論　説

Optimal Subsidy and Tariff in a Two-country Model

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Abstract

The paper examines the optimal policy on subsidy and import tariff under international oligopoly in a two-country model. We show that the optimal subsidy provided to domestic firms always deters foreign firms from entering the domestic market, whereas imposing an optimal tariff on foreign firms allows foreign firms to enter the market. In addition, it is shown that the domestic government can bring about greater domestic welfare by subsidizing the domestic firms than by imposing a tariff on foreign firms. The results suggest that from the viewpoint of protection of the domestic industry, the national government prefers the subsidy policy to the tariff policy in order to restrict import.

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1 Introduction

In recent decades, the rapid development of globalization has increased the gains from trade all over the world, and many people have recognized the importance of trade liberalization. Since the establishment of the World Trade Organization (WTO) in 1995 along with the conclusions of the Free Trade Agreement (FTA) and/or the Economic Partnership Agreement (EPA), trade liberalization has accelerated and various trade barriers have been removed not only among the developed countries but also among the developing countries. Nevertheless, in reality, there are still a lot of trade barriers in various fields of industry. Particularly, in the developed countries, a large part of the agricultural domain is still protected. For example, an extremely high import tariff was imposed on the pretext that domestic farmers should be protected from the harsh international competition. As a recent example, the WTO Doha Development Round negotiations pertaining to the agricultural, mining, and manufacturing industries were terminated in July 2008. Moreover, in many countries, negotiations on the FTA between two countries have made little headway, because it is expected that a complete elimination of the trade barriers would result in catastrophic damage to the domestic producers.

With regard to a theoretical perspective on trade policy, considerable attention has been paid to the optimal setting of trade barriers by the national government in a country. Even if the import tariff is abandoned after the conclusion of the FTA, as far as the subsidy policy to the domestic firms works effectively, the government of the home country can continue to protect the domestic producers like before. Moreover, the subsidy policy may work more effectively than the tariff policy. If possible, a comprehensive consideration of the elimination of trade barriers including the industrial policy to promote the development of the dominant industry will be required to realize true trade liberalization. Therefore, in order to investigate the choice of policy of the domestic government to protect the domestic industry, how different policy instruments work as trade barriers must be properly clarified.

In the paper, we examine the optimal subsidy policy and the optimal tariff policy under an

international oligopoly in a two-country model. Moreover, by comparing the subsidy policy with the tariff policy, we examine which of the two policies — the subsidy policy to the domestic firms or the policy of import tariffs on foreign firms — most increases the domestic welfare, in order to determine the domestic government's preferred policy. The paper demonstrates that the optimal subsidy completely deters foreign firms from entering the domestic market, whereas the optimal tariff does not. Furthermore, we show that the domestic welfare under the optimal subsidy is always greater than that under the optimal tariff. This result is in sharp contrast with the existing result in a third-county model.

A vast amount of literature has dealt with the optimal trade policy. In a seminal article on strategic trade policy, Brander and Spencer (1985) examine export rivalry in a third-country market. They show that export subsidies can enable the exporting firms to commit to aggressive quantities. Eaton and Grossman (1986) examine taxes and subsidies under international oligopoly with conjectural variations and clarify the effects of the nature of market competition on the optimal trade policy. Cheng (1988) investigates how the optimal combination of trade and industrial policies is affected by the nature of duopolistic competition. The aforementioned articles analyze strategic trade policy by using the model of oligopolistic competition in a third-country market. On the other hand, there are several articles that investigate how industrial policy affects trade. By using a two-country model, Horn and Levinsohn (2001) and Richardson (1999) show that trade liberalization can induce governments to adopt a more competitive industrial policy.

Most of the papers have dealt with strategic trade policy by applying the model to a third-country market, whereas the papers concerning the relationship between industrial policy and trade adopt a two-country model. Although the third-country model abstracts consumers' surplus from the analysis in order to focus on strategic interaction between home and foreign firms, in most of the actual policy implementation, the government must adopt the optimal trade and/or industrial policy, taking the consumers' surplus in the home market as well as profits of the domestic firms into consideration.

