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Effect of Import Tariffs on Foreign Export Subsidies and Countervailing Duties

— An Extension of the Model of Wang (2004) —

Kojun Hamada*

Abstract

In this paper, we present an extension of the model of Wang (2004) to analyze the effect of a constraint pertaining to countervailing duties (CVDs). In WTO agreements, it is stipulated that CVDs should not exceed foreign export subsidies; this is different from the setting of Wang (2004). Taking the constraint on CVDs that they do not exceed foreign export subsidies into consideration, we clarify that CVDs are not levied on the foreign firm and foreign export subsidies are not given to the foreign firm. Our result sharply contrasts with the result of Wang (2004) who analyzes the situation in which CVDs can be higher than the subsidies and shows that positive foreign export subsidies come into existence.

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* Faculty of Economics, Niigata University

Address: 8050 Ikarashi 2-no-cho, Nishi-ku, Niigata City, 950-2181 Japan

Tel. and fax: +81-25-262-6538

E-mail address: khamada@econ.niigata-u.ac.jp

1 Introduction

In this paper, we present an extension of the model of Wang (2004) to analyze the effect of a constraint pertaining to countervailing duties (CVDs). Wang (2004) explores a model in which the optimal CVDs, foreign export subsidies, and import tariffs are endogenized under imperfect competition. He clarifies the relationship among the above three instruments of trade policy. In particular, he analyzes the situation in which CVDs can be higher than the subsidies and shows that positive foreign export subsidies come into existence. However, such a situation seems to be somewhat unrealistic in the context of the customary practices of trade policy. In an extreme situation that Wang (2004) analyzes, it is possible that even if the foreign country does not give any subsidy to the foreign firms, CVDs are levied on them. In such a situation, the role of CVD in the model is quite different from the original role of CVD of seeking to improve the competitive disadvantage of domestic firms only when unfair subsidies are granted to foreign rivals.

In WTO agreements (Agreement on Subsidies and Countervailing Measures), Article 19 (Imposition and Collection of Countervailing Duties) stipulates as follows:

> 19.2 The decision whether or not to impose a countervailing duty in cases where all requirements for the imposition have been fulfilled, and the decision whether the amount of the countervailing duty to be imposed shall be the full amount of the subsidy or less, are decisions to be made by the authorities of the importing Member. It is desirable that the imposition should be permissive in the territory of all Members, that *the duty should be less than the total amount of the subsidy if such lesser duty would be adequate to remove the injury to the domestic industry*, and that procedures should be established which would allow the authorities concerned to take due account of representations made by domestic interested parties whose interests might be adversely affected by the imposition of a countervailing duty. (*Italic font added for emphasis by the author*)

In WTO agreements, it is stipulated that CVDs should not exceed foreign export subsidies. We examine what happens if a realistic constraint on the relationship between CVDs and foreign export subsidies is introduced. In this paper, we impose the constraint that CVDs do not exceed foreign export subsidies following the WTO agreements and reexamine the relationship among CVDs, foreign export subsidies, and import tariffs, and obtain a result that contrasts with the result of Wang (2004).

There exist many articles on the relationship between foreign subsidies and domestic CVDs.

Dixit (1987) explores a model to construct conjectural variations under international oligopoly in which the domestic country responds to the foreign export subsidy. He shows that as the optimal domestic response to a foreign export subsidy, the domestic country levies tariffs that countervail a part of the subsidy. Collie (1991) finds that when the domestic country adopts only the optimal tariff as trade policy, the foreign country does not give a foreign export subsidy. The above results suggest that tariffs are used partially to retaliate against foreign export subsidy. In contrast to the existing results that the CVDs deter the foreign country from subsidizing its exports, Qiu (1995) introduces other factors such as the delay in retaliation, the constraint on CVDs, and voluntary export restraints into the model, to explain the coexistence of foreign export subsidies and CVDs. He finds that these factors reduce the efficacy of retaliation by CVDs and fail to deter export subsidization. Spencer (1988) presents the conditions under which a CVD will offset the effect of foreign export subsidy and shows that under the GATT rule, profit shifting motives for a subsidy still exist even when the CVD is levied. Wang (2004) examines the relationship between CVDs, foreign export subsidies, and import tariffs under imperfect competition. One of his interesting results is that the optimal import tariff is so high that the optimal CVD is zero and hence foreign export subsidization occurs.

Wang (2004) is different from other papers in terms of the setting of both the timing of CVD and the GATT rules on CVD. Previous papers including Dixit (1988), Collie (1991), and Qiu (1995) consider a situation in which the import tariff is determined after the foreign export subsidy. In their settings, CVD has been regarded as a form of import tariff and the difference between CVD and import tariff is not clear. In contrast, Wang (2004) distinguishes CVD from import tariff and assumes that CVD is levied after foreign export subsidization. While on one side, Collie (1991), Qiu (1995), and Spencer (1988) include the GATT rules that limit CVD to the subsidy into consideration, on the other, Wang (2004) does not.

In this paper, we analyze the situation in which a CVD is levied after the foreign country subsidizes the export; this is in addition to the consideration of WTO agreements. We clarify that CVDs are never levied on the foreign firm and that the export subsidies are prevented under the constraint that CVDs do not exceed foreign export subsidies. By adding this realistic constraint, we show that CVDs are not realized in equilibrium under imperfect competition, although CVDs have a potential role as a deterrent to nullify any subsidies by the foreign country. Our result sharply contrasts with the result of Wang (2004) that the optimal import tariff is relatively high and the positive export subsidies come into existence when CVDs can be higher than the subsidies in equilibrium. If the constraint on CVDs is not taken into consideration, as in the existing literature, CVDs are merely used as one of the policy instruments to win trade wars. In contrast, the additional constraint, which is based on the stipulation in WTO agreements, presents a realistic explanation for the role of CVD as a deterrent to prevent protectionism.

The reminder of the paper is organized as follows. Section 2 presents the model. Section 3 presents the main results on the relationship among CVDs, foreign export subsidies, and import tariffs under the constraint on CVDs. Section 4 gives the concluding remarks.

