(4-2b-b^2)^2},$$

which are positive if  $b \in (0, 1)$ . In addition, from the same equation and table, we get

$$\hat{\pi}_i^B - \pi_i^B = \frac{(1-b)(8-4b-3b^2+b^3)b^2}{(2-b)^2(4-2b-b^2)^2}, \quad \hat{W}_i^B - W_i^B = \frac{-(1-b)(4-3b)b^3}{(1+b)(2-b)^2(4-2b-b^2)^2},$$

which are positive if  $b \in (-1, 0)$ .

Q.E.D.

Proposition 5 can be explained as follows. Suppose that goods are complements. In this case, the contract mode does not change in spite of exogenous trade liberalization and thus Bertrand competition prevails in markets. Moreover, when government intervention is allowed, the Nash equilibrium under Bertrand competition is for both government to impose export taxes. Since exogenous trade liberalization (removal of export taxes) increases firms' outputs, the equilibrium profits, which are a positive function of output in equilibrium, also increase due to government non-intervention policy in international trade (i.e.,  $\hat{\pi}_i^B > \pi_i^B$ ). A strategic trade policy game typically involves a prisoner's dilemma. In a non-cooperative game where governments move simultaneously, the dominant strategy for each government under Bertrand competition is to impose an export tax. At the Nash equilibrium, both governments would impose export tax. However, both countries would be better off if the governments could cooperate to establish a free trade agreement, that is,  $\hat{W}_i^B > W_i^B$ .

Next, suppose that goods are substitutes. In this case, the contract mode shifts from Bertrand to Cournot competition as trade liberalization progresses exogenously. We have already found that  $\hat{\pi}_i^B > \pi_i^B$  holds irrespective of the nature of goods. In addition, according to Singh and Vives' (1984) rankings on equilibrium profits under Cournot and Bertrand competition,  $\hat{\pi}_i^B < \hat{\pi}_i^C$  holds if goods are substitutes (see Lemma 5). Considering these two inequalities, we find that firms' equilibrium profits increase with the shift from Bertrand to Cournot competition due to exogenous trade liberalization, that is,  $\hat{\pi}_i^C > \pi_i^B$ .

Regarding welfare change due to the shift in competition mode, we have already found from Eq. (29) that welfare under Cournot competition is greater than that under Bertrand competition if goods are substitutes, that is,  $W_i^C > W_i^B$ . A strategic trade policy game with export subsidies also involves a prisoner's dilemma. The dominant strategy for each government under Cournot competition is to subsidize exports, implying that at the Nash equilibrium both countries employ export subsidies. However, both countries would be better off if they cooperated to establish an agreement not to intervene in international trade, that is,  $\hat{W}_i^C > W_i^C$ . Considering these two inequalities, we find that if goods are substitutes, countries' welfare increases by the shift from Bertrand to Cournot competition due to exogenous trade liberalization, that is,  $\hat{W}_i^C > W_i^B$ .

## VI. Concluding Remarks

By incorporating the third-market model into strategic trade policy analysis, we have demonstrated the importance of endogenous choice of strategic variables for prices or quantities. Unlike in the industrial organization context, we have suggested that the choice of Bertrand competition is the dominant strategy for both competing firms regardless of the nature of goods. In equilibrium, if both firms employ export subsidies, they face a prisoners' dilemma

where they are worse off under Bertrand competition than under Cournot competition (except in the case where goods are highly complementary). However, from the government perspective, Cournot competition is more efficient than Bertrand competition when goods are substitutes, and vice versa when goods are complements. From the firms' aspect, these results imply that the equilibrium would be Pareto superior (inferior) with a government subsidy policy when goods are substitutes (complements). Moreover, we have found that exogenous trade liberalization, such as that via free trade agreements, brings about a change in the competition mode from Bertrand competition to Cournot competition if goods are substitutes. However, Bertrand competition prevails in the market if goods are complements. Hence, even though a home firm and a foreign firm choose to strategically set prices or quantities in a third market, a commitment by the countries toward non-intervention in international trade increases not only firms' profits but also the welfare of both countries irrespective of the nature of goods.

We conclude with a discussion of the limitations of this paper. We have used the simplifying assumption that the one home firm and one foreign firm are symmetric. By making this assumption, we did not take into account any cost or demand differences that may arise from the export subsidy regime in place between the home and foreign firms. Moreover, in this paper, we have assumed that symmetrical subsidies or taxes occur in equilibrium. The international trade literature has indicated that the optimal domestic response to a foreign export subsidy is to retaliate with (partial) countervailing duties. If countervailing duties and import tariffs are set in different ways and for different purposes, we need to re-examine the relationship between countervailing duties, foreign export subsidies, and import tariffs under imperfect competition (see Collie, 1991; Wang, 2004). Finally, we did not extend our results by considering nonlinear demand structures. The extension of our model in these directions is left for future research.

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