Among the several papers that have adopted a two-country model in order to examine the optimal choice of trade policy instruments, Brander and Spencer (1984) have shown that either a tariff or a subsidy can be used to extract rent from foreign firms, depending on the nature of demand and cost. Corchón and González-Maestre (2001) compare the optimal import policy between tariff and quota. Egli and Westermann (2004) analyze the optimal tariff and subsidy policies and examine how the change in market structure affects the levels of the optimal subsidy or tariff. However, they have not mentioned which policy is optimal for the government to maximize the welfare in the home country. Moreover, they do not argue the possibility of the optimal policy deterring the exporter from entering the home market. By using a two-country model and taking into consideration the possibility of entry deterrence, this paper clarifies which of the two — subsidies to domestic firms or import tariffs on foreign firms — results in a greater domestic welfare. In the sense that production subsidy and import tariff are compared in a two-country model, Collie (2006) and Toshimitsu (2002) are closely related to our paper. The setting of their papers is similar to ours. Collie (2006) compares the welfare effects of ad valorem and specific tariffs and subsidies. However, Collie (2006) does not argue the optimal trade policy that the domestic government chooses in order to maximize the domestic welfare. Toshimitsu (2002) analyzes the choice of optimal policy instruments under general conditions of cost asymmetries between domestic and foreign firms and presents general results on the policy choice. However, his model assumes the linear inverse demand function and the case of cost symmetry is excluded from his analysis.

Our paper analyzes the optimal choice between production subsidy and import tariff under general demand function in a two-country oligopolistic model, although we limit the argument to the cost symmetric case. Taking into consideration the possibility of withdrawal of foreign firms from exporting when they cannot make positive profits, we show that the optimal subsidy provided to domestic firms always deters foreign firms from entering the domestic market, whereas imposing an optimal tariff on foreign firms allows foreign firms to enter the market. In addition, it is shown that the domestic government can bring about greater domestic welfare by

subsidizing the domestic firms than by imposing a tariff on foreign firms.

The remainder of the paper is organized as follows. Section 2 describes a two-country model wherein there are domestic and foreign firms competing in a home country and where the domestic government implements the subsidy or tariff policy. Sections 3 and 4 present the main results on the optimal subsidy and tariff policies, respectively. In Section 3 (resp. Section 4), we derive the optimal level of subsidy (resp. tariff) under the subsidy (resp. tariff) policy and investigate whether foreign firms are deterred from entering the home market. Section 5 compares the optimal subsidy policy with the optimal tariff one and examines which policy the domestic government prefers. Section 6 provides some concluding remarks.

2 The model

We analyze the partial equilibrium of a domestic market in a two-country model. In our model, there is a home country and a foreign country. There exists a market only in the home country, and there is no foreign market. In the domestic market, the domestic consumers demand homogenous goods, which both the domestic and foreign firms supply. Foreign firms export the goods and the firms are engaged in Cournot quantity competition. The government of the home country implements the subsidy or import tariff in order to control the import from abroad.

We index domestic (resp. foreign) firms by $i = \{1, 2, \ldots, n_d\}$ (resp. $j = \{1, 2, \ldots, n_f\}$), where n_d (resp. n_f) denotes the number of domestic (resp. foreign) firms. We denote the quantity of firm i (resp. firm j) by q_i (resp. q_j). As all domestic (resp. foreign) firms are identical, the quantity of each domestic (resp. foreign) firm is denoted by q_d (resp. q_f). Q_d (resp. Q_f) denotes the total quantity of domestic (resp. foreign) firms.

The inverse demand function of homogenous goods is represented by $p = p(Q)$, where p is the price and Q is the total quantity. We assume that $p'(Q) < 0$ and $p'(Q) + p''(Q)q_i < 0$. The latter assumption guarantees that each firm's marginal revenue (MR) is strictly decreasing. The second-order condition and the stability of the equilibrium are satisfied by the assumption.

The utility of the consumers in the home country is denoted by $U(Q) = \int_0^Q p(q)dq$ and the consumers' surplus by $CS(Q) = U(Q) - p(Q)Q$. The domestic consumers are passive players in our model. For an analytical simplification, all firms have the same technology with constant returns to scale. c denotes the constant marginal cost of the identical firm. It is assumed that $p(0) > c$.

The domestic government can subsidize the domestic firms or impose an import tariff on foreign firms in order to maximize the welfare of the home country. The subsidy or tariff is set in a per-unit form. $s(\geq 0)$ denotes the per unit subsidy that is given to the domestic firms and $t(\geq 0)$ denotes the per unit import tariff that is imposed on foreign firms. We define the virtual marginal cost of domestic (resp. foreign) firms by $\widehat{c}_d \equiv c - s$ (resp. $\widehat{c}_f \equiv c + t$) under the subsidy (resp. tariff) policy.