2 Model

The basic structure of the model is the same as in Wang (2004) except for the constraint on CVD. We consider an international duopoly model in which a home firm and a foreign firm supply to the home market. The representative consumer in the home market has a quasi-linear utility function $V(m, y_h, y_f) = m + U(y_h . y_f)$, where $U(y_h . y_f) = a_h y_h + a_f y_f - \frac{1}{2}(b_h y_h^2 + b_f y_f^2) - k y_h y_f$, $a_i, b_i > 0$ $(i = h, f)$, and $k \in [0, 1]$. m denotes the amount of the numeraire good and y_h (y_f) denotes the amount of the good produced by the home (foreign) firm. The foreign firm exports the good to the home market. For convenience and without loss of generality, let us specify $b_i = 1$. k denotes the degree of product differentiation between y_h and y_f. Under the above utility function, the inverse demand function is derived as follows:

$$p_i = a_i - y_i - k y_j, \quad i, j = h, f,\ i \neq j, \tag{1}$$

where p_i is the price of y_i. The consumer's surplus is denoted by $CS \equiv U(y_h, y_f) - p_h y_h - p_f y_f = \frac{1}{2}(y_h^2 + y_f^2) + k y_h y_f$.

The home country imposes a specific import tariff t on the foreign firm. On the other hand, after observing the level of import tariff t, the foreign country gives a per unit export subsidy s to the foreign firm. When the foreign exporting firm is subsidized ($s \geq 0$), the home country can levy a specific CVD v on the exporting firm.[1] The only difference from Wang (2004) is that we do not allow the CVD to be higher than the foreign export subsidy. Hence, the case of

[1] As Wang insists, CVDs and import tariffs may be set differently for different purposes. If we can formulate the model under the situation in which there are multiple customs authorities that have different objectives in choosing the levels of tariff and CVD, we can obtain more detailed results on the effect of CVD. However, while such an extension complicates the problem, we believe that the qualitative results remain unchanged. As such, we do not consider multiple authorities in the model. The issue of multiple authorities is left for the future.

$v > s$ is excluded from the analysis. We add the constraint that $v \leq s$ must hold and solve the optimization problem. The profit functions of the home firm and the foreign firm are written as follows:

$$\pi_i = [p_i - c_i + D_i(s - t - v)]y_i - K_i, \tag{2}$$

where $D_i = 0$ (1) as $i = h$ (f) is an index function, and c_i and K_i are the constant marginal cost and fixed cost, respectively. It is assumed that $c_i < a_i$.

The timing of the model is as follows. In the first stage, the home government imposes a specific import tariff t on the foreign firm. In the second stage, after observing the tariff level, the foreign government gives a per unit export subsidy s to the foreign firm. In the third stage, after observing the subsidy level, the home country levies a specific CVD v on the exporting firm, as long as $v \leq s$. In the fourth stage, the home firm and the foreign firm compete in the home market in the Cournot fashion. The solution concept is the subgame perfect equilibrium.

3 Results

In this section, we derive the subgame perfect equilibrium in this multi-stage game. We solve it by backward induction.

3.1 Fourth stage

In the fourth stage, given the levels of (t, s, v), the home firm and the foreign firm choose their output levels to maximize their profits, that is, $\max_{y_i} \pi_i = [p_i - c_i + D_i(s - t - v)]y_i - K_i$. By simultaneously solving their first-order conditions, the Cournot equilibrium outputs are obtained as follows:[2]

$$y_h = \gamma[2e_h - k(e_f + (s - t - v))] = \gamma(2e_h - k\widehat{e}_f), \tag{3}$$

$$y_f = \gamma[-ke_h + 2(e_f + (s - t - v))] = \gamma(2\widehat{e}_f - ke_h), \tag{4}$$

where $e_i \equiv a_i - c_i > 0$ $(i = h, f)$, $\gamma \equiv \frac{1}{4-k^2} \in [\frac{1}{4}, \frac{1}{3}]$, and $\widehat{e}_f \equiv e_f + (s - t - v) > 0$.[3] e_i indicates the cost advantage of firm i and e_h ($\widehat{e}_f$) indicates the virtual cost advantage of firm h (f) taking the substantial changes in costs by trade policy into consideration. Some results regarding

[2] Under the above setting on the linear inverse demand function, the second-order and stability conditions are satisfied.

[3] For $y_i > 0$, $\frac{k}{2} < \frac{e_f+(s-t-v)}{e_h} (= \frac{\widehat{e}_f}{e_h}) < \frac{2}{k}$. In other words, $2e_h - k\widehat{e}_f > 0$ and $2\widehat{e}_f - ke_h > 0$. We assume these inequalities throughout the analysis.

comparative statics are obtained from (3) and (4) as follows: $\frac{\partial y_h}{\partial t} = \frac{\partial y_h}{\partial v} = -\frac{\partial y_h}{\partial s} = k\gamma > 0$ and $\frac{\partial y_f}{\partial t} = \frac{\partial y_f}{\partial v} = -\frac{\partial y_f}{\partial s} = -2\gamma < 0$. It can be easily deduced that the increase in t or v (s) raises (lowers) y_h and lowers (raises) y_f. The welfare of the home country and that of the foreign country are defined as $W_h = CS + \pi_h + (t+v)y_f$ and $W_f = \pi_f - sy_f$, respectively. The result is summarized in Table 1. Note that $\pi_i = y_i^2 - K_i$.

Output	$y_h = \gamma[2e_h - k(e_f + (s-t-v))] = \gamma(2e_h - k\widehat{e}_f)$ $y_f = \gamma[-ke_h + 2(e_f + (s-t-v))] = \gamma(2\widehat{e}_f - ke_h)$
Price	$p_h = a_h - \gamma[(2-k^2)e_h + k\widehat{e}_f]$ $p_f = a_f - \gamma[ke_h + (2-k^2)\widehat{e}_f]$
Profit margin	$p_h - c_h = y_h$ $p_f - c_f + (s-t-v) = y_f$
Profit	$\pi_h = y_h^2 - K_h = \gamma^2(2e_h - k\widehat{e}_f)^2 - K_h$ $\pi_f = y_f^2 - K_f = \gamma^2(2\widehat{e}_f - ke_h)^2 - K_f$
Consumer surplus	$CS = \frac{1}{2}(y_h^2 + y_f^2) + ky_hy_f = \gamma^2[(2 - \frac{3}{2}k^2)(e_h^2 + \widehat{e}_f^2) + k^3e_h\widehat{e}_f]$.

