연세경제연구 제 IX권 제 I 호
Yonsei Economic Studies, Vol. IX, No. 1 (March 2002)

Export Subsidy, Import Tariff and World Welfare

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This paper examines the effect of export subsidies and import tariffs on national welfare and world welfare under imperfect competition. The paper recognizes the possibility that an increase in export subsidies increases national welfare of an exporting country and that of an importing country as well. Similarly, a decrease in import tariffs proves to be able to augment national welfare of the importing country and that of the exporting country at the same time. The paper identifies the region of export subsidies and import tariffs in which an increase in export subsidies, or a decrease in import tariffs, improves world welfare without hurting any country.

I. Introduction

There is large volume of literature on the effects of export subsidies and

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import tariffs upon the pattern of international trade and national welfare under imperfect competition. On the exporter's side, Brander and Spencer[1] and Eaton and Grossman[2] have shown that the government of an exporting country has an incentive to give export subsidies to domestic firms to help the domestic firms capture a larger share of a profitable international market. On the importer's side, Katrak,[3] Svedberg,[4] and Brander and Spencer[5] have demonstrated that an import tariff can increase national welfare of the importing country. Little attention, however, has been paid to the effect of export subsidies and import tariffs on national welfare of the other country.

Mai and Hwang[6] have analyzed the effect of domestic export subsidies on national welfare of the foreign importing country under imperfect competition. An export subsidy is shown to increase national welfare of the foreign importing country if the demand curve is linear and the market share of the domestic firm is greater than that of the foreign firm. However, they determine the effect of export subsidies under the highly restrictive assumption that the domestic government is the only active government to intervene in international trade ; the possibility of intervention by the foreign government is neglected. Furthermore, they have not analyzed the effect of export subsidies on national welfare of the exporting country. That is, their analysis is confined to the change in national welfare of the importing country, though they asserted that they examined the conditions under which an export subsidy increases world welfare.

In this paper we construct a general model to analyze the effects of export

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1) Brander and Spencer [3].
2) Eaton and Grossman [5].
3) Katrak [7].
4) Svedberg [10].
5) Brander and Spencer [1] [2].
6) Mai and Hwang [9].

subsidies and import tariffs on world welfare. The model allows for both an export subsidy of an exporting country and an import tariff of an importing country. The existence of export subsidies and import tariffs has two effects. First, tariff revenue should be included in the definition of national welfare of the importing country. Second, the effects of an export subsidy and an import tariff on national welfare depend upon both export subsidies and import tariffs.

An increase in export subsidies turns out to have exactly the same effect on world welfare as a decrease in import tariffs by the same amount. An increase in export subsidies is found to increase national welfare of the importing country if the initial import tariff is greater than or equal to the initial optimal tariff level. Similarly, a decrease in import tariffs augments national welfare of the exporting country if the initial export subsidy is less than or equal to the initial optimal subsidy level. By combining these results, we identify the set of combinations of an export subsidy and an import tariff where either an increase in subsidy or a decrease in tariff improves world welfare in the Pareto sense. However, an increase of export subsidies can reduce foreign welfare when the initial import tariff is less than the optimal. In the next section these results are derived from the generalized version of Mai and Hwang.[7] An example is constructed to show the invalidity of the proposition of Mai and Hwang[8] and to show the possibility of a reduction in foreign welfare by an increase of an export subsidy when the initial tariff is less than the optimal. The set of export subsidies and import tariffs is illustrated where either an increase in export subsidy or a decrease in tariff Pareto-improves world welfare.

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7) Mai and Hwang [9].

8) Mai and Hwang [9] p. 187.

Ⅱ. The Model

There are two countries, 'domestic' and 'foreign'. Each country has one firm producing a homogeneous good. It is further assumed that the good is not consumed in the domestic country so that all goods produced by the domestic firm are exported to the foreign country.[9]

The domestic government sets the level of an export subsidy. The foreign government levies an import tariff. Subsequently, domestic and foreign firms, taking the levels of a subsidy and a tariff as given, make output decisions and arrive at a Cournot-Nash equilibrium.