π_i (resp. π_j) denotes the profit of the domestic firm i (resp. foreign firm j). As all domestic (resp. foreign) firms are identical, the profit of each domestic (resp. foreign) firm is denoted by π_d (resp. π_f). When the subsidy (resp. tariff) policy is implemented, $\pi_d = (p(Q) - \widehat{c}_d)q_d$, $\pi_f = (p(Q) - c)q_f$ (resp. $\pi_d = (p(Q) - c)q_d$, and $\pi_f = (p(Q) - \widehat{c}_f)q_f$). The producers' surplus in the home (resp. foreign) country is denoted by $PS_d = n_d\pi_d$ (resp. $PS_f = n_f\pi_f$). $SP = sQ_d$ and $TR = tQ_f$ denote the total subsidy payment to the domestic firms and the total tariff revenue from foreign firms, respectively. W_d denotes the social welfare of the home country, where $W_d = CS + PS_d - SP$, when the government subsidizes the domestic firms, and $W_d = CS + PS_d + TR$, when it imposes the import tariff on foreign firms. The social welfare of the foreign country is constituted by the producers' surplus in the foreign country, that is, $W_f = PS_f$.

Domestic (resp. foreign) firm i (resp. j) maximizes its profit with regard to q_i (resp. q_j) non-cooperatively and simultaneously, given the quantities of all other firms. The domestic government maximizes the domestic welfare in the home country with regard to s or t. There exists no foreign government that protects its producers. It is assumed that the second-order conditions for the maximization of both firms and the domestic government are satisfied. Moreover, it is assumed that the stability of the Cournot-Nash equilibrium is guaranteed in the second stage.

The solution concept is a subgame perfect Nash equilibrium. In order to eliminate the indeterminacy of whether foreign firms will enter the home market, we assume that if foreign firms cannot make a positive profit, they will not enter the home market.

We now describe the timing of the two-stage game. In the first stage, the domestic government pays the per unit subsidy s to the domestic firms or imposes the per unit import tariff t on foreign firms in order to maximize the social welfare of the domestic country W_d. In the second stage, after observing the subsidy or tariff level, s or t, each domestic (resp. foreign) firm determines the output level q_i (resp. q_j) non-cooperatively and simultaneously, in order to maximize its own profit.

In the subsequent sections, we analyze the equilibrium in the subsidy and tariff policies, respectively.

3 Subsidy policy

3.1 The second stage

After the first stage, wherein the domestic government determines the optimal subsidy level s, in the second stage, the domestic and foreign firms determine their output levels given s, in order to maximize their own profits, π_i and π_j, respectively.

As the domestic firm obtains a non-negative subsidy, we focus on the case wherein the quantity of the domestic firm is positive throughout our analysis. However, we cannot determine in advance, whether the quantity of the foreign firm is positive in the equilibrium. As it is not necessarily guaranteed that the solution is an interior one in the second-stage subgame, we need to consider the possibility that $q_j = 0$. Under the non-negative quantity constraint, the first-order conditions (FOCs) of domestic firm i and foreign firm j are obtained as follows:

$$\frac{\partial \pi_i(q_i; Q_{-i})}{\partial q_i} = p(Q) - \widehat{c}_d + p'(Q)q_i = 0, \tag{1}$$

$$q_j \frac{\partial \pi_j(q_j; Q_{-j})}{\partial q_j} = q_j(p(Q) - c + p'(Q)q_j) = 0, \tag{2}$$

where $Q_{-i} \equiv \sum_{k\neq i}^{n_d} q_k + Q_f = Q - q_i$ and $Q_{-j} \equiv \sum_{l\neq j}^{n_f} q_l + Q_d = Q - q_j$.

By the Kuhn-Tucker condition, (1) and (2) are arranged as follows:

$$p(Q) - \widehat{c}_d + p'(Q)q_i = 0. \tag{3}$$

$$\begin{aligned} &\text{If} \quad q_j > 0, \quad p(Q) - c + p'(Q)q_j = 0. \\ &\text{If} \quad q_j = 0, \qquad\quad p(Q) - c \leq 0. \end{aligned} \tag{4}$$

The second-order condition is satisfied by the strictly decreasing MR condition.