Table 1: Result of the fourth stage

3.2 Third stage

In the third stage, after observing the levels of (t, s), the home government levies a CVD on the foreign firm under the constraint that CVD cannot exceed foreign export subsidy. The maximization problem of the home government in the third stage is delineated as follows:

$$\max_v W_h = CS + \pi_h + (t+v)y_f, \tag{5}$$

$$\text{s.t.} \quad 0 \le v \le s, \ (3) \text{ and } (4). \tag{6}$$

By using the Lagrange multipliers, we attempt to solve the optimal CVD level. Define a Lagrangian by $L(v, \lambda) \equiv W_h(v) + \lambda(s - v)$, where λ is a Lagrange multiplier.

The Karush-Kuhn-Tucker necessary conditions are as follows:[4]

$$v^*L_v = v^*(\frac{\partial W_h}{\partial v} - \lambda) = 0 \text{ and } L_v^* \le 0, \tag{7}$$

$$\lambda^*(s - v^*) = 0 \text{ and } s - v^* \ge 0, \tag{8}$$

[4] The sufficient condition is satisfied because $\frac{\partial^2 W_h}{\partial v^2} = -3\gamma < 0$. The superscript $*$ denotes the optimal levels of CVD, foreign export subsidy, import tariff, and multiplier.

where $L_v \equiv \frac{\partial L(v,\lambda)}{\partial v}$. By simple calculation, we obtain $\frac{\partial W_h^v}{\partial v} = \gamma(e_f + s - 3t - 3v)$. By the complementary slackness conditions, if $L_v < 0$, then $v^* = 0$, and if $v^* > 0$, then $L_v = 0$. Likewise, if $v^* < s$, then $\lambda^* = 0$, and if $\lambda^* > 0$, then $v^* = s$. Therefore, the optimal CVD level v^* is classified into three cases as follows:[5]

$$v^* = \begin{cases} 0 \text{ (corner)} & L_v \leq 0 \text{ and } \lambda^* = 0 \quad \text{(Case I)} \\ v^{**} \text{ (interior)} \text{ if} & L_v = 0 \text{ and } \lambda^* = 0 \quad \text{(Case II)} \\ s \text{ (corner)} & L_v = 0 \text{ and } \lambda^* \geq 0 \quad \text{(Case III).} \end{cases} \tag{9}$$

The three cases are depicted in Figure 1.

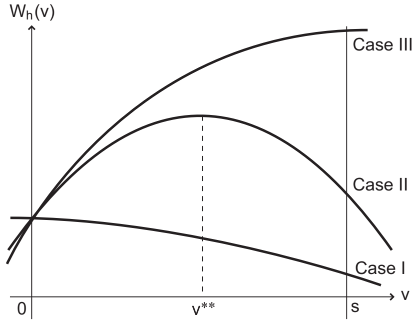

Figure 1: Three cases of the third stage

3.2.1 Case I

In Case I, CVD is not levied. In this case, as $\lambda^* = 0$, $L_v = \frac{\partial W_h}{\partial v} = \gamma(e_f + s - 3t - 3v) \leq 0$. $\frac{\partial W_h}{\partial v}$, which is evaluated at $v = 0$, satisfies the following equation:

$$\left.\frac{\partial W_h}{\partial v}\right|_{v=0} = \gamma(e_f + s - 3t) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \text{ if } s \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} \widehat{s}(t) \equiv 3t - e_f \tag{10}$$

$$\left(\text{or equivalently, if } t \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} \widehat{t}(s) \equiv \frac{e_f + s}{3}\ \right).$$

Though if the subsidy exceeds a threshold $\widehat{s}(t)$, the domestic government levies a CVD, a positive CVD is not available in Case I. As such, in Case I, the subsidy level must not exceed a threshold $\widehat{s}(t)$, i.e., $s \leq \widehat{s}(t)$.

[5] The superscript $**$ denotes the optimal interior solution of the variables.

3.2.2 Case II

In Case II, the solution is interior. As $L_v = 0$ and $\lambda^* = 0$, $L_v = \frac{\partial W_h}{\partial v} = \gamma(e_f + s - 3t - 3v) = 0$. The optimal CVD level is calculated as $v^{**}(s,t) = \frac{e_f + s - 3t}{3}$. As $0 \leq v^{**}(s,t) \leq s$ must be satisfied in the interior solution, $s \geq \max\{\widehat{s}(t), -\frac{\widehat{s}(t)}{2}\}$, where $\widehat{s}(t) \equiv 3t - e_f$ (or equivalently, $-2s \leq \widehat{s}(t) \leq s$) must hold in Case II. It should be noted that $v^{**}(\widehat{s}(t), t) = 0$ and $v^{**}(-\frac{\widehat{s}(t)}{2}, t) = -\frac{\widehat{s}(t)}{2}$. The partial derivative of $v^{**}(s,t)$ on s is $\frac{\partial v^{**}(s,t)}{\partial s} = \frac{1}{3} < 1$. The partial derivative of $v^{**}(s,t)$ on t is $\frac{\partial v^{**}(s,t)}{\partial t} = -1$.

3.2.3 Case III

In Case III, as $L_v = 0$ and $\lambda^* \geq 0$, $L_v = \frac{\partial W_h}{\partial v} - \lambda^* = 0$ is satisfied. By arranging this first-order condition, we obtain $\lambda^* = \gamma(e_f + s - 3t - 3v)(\geq 0)$. In the corner solution $v^* = s$, $\lambda^* = \gamma(e_f - 2s - 3t)$ is satisfied. $\frac{\partial W_h}{\partial v}$, which is evaluated at $v = s$, satisfies the following equation:

$$\left.\frac{\partial W_h}{\partial v}\right|_{v=s} = \gamma(e_f - 2s - 3t)\left\{\begin{array}{c} > \\ = \\ < \end{array}\right\} 0 \ \text{ if } \ s \left\{\begin{array}{c} < \\ = \\ > \end{array}\right\} -\frac{\widehat{s}(t)}{2} \tag{11}$$

$$\text{(or equivalently, if } \ t \left\{\begin{array}{c} < \\ = \\ > \end{array}\right\} \frac{e_f - 2s}{3}(= \widehat{t}(s) - s\ ).$$

Though if the subsidy exceeds a threshold $-\frac{\widehat{s}(t)}{2}$, the home government levies a CVD less than the subsidy, the interior solution on CVD is not possible in Case III. As such, in Case III, the subsidy level does not exceed a threshold $-\frac{\widehat{s}(t)}{2}$ and the home government levies a CVD equal to the subsidy.