The inverse market demand for the good is given by

$$P = P(x + y) \tag{1}$$

where x and y are production volumes of domestic and foreign firm, respectively. P is assumed to be downward-sloping and twice continuously differentiable. Domestic and foreign firms' profits can be written as, respectively

$$F = P(x + y)x - c(x) + sx - tx \tag{2}$$

$$F^* = P(x + y)y - c^*(y) \tag{3}$$

where s is a per-unit specific subsidy and t is a per-unit specific tariff. c and c^* are cost functions. Variables with an asterisk * are associated with the foreign country. A Cournot-Nash equilibrium can be found by solving the first-order conditions of profit maximization.

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9) This assumption can be relaxed to allow for two-way trade. See Dixit [4] and Kang and Lee [6].

$$F_x = P'x + P - c'(x) + s - t = 0 \tag{4}$$

$$F_y^* = P'y + P - c^{*\prime}(y) = 0 \tag{5}$$

Each subscript denotes partial differentiation with respect to that subscript. The second order conditions $F_{xx} < 0$, $F_{yy}^* < 0$ and the stability condition for the Cournot-Nash solution are assumed to be satisfied[10] From (4) and (5), x and y can be expressed as functions of s and t by the implicit function theorem, since the stability condition is assumed to be satisfied. By totally differentiating (4) and (5), we obtain comparative static results of changes of s and t.

$$x_s = -x_t = -(2P' + yP'' - c^{*\prime})/D > 0 \tag{6}$$

$$y_s = -y_t = (P' + yP'')/D < 0 \tag{7}$$

where $D = F_{xx}F_{yy}^* - F_{xy}F_{yx}^* > 0$ by the stability condition. These results have the same qualitative implications as the counterpart results obtained by Brander and Spencer[11] and Mai and Hwang.[12]

We now examine the effects of a change of an export subsidy or an import tariff on national and world welfares. Domestic, foreign, and world welfare are given by, respectively

$$W = U(x, y) - tx \tag{8}$$

$$W^* = V(x, y) + tx \tag{9}$$

$$G = W + W^* = U(x, y) + V(x, y) \tag{10}$$

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10) For a detailed discussion, see Dixit [4].

11) Brander and Spencer [3].

12) Mai and Hwang [9].

where $U(x, y)$ and $V(x, y)$ are continuously differentiable with respect to x and y. W and W^* can represent a wide variety of definitions of national welfare. The typical definition of W is profit less subsidy. In that case $U(x, y)$ is just the total revenue less total production cost of the firm. A typical characterization of $V(x, y)$ is the sum of consumer surplus and profits. Since x and y are functions of s and t, both W and W^* are functions of s and t. From (10) we find that

$$G_s = -G_t$$

An increase in an export subsidy has exactly the same effect on world welfare as a decrease in an import tariff by the same amount.

We now analyze the effects of export subsidies and import tariffs on national welfare. W is assumed to be strictly concave with respect to s for a given t. Furthermore, for any t, the equation $W_s(s, t) = 0$ is assumed to have a solution denoted by s^*. This simply means that the exporting country cannot increase national welfare indefinitely by either increasing or decreasing the level of an export subsidy indefinitely. Since W is strictly concave with respect to s, it follows that s^* is unique for a given t and can be expressed as a function of t, i.e., $s^* = s^*(t)$. For a given t, s^* denotes the optimal export subsidy which maximizes national welfare of the exporting country.

By the same reasoning, W^* is assumed to be strictly concave with respect to t for a given s. For any s, the equation $W_t^*(s, t) = 0$ is again assumed to have a solution denoted by t^*. t^* is unique for a given s and, hence, can be expressed as a function of s, i.e., $t^* = t^*(s)$. t^* is the optimal import tariff. Now the main results are stated.

Proposition 1

For any $s \leq s^*(t)$,

(i) $W_s(s, t) \geq 0$

(ii) $W_t(s, t) < 0$.

<proof>

(i) This comes from the definition of s^*.

(ii) By partially differentiating W with respect to t, we obtain

$$\begin{aligned} W_t &= U_x x_t + U_y y_t - t x_t - x \\ &= -(U_x x_s + U_y y_s - t x_s) - x \qquad \text{(by (4) and (5))} \\ &= -W_s - x \end{aligned}$$

Since W is strictly concave with respect to s, $W_s \geq 0$, for any $s \leq s^*(t)$.