As all domestic (resp. foreign) firms are identical, $q_i = q_d \ \forall i$ (resp. $q_j = q_f \ \forall j$) is satisfied in the equilibrium. The FOCs are rearranged as follows:

$$p(n_d q_d + n_f q_f) - \widehat{c}_d + p'(n_d q_d + n_f q_f)q_d = 0. \tag{5}$$

$$\begin{aligned} &\text{If} \quad q_f > 0, \quad p(n_d q_d + n_f q_f) - c + p'(n_d q_d + n_f q_f)q_f = 0. \\ &\text{If} \quad q_f = 0, \qquad\qquad\qquad\qquad\quad p(n_d q_d) - c \leq 0. \end{aligned} \tag{6}$$

Solving (5) and (6) with regard to (q_d, q_f), we obtain the equilibrium quantity, which is denoted by $(q_d(s), q_f(s))$. If $q_f > 0$, by totally differentiating (5) and (6), we obtain the comparative statics with regard to s as follows:

$$q_d'(s) = -\frac{D}{AD - BC} > 0, \tag{7}$$

$$q_f'(s) = \frac{C}{AD - BC} < 0, \tag{8}$$

$$Q'(s) = -\frac{n_d p'}{AD - BC} > 0, \tag{9}$$

where $A \equiv p' + n_d(p' + p''q_d) < 0$, $B \equiv n_f(p' + p''q_d) < 0$, $C \equiv n_d(p' + p''q_f) < 0$, $D \equiv p' + n_f(p' + p''q_f) < 0$, and $AD - BC = p'((n+1)p' + p''Q) > 0$.

By (7) and (8), as the subsidy increases, the domestic firm's output increases and the foreign firm's output decreases. It should be noted that by assumption, if s is sufficiently small, the equilibrium is interior.

On the other hand, if $q_f = 0$, that is, $q_f'(s) = 0$, by totally differentiating (5), we obtain the comparative statics of q_d with regard to s as follows:

$$q_d'(s) = -\frac{1}{A} > 0, \tag{10}$$

$$Q'(s) = n_d q'_d(s) = -\frac{n_d}{A} > 0. \tag{11}$$

3.2 The first stage

Conjecturing the result of the second stage, the domestic government determines the optimal subsidy level, in order to maximize the domestic welfare. The maximization problem for the domestic government is as follows: $\max_{s\geq 0} W_d = CS + PS_d - SP$. We denote the optimal subsidy level by s^*. By $\frac{\partial CS}{\partial s} = -p'(Q)Q \times Q'(s)$, $\frac{\partial PS_d}{\partial s} = n_d \frac{\partial \pi_d}{\partial s}$, and $\frac{\partial SP}{\partial s} = Q_d + sQ'_d(s)$, the derivative of W_d with respect to s satisfies the following equation:

$$\frac{\partial W_d}{\partial s} = -p'(Q)Q \times Q'(s) + n_d \frac{\partial \pi_d}{\partial s} - Q_d - sQ'_d(s). \tag{12}$$

Substituting $\frac{\partial \pi_d}{\partial s} = (p(Q) - c + s)q'_d(s) + (p'(Q)Q'(s) + 1)q_d(s)$ into (12), we obtain the following equation:

$$\frac{\partial W_d}{\partial s} = n_d(p(Q) - c)q'_d(s) - p'Q_f Q'(s). \tag{13}$$

Suppose that $q_f > 0$. Substituting (7) and (9) into (13), we obtain the following equation:

$$\frac{\partial W_d}{\partial s} = -\frac{n_d((p(Q) - c)D - (p')^2 Q_f)}{AD - BC}. \tag{14}$$

On the other hand, suppose that $q_f = 0$. Substituting (10) and (11) into (13), we obtain the following equation:

$$\frac{\partial W_d}{\partial s} = -\frac{n_d((p(Q) - c) - p'Q_f)}{A}. \tag{15}$$

By (14) and (15), we obtain the following proposition.