3.2.4 Summary of the third stage

If $t > \frac{e_f}{3}$, $\widehat{s}(t) > 0$. In this case, by (11), $\frac{\partial W_h}{\partial v}|_{v=s} < 0$. As such, the optimal CVD level must be such that $v^* < s$. This case corresponds to Case I or Case II. If $t = \frac{e_f}{3}$, $\widehat{s}(t) = 0$. By (10) and (11), $\frac{\partial W_h}{\partial v}|_{v=0} \geq 0$ and $\frac{\partial W_h}{\partial v}|_{v=s} \leq 0$. This case corresponds to Case II. The optimal CVD is $v^{**}(s,t)$. If $t < \frac{e_f}{3}$, $\widehat{s}(t) < 0$. By (10), $\frac{\partial W_h}{\partial v}|_{v=0} > 0$. As such, the optimal CVD level must be such that $v^* > 0$. This case corresponds to Case II and Case III. Therefore, the optimal CVD level of the third stage is summarized as follows:

$$v^* = \begin{cases} 0 & t > \frac{e_f}{3} \text{ and } s < \widehat{s}(t) \\ v^{**}(s,t) \quad \text{if} & t > \frac{e_f}{3} \text{ and } s \geq \widehat{s}(t), \text{ or } t < \frac{e_f}{3} \text{ and } s \geq -\frac{\widehat{s}(t)}{2}, \text{ or } t = \frac{e_f}{3} \text{ and } \forall s \\ s & t < \frac{e_f}{3} \text{ and } s < -\frac{\widehat{s}(t)}{2}. \end{cases} \tag{12}$$

where $v^{**}(s,t) = \frac{e_f+s-3t}{3}$. Obviously, the optimal CVDs depend on the existing levels of foreign export subsidy and import tariff. Based on whether import tariff t exceeds $\frac{e_f}{3}$, we can classify all cases into three types: Cases (i), (ii), and (iii). In Case (i) ((ii) and (iii)), $t < \frac{e_f}{3}$ ($t = \frac{e_f}{3}$ and $t > \frac{e_f}{3}$). We depict the optimal CVDs in the three cases in Figures 2–4 respectively:

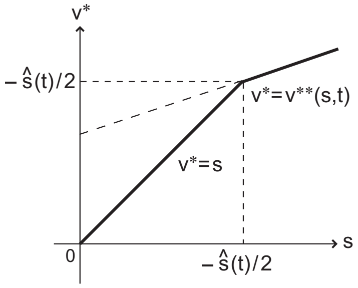

Figure 2: Case (i) $t < \frac{e_f}{3}$

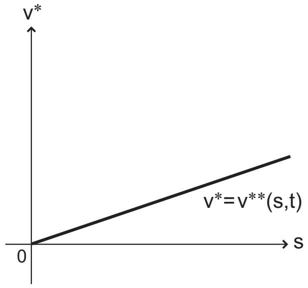

Figure 3: Case (ii) $t = \frac{e_f}{3}$

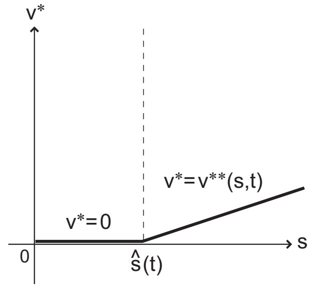

Figure 4: Case (iii) $t > \frac{e_f}{3}$

Now, from (12), we can summarize what happens if the constraint on CVD is required, as is stipulated under WTO agreements, in the following proposition.

Proposition 1. *Suppose that a constraint on CVDs such that they cannot exceed foreign export subsidies is required. If the existing import tariff and foreign export subsidy are sufficiently low, the optimal CVD is equal to the subsidy. If the subsidy is sufficiently high, regardless of the import tariff, the optimal CVD is less than the subsidy. If the import tariff is sufficiently low and the export subsidy is sufficiently high, CVD is not levied. More exactly, if* $t < \frac{e_f}{3}$ *and* $s < -\frac{\widehat{s}(t)}{2}$*, then* $v^* = s$*. If* $s \geq \widehat{s}(t)$ *when* $t < \frac{e_f}{3}$*, if* $s \geq -\frac{\widehat{s}(t)}{2}$ *when* $t < \frac{e_f}{3}$*, and for all* s *when* $t = \frac{e_f}{3}$*,* $v^* = v^*(s,t) < s$*. If* $t > \frac{e_f}{3}$ *and* $s < \widehat{s}(t)$*, then* $v^* = 0$.

Several existing articles do not take the upper limit that is imposed to the CVD into consideration. Wang (2004) insists that the optimal CVD may be more than the full foreign export subsidy when the existing import tariff is sufficiently low. The introduction of the additional constraint on CVD excludes the possibility that the CVD is more than the export subsidy. Under the additional constraint, our result insists that the optimal CVD is at most equal to the foreign export subsidy even if the tariff is sufficiently low. In the following subsection, we examine how the introduction of the additional constraint affects the optimal subsidy policy in equilibrium.

3.3 Second stage

In the second stage, after observing the level of import tariff t, the foreign government chooses the level of foreign export subsidy to maximize foreign welfare. Foreign welfare is defined by the foreign firm's profit minus the subsidy expenditure, $W_f = \pi_f - sy_f$. The maximization problem of the foreign government in the second stage is delineated as follows:

$$\max_{s \geq 0} W_f = \pi_f - sy_f (= y_f^2 - K_f - sy_f), \tag{13}$$

$$\text{s.t. } v = v^*, \ (3) \text{ and } (4), \tag{14}$$

where the optimal CVD v^* satisfies (12).