Proposition 1. *Suppose that the domestic government implements the subsidy policy for the domestic firms in order to maximize the domestic welfare. No foreign firms can enter the home market at the optimal subsidy level.*

Proof. Suppose that $q_f > 0$. As $AD - BC > 0$, $D < 0$, $Q_f > 0$, and $p - c = -p'q_f > 0$ by (6), $\frac{\partial W_d}{\partial s} > 0$ is satisfied in (14). In other words, if $q_f > 0$, the domestic government can raise the domestic welfare by increasing the subsidy level. Therefore, as far as foreign firms produce

positive quantity in the market, no subsidy level maximizes the domestic welfare. On the other hand, suppose that $q_f = 0$. In this case, as $Q_f = 0$ and $p - c \leq 0$ by (6), $\frac{\partial W_d}{\partial s} \leq 0$ is satisfied in (15). If $q_f > 0$, $q_f'(s) < 0$ is satisfied by (8). If $q_f = 0$, $q_d'(s) > 0$ is satisfied by (10) and $\frac{\partial W_d}{\partial s} = 0$ is satisfied when $p(n_d q_d) - c = 0$. Therefore, when $q_f = 0$ and $p(n_d q_d) = c$, the domestic welfare is maximized. □

Proposition 1 implies that the domestic government can deter the foreign firm from entering the home market by setting the subsidy at the level at which price equals the marginal cost. No foreign firms can enter the domestic market under the optimal subsidy policy. The optimal subsidy level is set at the level under which foreign firm's profit tends to be zero. Subsidizing the domestic firms completely deters foreign firms from entering the market and succeeds in protecting the domestic industry. It should be noted that this result is satisfied irrespective of the number of foreign firms, n_f. The optimal subsidy level s^*, which satisfies $p(n_d q_d(s^*)) = c$, depends only on the number of domestic firms n_d.

4 Tariff policy

4.1 The second stage

After the first stage, wherein the domestic government determines the optimal tariff level t, in the second stage, the domestic and foreign firms determine their output levels given t, in order to maximize their own profits, π_i and π_j, respectively.

It cannot be determined in advance whether the quantity of the foreign firm is positive in the equilibrium. As it is not necessarily guaranteed that the solution is interior in the second-stage subgame, we need to take into consideration the possibility that $q_j = 0$. Under the non-negative quantity constraint, the FOCs of domestic firm i and foreign firm j are obtained as follows:

$$\frac{\partial \pi_i(q_i; Q_{-i})}{\partial q_i} = p(Q) - c + p'(Q)q_i = 0, \tag{16}$$

$$q_j \frac{\partial \pi_j(q_j; Q_{-j})}{\partial q_j} = q_j(p(Q) - \widehat{c}_f + p'(Q)q_j) = 0. \tag{17}$$

By the Kuhn-Tucker condition, (16) and (17) are rearranged as follows:

$$p(Q) - c + p'(Q)q_i = 0. \tag{18}$$

$$\begin{aligned} &\text{If} \quad q_j > 0, \quad p(Q) - \widehat{c}_f + p'(Q)q_j = 0. \\ &\text{If} \quad q_j = 0, \qquad\quad p(Q) - \widehat{c}_f \leq 0. \end{aligned} \tag{19}$$

The second-order condition is satisfied by the strictly decreasing MR condition.

As all domestic (resp. foreign) firms are identical, $q_i = q_d \ \forall i$ (resp. $q_j = q_f \ \forall j$) is satisfied in the equilibrium. The FOCs are rearranged as follows:

$$p(n_d q_d + n_f q_f) - c + p'(n_d q_d + n_f q_f)q_d = 0. \tag{20}$$

$$\begin{aligned} &\text{If} \quad q_f > 0, \quad p(n_d q_d + n_f q_f) - \widehat{c}_f + p'(n_d q_d + n_f q_f)q_f = 0. \\ &\text{If} \quad q_f = 0, \qquad\qquad\qquad\qquad\quad p(n_d q_d) - \widehat{c}_f \leq 0. \end{aligned} \tag{21}$$

Solving (20) and (21) with regard to (q_d, q_f), we obtain the equilibrium quantity, which is denoted by $(q_d(t), q_f(t))$. If $q_f > 0$, by totally differentiating (20) and (21), we obtain the comparative statics with regard to t as follows:

$$q_d'(t) = -\frac{B}{AD - BC} > 0, \tag{22}$$

$$q_f'(t) = \frac{A}{AD - BC} < 0, \tag{23}$$

$$Q'(t) = \frac{n_f p'}{AD - BC} < 0. \tag{24}$$

By (22) and (23), as the tariff increases, the domestic firm's output increases and the foreign firm's output decreases. It should be noted that by assumption, if t is sufficiently small, the equilibrium is interior.

On the other hand, if $q_f = 0$, that is, $q_f'(t) = 0$, (20) does not depend on t. Unlike the subsidy policy, from (20), it is shown that if $q_f = 0$, q_d does not depend on t.

4.2 The first stage

Conjecturing the result of the second stage, the domestic government determines the tariff level, in order to maximize the domestic welfare. The maximization problem for the domestic

government is as follows: $\max_{t\geq 0} W_d = CS + PS_d + TR$. We denote the optimal tariff by t^*. By $\frac{\partial CS}{\partial t} = -p'(Q)Q \times Q'(t)$, $\frac{\partial PS_d}{\partial t} = n_d \frac{\partial \pi_d}{\partial t}$, and $\frac{\partial TR}{\partial t} = Q_f + tQ'_f(t)$, the derivative of W_d with respect to t satisfies the following equation:

$$\frac{\partial W_d}{\partial t} = -p'(Q)Q \times Q'(t) + n_d \frac{\partial \pi_d}{\partial t} + Q_f + tQ'_f(t). \tag{25}$$

Substituting $\frac{\partial \pi_d}{\partial t} = (p(Q) - c)q'_d(t) + p'(Q)Q'(t)q_d$ into (25), we obtain the following equation:

$$\frac{\partial W_d}{\partial t} = n_d(p(Q) - c)q'_d(t) + (1 - p'(Q)Q'(t))Q_f + tQ'_f(t). \tag{26}$$

Suppose that $q_f > 0$. Substituting (22) and (24) into (26), we obtain the following equation:

$$\frac{\partial W_d}{\partial t} = \frac{tn_f A - n_d(p(Q) - c)B + p'((n_d + 1)p' + p''Q)Q_f}{AD - BC}. \tag{27}$$

On the other hand, if $q_f = 0$, W_d does not depend on t.

By (27), we obtain the following proposition.

Proposition 2. *Suppose that the domestic government implements the tariff policy for foreign firms in order to maximize the domestic welfare. The optimal tariff is set as the level at which foreign firms produce a positive quantity.*

Proof. By (23), as the tariff level increases, foreign firms decrease the quantities that they produce. If the domestic government imposes a sufficiently large tariff on foreign firms, the foreign firms quit exporting. By (20) and (21), when the tariff level exceeds $\overline{t} \equiv p(n_d q_d) - c = -p'(n_d q_d)q_d$, foreign firms withdraw from the home market. Thus, if foreign firms produce positive quantities, the tariff level is required to satisfy $t < \overline{t}$. Let us consider the sign of $\frac{\partial W_d}{\partial t}$ in the range of $t \in [0, \overline{t})$. Substituting $t = 0$ or $\overline{t}$ into (27), we obtain the following equations:

$$\frac{\partial W_d}{\partial t}\Big|_{t=0} = \frac{-n_d(p(Q) - c)B + p'((n_d + 1)p' + p''Q)Q_f}{AD - BC} > 0, \tag{28}$$

$$\frac{\partial W_d}{\partial t}\Big|_{t\uparrow \overline{t}} = \frac{\overline{t}(n_f A - n_d B)}{AD - BC} = \frac{\overline{t} n_f p'}{AD - BC} < 0. \tag{29}$$

From the signs of $\frac{\partial W_d}{\partial t}$ in (28) and (29), it can be concluded that there exists an optimal tariff level at which the domestic welfare is maximized in the interval of $t \in [0, \overline{t})$. Therefore, when the

domestic government sets the optimal tariff level, foreign firms do not withdraw from the home market and produce a positive quantity. If the second-order condition for welfare maximization with regard to t is satisfied, that is, $\frac{\partial^2 W_d}{\partial t^2} < 0$, the optimal tariff level t^* satisfies $\frac{\partial W_d}{\partial t}\Big|_{t=t^*} = 0$. □

In contrast to the subsidy policy, Proposition 2 implies that the domestic government does not deter foreign firms from exporting to the home market. By setting the tariff at the level at which the price is higher than the marginal cost plus tariff, the foreign firm is guaranteed to produce a positive quantity under the optimal tariff level. This is explained by the existence of tariff revenue. If foreign firms enter the home market and pay the import tariff, the domestic government can obtain the tariff revenue, which transfers a part of the profits of foreign firms to the home country. If a sufficiently high tariff is imposed, foreign firms withdraw from the market and no tariff revenue is obtained. Unlike the subsidy policy, which only redistributes the domestic welfare between the consumers and domestic firms, the tariff policy can deprive foreign firms of part of the profits. Thus, the domestic government sets the optimal tariff at the level under which the foreign firm's profit is positive.