To solve the optimal subsidy level s^*, which depends on the import tariff level, let us separately consider the cases where t exceeds $\frac{e_f}{3}$ and where it does not. Case (i) ((ii) and (iii)) denotes the case in which $t < \frac{e_f}{3}$ ($t = \frac{e_f}{3}$ and $t > \frac{e_f}{3}$), as is shown in Figure 2 (3 and 4).

3.3.1 Case (i)

In Case (i) $t < \frac{e_f}{3}$, the optimal CVD is $v^* = s$ if $s < -\frac{\widehat{s}(t)}{2}$ and $v^* = v^{**}(s,t)$ if $s \geq -\frac{\widehat{s}(t)}{2}$. First, let us consider the optimal subsidy when $s \geq -\frac{\widehat{s}(t)}{2}$. As the optimal CVD is $v^{**}(s,t) = \frac{e_f+s-3t}{3}$ within this range of subsidy, the first-order condition on s to maximize foreign welfare is $\frac{dW_f}{ds} = \frac{\partial W_f}{\partial y_f}(\frac{\partial y_f}{\partial s} + \frac{\partial y_f}{\partial v}\frac{\partial v^{**}(s,t)}{\partial s}) + \frac{\partial W_f}{\partial s} = \frac{(8\gamma-3)y_f - 4\gamma s}{3} = 0$.[6] However, as the derived solution is $s = \frac{(8\gamma-3)}{4\gamma}y_f < 0$ because $8\gamma - 3 < 0$, the interior solution cannot be within the range of $s \geq -\frac{\widehat{s}(t)}{2}$. Thus, the maximum corner solution is $s = -\frac{\widehat{s}(t)}{2}$.

On the other hand, let us consider the optimal subsidy when $s < -\frac{\widehat{s}(t)}{2}$. As the optimal CVD is $v^* = s$, y_f does not depend on s and v, i.e., $y_f = \gamma(2(e_f - t) - ke_h)$. As the first-order condition on s is $\frac{dW_f}{ds} = -y_f < 0$ and the second-order condition is $\frac{d^2W_f}{ds^2} = 0$, the optimal solution is corner, that is, $s = 0$.

As W_f is continuous with respect to s, for all $s \geq 0$, as s becomes smaller, W_f becomes larger. Therefore, in Case (i), the optimal subsidy level is $s^* = 0$ and the optimal CVD is $v^* = s^* = 0$.

[6] The second-order condition is satisfied because $\frac{d^2W_f}{ds^2} = \frac{8\gamma(4\gamma-3)}{9} < 0$.

3.3.2 Case (ii)

In Case (ii) $t = \frac{e_f}{3}$, the optimal CVD is $v^* = v^{**}(s,t)$ for all $s \geq 0$. The first-order condition on s is $\frac{dW_f}{ds} = \frac{(8\gamma-3)y_f - 4\gamma s}{3} = 0$. However, as the derived solution is $s = \frac{(8\gamma-3)}{4\gamma} y_f < 0$, there is no interior solution for all $s \geq 0$. Therefore, in Case (ii), the optimal subsidy level is $s^* = 0$ and the optimal CVD is $v^* = s^* = 0$.

3.3.3 Case (iii)

In Case (iii) $t > \frac{e_f}{3}$, the optimal CVD is $v^* = 0$ if $s < \widehat{s}(t)$ and $v^* = v^{**}(s,t)$ if $s \geq \widehat{s}(t)$. First, let us consider the optimal subsidy when $s \geq \widehat{s}(t)$. As the optimal CVD is $v^{**}(s,t) = \frac{e_f+s-3t}{3}$, the first-order condition on s is $\frac{dW_f}{ds} = \frac{(8\gamma-3)y_f - 4\gamma s}{3} = 0$. However, as the derived solution is $s = \frac{(8\gamma-3)}{4\gamma} y_f < 0$, the interior solution cannot be within the range of $s \geq \widehat{s}(t)$. Thus, the maximum corner solution is $s = \widehat{s}(t)$.

On the other hand, let us consider the optimal subsidy when $s < \widehat{s}(t)$. As the optimal CVD is $v^* = 0$, y_f does not depend on v, i.e., $y_f = \gamma(2(e_f + s - t) - ke_h)$. The first-order condition on s is $\frac{dW_f}{ds} = \frac{\partial W_f}{\partial y_f}\frac{\partial y_f}{\partial s} + \frac{\partial W_f}{\partial s} = (4\gamma-1)y_f - 2\gamma s = 0$ and the second-order condition is $\frac{d^2W_f}{ds^2} = 4\gamma^2(2\gamma-1) < 0$. The optimal solution satisfies $s^{**} = \frac{4\gamma-1}{2\gamma} y_f (= \frac{k^2}{2} y_f) > 0$. By arranging the above equation with respect to s^*, we obtain the optimal solution $s^{**}(t) = \frac{k^2\gamma(2(e_f-t)-ke_h)}{2(1-k^2\gamma)} = \frac{k^2(2(e_f-t)-ke_h)}{4(2-k^2)}$, which depends on t. For s^{**} to be positive, $t < \bar{t} \equiv \frac{2e_f - ke_h}{2}$. As $4e_f - 3ke_h > 0$ must hold for $\frac{e_f}{3} < \bar{t}$ in Case (iii), we assume that $4e_f - 3ke_h > 0$. $s^{**} \lesseqgtr \widehat{s}(t)$ if and only if $t \gtreqless \widehat{t} \equiv \frac{2(4-k^2)e_f - k^3 e_h}{2(12-5k^2)}$. Under this assumption, $\frac{e_f}{3} < \widehat{t} < \bar{t}$. Therefore, by combining the above result that the optimal subsidy is $s = \widehat{s}(t)$ when $s \geq \widehat{s}(t)$, we obtain the result that if $t \in (\frac{e_f}{3}, \widehat{t})$, then the optimal subsidy is $s^* = \widehat{s}(t) = 3t - e_f$, and if $t \in (\widehat{t}, \bar{t})$, then the optimal subsidy is $s^* = s^{**}(t) = \frac{k^2(2(e_f-t)-ke_h)}{4(2-k^2)}$.[7] In Case (iii), when $t \in (\frac{e_f}{3}, \widehat{t})$, the optimal subsidy level is $s^* = \widehat{s}(t)$ and the optimal CVD is $v^* = 0$. When $t \in (\widehat{t}, \bar{t})$, the optimal subsidy level is $s^* = s^{**}(t)$ and the optimal CVD is $v^* = 0$.

3.3.4 Summary of the second stage

From subsections 3.3.1–3.3.3, we can summarize the optimal CVD and the optimal subsidy in the second stage for all three cases as follows:

[7] By definition, $s^{**}(\bar{t}) = 0$.

$$v^* = 0 \quad \forall t \geq 0, \tag{15}$$

$$s^* = \begin{cases} 0 & & t \in [0, \frac{e_f}{3}) & \text{(Case (a))} \\ \widehat{s}(t) = 3t - e_f & \text{if} & t \in [\frac{e_f}{3}, \widehat{t}\,) & \text{(Case (b))} \\ s^{**}(t) = \frac{k^2(2(e_f - t) - ke_h)}{4(2-k^2)} & & t \in (\widehat{t}, \overline{t}) & \text{(Case (c)).} \end{cases} \tag{16}$$

where $\widehat{t} \equiv \frac{2(4-k^2)e_f - k^3 e_h}{2(12-5k^2)}$ and $\overline{t} \equiv \frac{2e_f - ke_h}{2}$.

Based on the size of import tariff t, we classify all cases into three types: Cases (a), (b), and (c). Case (a) $t \in [0, \frac{e_f}{3})$ contains Cases (i) and (ii) that are described in subsection 3.2. Case (b) $t \in [\frac{e_f}{3}, \widehat{t}\,)$ and Case (c) $t \in (\widehat{t}, \overline{t})$ divide Case (iii) into two parts depending the size of the import tariff. We depict the optimal subsidy in response to the level of import tariff in Figure 5.

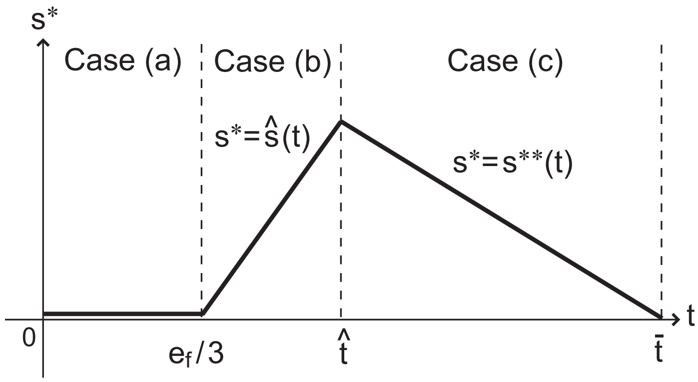

Figure 5: Optimal subsidy in the second stage

$(\widehat{s}(t) = 3t - e_f$, $s^{**}(t) = \frac{k^2(2(e_f - t) - ke_h)}{4(2-k^2)}$, $\widehat{t} \equiv \frac{2(4-k^2)e_f - k^3 e_h}{2(12-5k^2)}$ and $\overline{t} \equiv \frac{2e_f - ke_h}{2})$

From (15) and (16), we can conclude the optimal CVD and the optimal subsidy when the constraint on the CVD is added, in the following proposition.

Proposition 2. *The optimal CVD is always zero regardless of the levels of subsidy and import tariff. Under the constraint, CVDs are never levied by the home government.*

When the existing import tariff is sufficiently low, the subsidy is zero, despite the fact that CVDs are not implemented. When the tariff is sufficiently high, the optimal subsidy can be a positive value and the CVD does not deter this subsidy. More exactly, if $t \leq \frac{e_f}{3}$*, then* $s^* = 0$*, and if* $t > \frac{e_f}{3}$*, then* $s^* > 0$.

Proposition 2 implies that for all cases, the home government does not levy any CVD on the foreign firm. This result is in sharp contrast with the existing literature. The second proposition of Wang (2004) insists that when the existing import tariff is sufficiently low (high), the optimal CVD can (cannot) deter the export subsidy set by the foreign government. In contrast, in our model wherein the additional constraint on CVD is introduced, CVD is never levied. It seems more appropriate that CVD is not levied under the constraint when the subsidy is not given by the foreign country. Moreover, even though the foreign country gives a positive subsidy, the domestic government does not levy any CVD and therefore never deters the foreign government from setting the export subsidy. In other words, in our model, CVDs do not function effectively to prevent foreign export subsidies.

The optimal subsidy depends only on the level of the import tariff. If the tariff is relatively low, the foreign government does not subsidize the foreign firm. On the other hand, if the tariff is sufficiently high, it gives a positive subsidy to the foreign firm to restore the competitiveness of the foreign firm. Different from CVD, the import tariff functions effectively to determine the level of export subsidy.

To be precise, the result that the CVD does not function effectively to prevent the export subsidy has no relationship with whether or not the constraint on CVD is added. Even if the constraint is not taken into consideration, the subsidy cannot be prevented only by CVD. The level of import tariff imposed by the domestic government in the first stage determines whether the foreign country gives export subsidy and the level of subsidy in the next stage; the existing literature does not exhibit such an implication explicitly, despite the fact that the existing literature implies that the import tariff affects the subsidy. Two instruments of trade policy for the home country —the import tariff in the first stage and the CVD in the third stage— play a similar role to maintain domestic welfare and discourage the foreign government from subsidizing the export firm. In the model, the only difference between the two is the timing. Therefore, if the import tariff functions effectively to achieve its purpose, it is natural that CVD is nullified, because the domestic country has a larger number of trade policy instruments than the foreign country. Therefore, even if there is a constraint on CVD, proper setting of the import tariff can completely coordinate the distortion in market competition arising from export subsidies. When the import tariff precedes CVD, the domestic government prefers not to activate the CVD and may actually prefer to connive the foreign export subsidy from the viewpoint of the maximization of domestic welfare.

In the following subsection, we clarify the trade policy in the subgame perfect equilibrium. We examine how the introduction of the additional constraint affects the optimal tariff policy of the domestic government in the equilibrium.