In contrast to the subsidy policy, the optimal tariff does not deter foreign firms from entering the market. This result suggests that the subsidy policy is more likely to effectively impede the gains from trade than the tariff policy is. If the protectionists of the domestic industry can choose either subsidy or tariff as an instrument to restrict import, they will choose subsidy because it can keep out foreign products completely.

Unlike the optimal subsidy level s^*, the optimal tariff level t^* depends on the number of foreign firms, n_f. Moreover, if the second-order condition is satisfied, the optimal tariff level t^* satisfies $\frac{\partial W_d}{\partial t}\Big|_{t=t^*} = 0$. In this case, in general, t^* depends on (n_d, n_f).

5 Welfare comparison between subsidy and tariff policy

We compare the domestic welfare under the optimal subsidy policy and the optimal tariff policy. The following proposition summarizes the result of the sizes of the domestic welfare under two

different policies.

Proposition 3. *The domestic welfare under the optimal subsidy policy is always greater than that under the optimal tariff policy.*

Proof. We denote the superscript of variables s (resp. t) as those under the optimal subsidy (resp. tariff) policy. First, we consider the domestic welfare under the optimal subsidy policy. As $p(Q^s) = c$ is satisfied, the total quantity is the same as that in the perfectly competitive market. As the producers' surplus of the domestic firms is equal to the subsidy payment, i.e., $PS_d^s = (p(Q^s) - c + s^*)Q^s = s^*Q^s = SP$, the domestic welfare coincides with the consumers' surplus when the market is perfectly competitive. That is, $W_d^s = CS^s + PS_d^s - SP = CS(Q^s)$ is satisfied. Next, we consider the domestic welfare under the optimal tariff policy. As is shown by (20) and (21), that the profit margin is positive, and the total quantity is less than that in the perfectly competitive market, i.e., $Q^t < Q^s$. Thus, the consumers' surplus under the tariff policy is less than that under the subsidy policy, i.e., $CS(Q^t) < CS(Q^s)$. As $p(Q^t) - c = -p'q_d^t > 0$, the producers' surplus of the domestic firms is positive, i.e., $PS_d^t = (p(Q^t) - c)Q_d^t$. Moreover, as $t^* > 0$ and $q_f^t > 0$, the tariff revenue is positive, i.e., $TR = t^*Q_f^t > 0$. The sum of PS_d^t and TR is less than $(p(Q^t) - c)Q^t$, because $p(Q^t) - c > t^*$ is satisfied by (20) and (21). Unless the total quantity is equal to that when the market is perfectly competitive, the social welfare is less than that in the perfectly competitive market. Thus, $W_d^s = CS(Q^s) > CS(Q^t) + (p(Q^t) - c)Q^t > CS(Q^t) + (p(Q^t) - c)Q_d^t + t^*Q_f^t = W_d^t$ is satisfied. □

Proposition 3 implies that if the domestic government can choose either the subsidy or tariff policy in order to maximize the domestic welfare, it will choose the subsidy policy. Not only protectionists of the domestic industry but also the government prefers the subsidy policy to the tariff policy. As the optimal subsidy completely prevents foreign firms from exporting in the home market, as is shown in Proposition 1, subsidy is a more injurious trade barrier than imported tariff as a policy instrument to restrict import. Nevertheless, the proposition suggests that the subsidy policy results in greater domestic welfare than the tariff policy does at

the expense of foreign welfare and that the domestic government will implement the industrial policy in order to completely protect the domestic industry.

The reason why Proposition 3 holds true is as follows. In the subsidy policy, the subsidy to domestic firms reduces the virtual marginal cost of domestic firms and, therefore, increases the total quantity. It is utilized in order to improve the underproduction caused by imperfect competition. The optimal subsidy level is set in order to ensure that the consumers' surplus is equal to that when the market is perfectly competitive. On the other hand, in the tariff policy, as tariff revenue is generated if foreign firms export to the home market, the domestic government has an incentive to allow foreign firms to produce positive quantity. As underproduction is not completely eliminated under the tariff policy, unlike under the subsidy policy, dead weight loss caused by the insufficient production is necessarily incurred. We graph out the domestic welfare under the optimal subsidy policy and the optimal tariff policy in Figures 1 and 2, respectively.