3.4 First stage

In the first stage, the home government chooses the level of import tariff t. The home government maximizes domestic social welfare $W_h = CS + \pi_h + (t+v)y_f$. The maximization problem of the domestic government in the first stage is delineated as follows:

$$\max_{t \geq 0} W_h = CS + \pi_h + (t+v)y_f, \tag{17}$$

$$\text{s.t. } s = s^*, \ v^* = 0, \ (3), \ \text{and } (4), \tag{18}$$

where the optimal subsidy s^* satisfies (16).

To solve the optimal import tariff t^*, let us separately consider the three cases classified on the basis of the size of t, as in Figure 5. Case (a) ((b) and (c)) denotes the case in which $t \in [0, \frac{e_f}{3})$ ($t \in [\frac{e_f}{3}, \widehat{t})$ and $t \in [\widehat{t}, \overline{t})$), where $\widehat{t} \equiv \frac{2(4-k^2)e_f - k^3 e_h}{2(12-5k^2)}$ and $\overline{t} \equiv \frac{2e_f - ke_h}{2}$.

3.4.1 Case (a)

In Case (a) $t \in [0, \frac{e_f}{3})$, $s^* = v^* = 0$. Substituting $s^* = v^* = 0$ into W_h and differentiating W_h with respect to t, we obtain $\frac{dW_h}{dt} = \frac{\partial CS}{\partial t} + \frac{\partial \pi_h}{\partial t} + y_f + t\frac{\partial y_f}{\partial t} = \gamma(e_f - 3t)$. As the first-order condition is $\frac{dW_h}{dt} = 0$ and the second-order condition is $\frac{d^2 W_h}{dt^2} = -3\gamma < 0$, the maximized value is $t = \frac{e_f}{3}$. Thus, in Case (a), the maximum corner solution is $t = \frac{e_f}{3}$.[8]

3.4.2 Case (b)

In Case (b) $t \in [\frac{e_f}{3}, \widehat{t})$, $s^* = \widehat{s}(t) = 3t - e_f$ and $v^* = 0$. Substituting $s^* = 3t - e_f$ and $v^* = 0$ into W_h, and differentiating W_h with respect to t, we obtain $\frac{dW_h}{dt} = \frac{\partial CS}{\partial t} + \frac{\partial \pi_h}{\partial t} + y_f + t(\frac{\partial y_f}{\partial t} + \frac{\partial y_f}{\partial \widehat{s}}\frac{\partial \widehat{s}}{\partial t}) = \gamma(4\widehat{e}_f - 3ke_h + 4t)$. The second-order condition is satisfied because $\frac{d^2 W_h}{dt^2} = -8\gamma < 0$. By the first-order condition $\frac{dW_h}{dt} = 0$, the optimal tariff is obtained as $t = \frac{ke_h}{4}$. However, under the assumption that $4e_f - 3ke_h > 0$, $\frac{ke_h}{4} < \frac{e_f}{3}$. Thus, within the interval of $t \in [\frac{e_f}{3}, \widehat{t})$, the optimal tariff is a corner solution. Thus, in Case (b), the maximized value is $t = \frac{e_f}{3}$.

[8] More exactly, the solution is an open solution because $t \in [0, \frac{e_f}{3})$ is an open interval with respect to the upper bound.

3.4.3 Case (c)

In Case (c) $t \in [\widehat{t}, \overline{t})$, $s^* = s^{**}(t) = \frac{k^2(2(e_f - t) - ke_h)}{4(2-k^2)}$ and $v^* = 0$. Substituting s^{**} and $v^* = 0$ into W_h, and differentiating W_h with respect to t, we obtain $\frac{dW_h}{dt} = \frac{\partial CS}{\partial t} + \frac{\partial \pi_h}{\partial t} + y_f + t(\frac{\partial y_f}{\partial t} + \frac{\partial y_f}{\partial s^{**}}\frac{\partial s^{**}}{\partial t}) = \frac{\gamma(k^3 e_h + (4-3k^2)\widehat{e}_f) - 2t}{2(2-k^2)}$. The second-order condition is satisfied because $\frac{d^2 W_h}{dt^2} = -\frac{12-7k^2}{4(2-k^2)^2} < 0$. By the first-order condition $\frac{dW_h}{dt} = 0$, the optimal tariff is obtained as $t^{**} = \frac{k^3 e_h + 2(4-3k^2)e_f}{2(12-7k^2)} > 0$. However, under the assumption that $4e_f - 3ke_h > 0$, $t^{**} < \widehat{t}$.[9] Thus, within the interval of $t \in [\widehat{t}, \overline{t})$, the optimal tariff is a corner solution. Thus, in Case (c), the maximized value is $t = \widehat{t}$.

3.4.4 Summary of the first stage

From subsections 3.4.1–3.4.3, the relationship between the tariff and domestic welfare is as in Figure 6.

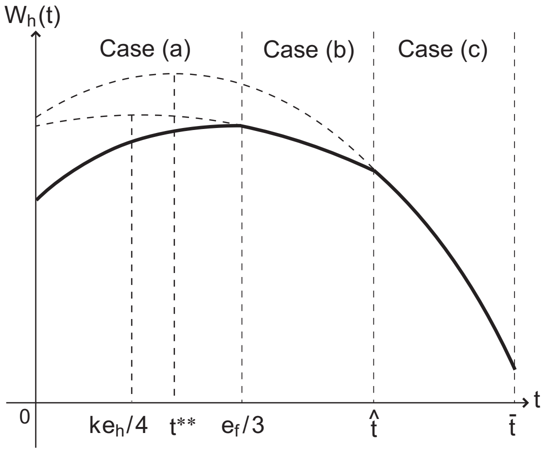

Figure 6: Optimal tariff in the first stage ($\frac{ke_h}{4} < t^{**} < \frac{e_f}{3}$ is satisfied)

Now, we can clarify the trade policy in the subgame perfect equilibrium. In the first stage, the domestic government sets the import tariff at $t^* = \frac{e_f}{3}$. In the second stage, the foreign government does not subsidize the foreign firm, i.e., $s^* = 0$. In the third stage, the domestic government does not levy any CVD on the foreign firm, i.e., $v^* = 0$. Given the trade policy, $(s^*, t^*, v^*) = (0, \frac{e_f}{3}, 0)$, the domestic firm and the foreign firm engage in Cournot quantity competition.

We summarize the result for the optimal import tariff in the following proposition.

[9] Moreover, $t^{**} < \frac{e_f}{3}$ is satisfied under the assumption $4e_f - 3ke_h > 0$.

Proposition 3. *The optimal import tariff is set at a level at which the optimal foreign export subsidization does not occur and hence the optimal CVD is zero. That is, under the constraint on CVD, the optimal trade policy is* $(s^*, t^*, v^*) = (0, \frac{e_f}{3}, 0)$.

It seems at first glance that under the constraint that the CVD cannot exceed the foreign export subsidy, foreign export subsidization is likely to occur. However, Proposition 3 implies that under this constraint, foreign export subsidization cannot occur and therefore CVD is not levied. This proposition contrasts with the existing literature that excludes any constraint on CVD. In his third proposition, Wang (2004) presents the result that the optimal import tariff is so high that the optimal CVD is zero and hence foreign export subsidization occurs. Our result shows that as the import tariff appropriately prevents the foreign export subsidy, the CVD has no substantial role to play.

The difference in the results can be attributed to the existence of a constraint on CVD. When the foreign government gives an export subsidy to the foreign firm, it must take into consideration the possibility that the domestic government might retaliate against the subsidy through CVDs. When there is no constraint on CVD, even if there is no or little subsidy, it is possible that the domestic government levies a CVD that exceeds the given subsidy to the foreign firm. If an excessive CVD is levied, the foreign government might give a sufficiently high export subsidy in advance to countervail the following CVD. Such a situation that is analogous to an arms race results in positive subsidization by the foreign government. In equilibrium, CVDs are not actually levied because the import tariff completely captures the profit shifting from the foreign firm. However, the positive export subsidy enhances the optimal import tariff. In contrast, when there is a constraint on CVD such as in our paper, the foreign government forecasts that the domestic government will not levy an excessive CVD. In this case, if the foreign government decides to give an export subsidy, a moderate CVD can be levied. In equilibrium, as the import tariff and not the CVD completely captures the profit shifting, foreign subsidization does not occur and CVDs are not levied. As a result, the optimal import tariff is relatively low as there is no export subsidy.

3.5 Equilibrium outputs and profits

Finally, we compare the equilibrium outputs and profits of the domestic firm and the foreign firm under the optimal trade policy. Substituting $(s^*, t^*, v^*) = (0, \frac{e_f}{3}, 0)$ into (3) and (4), we can obtain the equilibrium outputs and profits as follows:

$$y_h^* = \frac{2\gamma}{3}(3e_h - ke_f), \quad y_f^* = \frac{\gamma}{3}(4e_f - 3ke_h), \tag{19}$$

$$\pi_h^* = \frac{4\gamma^2}{9}(3e_h - ke_f)^2 - K_h, \quad \pi_f^* = \frac{\gamma^2}{9}(4e_f - 3ke_h)^2 - K_f. \tag{20}$$

To compare the equilibrium outputs and profits of the domestic firm and the foreign firm, we assume that both firms are identical. That is, $e_h = e_f \equiv e$ (i.e., $a_h = a_f \equiv a$ and $c_h = c_f \equiv c$) and $K_h = K_f \equiv K$. When both firms are identical, the following proposition is immediately obtained by (19) and (20).

Proposition 4. *Suppose that the domestic firm and the foreign firm are identical. The equilibrium output of the domestic firm is larger than that of the foreign firm. The equilibrium profit of the domestic firm is larger than that of the foreign firm. That is, $y_h^* > y_f^*$ and $\pi_h^* > \pi_f^*$.*

Proof. As $y_h^* = \frac{2\gamma(3-k)}{3}e$ and $y_f^* = \frac{\gamma(4-3k)}{3}e$ under the assumption $e_h = e_f \equiv e$, $y_h^* - y_f^* = \frac{\gamma(2+k)}{3}e > 0$. As $\pi_i = y_i^2 - K_i$, $\pi_h^* > \pi_f^*$ because $K_h = K_f \equiv K$. □

Proposition 4 implies that when the domestic firm and the foreign firm have the same production technologies, the domestic firm produces more than the foreign firm and as a result, the domestic firm acquires a larger profit than the foreign firm under the optimal trade policy. As the optimal trade policy in equilibrium is $(s^*, t^*, v^*) = (0, \frac{e_f}{3}, 0)$, the domestic government imposes on the foreign firm a positive import tariff and the foreign government does not give the foreign firm any export subsidy. The difference between the home government's support for their firms and the foreign government's support for their firms in respective national firms determines the competitive advantage of the firms. When there is a constraint on CVD, as in, the foreign government does not subsidize the foreign firm while the domestic government imposes a tariff on the foreign firm, the domestic firm that is protected by the import tariff enjoys a larger profit because of its cost advantage.

4 Concluding Remarks

In this paper, we examined how the optimal trade policy is affected by the existence of a constraint on CVD that is as stipulated in WTO agreements. We clarified that in the equilibrium trade policy, CVDs are not levied on the foreign firm under the constraint that the CVDs cannot exceed the foreign export subsidies; this contrasts with the existing literature. CVDs with the constraint do not trigger harsh competition between the governments over trade policy; this results in the foreign export subsidy being reduced and as a result, the domestic firm acquiring a competitive advantage. Our results suggest that by introducing an actual constraint on CVD, a more realistic explanation for the role of CVD as a deterrent to prevent protectionism can be presented.

Finally, we make some comments on the result that the CVD has no substantial role to play. In the model, the domestic government uses import tariff and CVD for the same purpose to maximize domestic welfare. Our result suggests that if the domestic government can utilize these two instruments of trade policy that differ only in timing, only one of the two instruments is needed. Therefore, multiple policy instruments are excessive. In the case of strategic substitutes under imperfect competition, the first-mover policymaker acquires a competitive advantage. The domestic government can maximize domestic welfare by appropriately choosing the import tariff anticipating the forthcoming export subsidy to be given by the foreign government. Hence, as Wang (2004) correctly pointed out, the profit shifting has been completely captured by the import tariff and hence the CVD cannot do anything.

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