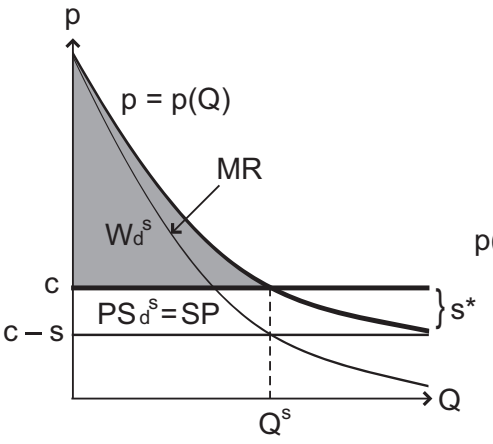

Figure 1: The domestic welfare under the optimal subsidy policy

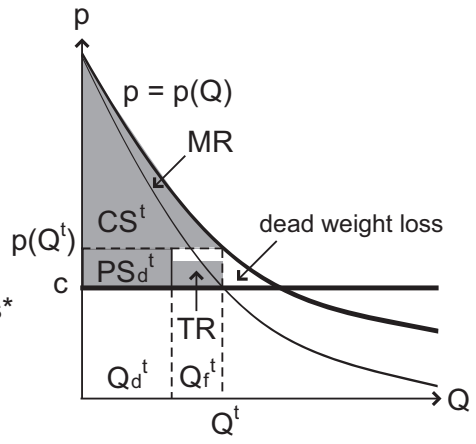

Figure 2: The domestic welfare under the optimal tariff policy

Different from the case of domestic welfare, we cannot obtain any definite result of the comparison of domestic producers' surplus under the general demand function. Under the optimal subsidy policy, the domestic producers' surplus is represented by $PS_d^s = s^*Q^s$. On the other hand, under the optimal tariff policy, it is represented by $PS_d^t = (p(Q^t) - c)Q_d^t$. Although $Q^s > Q_d^t$ is satisfied, whether s^* exceeds $p(Q^t) - c$ depends on the curvature of the demand function and the numbers of domestic and foreign firms in general.

6 Concluding remarks

In this paper, we showed that the optimal subsidy overcomes the underprovision problem that is caused by imperfect competition and it results in domestic welfare by driving foreign goods out of the domestic market. On the other hand, in the case of the tariff policy, tariff revenue from foreign firms is generated if foreign firms produce a positive quantity. Therefore, from the viewpoint of the maximization of domestic welfare, the domestic government never deters foreign firms from entering the home country at the optimal tariff level.

We demonstrated that for the purpose of the protection of the domestic industry, and of the maximization of the domestic welfare including the consumers' surplus, the government supports the subsidy policy against the tariff policy. In other words, we suggest that the subsidy policy is more undesirable for foreign firms than is the tariff policy. Even if the trade policies such as import tariff and quota were prohibited by WTO and FTA, the industrial policy peculiar to importing countries will continue to work as trade barriers. Under the existing circumstances, it remains difficult for the WTO to intervene in the affairs of a country directly and remove the obstacle to trade caused by the industrial policy completely. Moreover, often the recent economic recession accompanied by the credit crunch, even a lot of global giant firms like General Motors face the possibility of business failures and will require the government to inject public funds. As protectionism becomes prevalent all over the world, more industrial policies such as subsidy will be used as a cover by governments with the aim of more intensely protecting its national

welfare. From a theoretical point of view, the paper clarifies the result that the subsidy policy will exert a worse influence on trade as a trade barrier than will the tariff policy.

In this article, based on our analysis, we abstract the internal distribution of the domestic welfare between consumers and producers. Future research could consider the distribution problem in relation to domestic welfare. For example, even if domestic firms make a larger profit under the subsidy policy because of which the domestic welfare increases, the domestic consumers will object to the subsidy policy, unless they can enjoy the fruits of the increased welfare. Another interesting possibility for future research would be to introduce heterogeneity between the domestic and foreign firms into the model. If both firms have a different technology or differentiate their products, the domestic consumers can obtain additional gains from trade by importing from abroad. As a result, a variety of firms will have different influences on the decision-making of trade policy by the government.

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