Hence, $W_t(s, t) < 0$ for any $s \leq s^*(t)$. Q.E.D.

Proposition 1 indicates that a decrease (increase) in an import tariff by the foreign importing country always increases (decreases) national welfare of the exporting country if the initial export subsidy has been on or below the optimal level.

We now examine the effect of a change in export subsidy on national welfare of the foreign importing country. We obtain

Proposition 2

For any $t \geq t^*(s)$,

(i) $W_t^*(s, t) \leq 0$

(ii) $W_s^*(s, t) > 0$

<proof>

(i) This comes from the definition of t^*.

(ii) W^* is differentiated with respect to t, to obtain:

$$W_t^* = V_x x_t + V_y y_t + t x_t + x$$

$$= -(V_x x_s + V_y y_s + t x_s) + x$$

$$= -W_s^* + x$$

Since $W_t^* \leq 0$ for any $t \geq t^*(s)$, it follows that W_s^* is positive for any $t \geq t^*(s)$. Q.E.D.

In other words, an increase (decrease) of an export subsidy always increases (decreases) national welfare of the importing country if the initial import tariff has been greater than or equal to the optimal import tariff. An intuitive explanation for this result is as follows. When an import tariff is above the optimal level, a decrease of an import tariff would increases national welfare of the importing country. An increase of an export subsidy has the stronger effect on national welfare of the importing country than a decrease of an import tariff since the portion of tariff revenues, which might have been given up in case of a tariff reduction, is saved. Hence, an increase of an export subsidy increases national welfare of the importing country.

By combining *Proposition 1* and *Proposition 2* together, we can identify the region where an increase in subsidy or a decrease in tariff improves national welfares in a Pareto sense. Let us define

$$I \equiv \{ (s, t) \mid s \leq s^*(t), t \geq t^*(s) \}.$$

Proposition 3 is now obtained.

Proposition 3

For any (s, t) which belongs to I,

(i) A decrease in an import tariff Pareto-improves world welfare,

(ii) An increase in an export subsidy Pareto-improves world welfare.

We have identified the region of (s, t) in which an increase in an export subsidy or a decrease in an import tariff Pareto-improves world welfare. Note that the Nash equilibrium set (s^*, t^*) belongs to I. In the interior of I, an exporting country has an incentive to increase an export subsidy and both exporting and importing countries will benefit from this increase. Conversely, an importing country has an incentive to decrease an import tariff in this region.

The remaining question is whether $W_s^*(W_t)$ is negative (positive) when the initial import tariff (export subsidy) has been less (greater) than the optimal. Since both x and W_t^* are decreasing functions of t when $t < t^*(s)$, W_s^* can be either positive or negative. The same result holds for W_t.

<An Example>

An example is now constructed to illustrate the existence of the set I and the possibility of the negativity of W_s^* when $t < t^*$. The inapplicability of the proposition of Mai and Hwang[13] is also illustrated in the example.

Consider a linear demand curve

$$P = A - x - y \tag{11}$$

13) Mai and Hwang [9] p. 187.

From the first-order conditions of profit maximization, x and y can be easily calculated as

$$x = (A - 2c + 2s - 2t + c^*)/3 \tag{12}$$

$$y = (A + c - s + t - 2c^*)/3 \tag{13}$$

where c and c^* are constant marginal costs.

W is assumed to be the profit less subsidy expenditure. W^* is assumed to the sum of consumer surplus, profit and tariff revenue. W and W^* are given by, respectively

$$W = (A - s - 2c + c^* - 2t)(A - 2c + 2s + c^* - 2t)/9 \tag{14}$$

$$\begin{aligned} W^* = {} & (2A - c + s - t - c^*)^2/18 && \text{(consumer surplus)} \\ & + (A + c - s + t - 2c^*)^2/9 && \text{(profit)} \\ & + t(A - 2c + 2s - 2t + c^*)/3 && \text{(tariff revenue)} \end{aligned} \tag{15}$$

By solving the equations, $W_s = 0$ and $W_t^* = 0$, we find:

$$s^* = (A - 2c + c^* - 2t)/4 \tag{16}$$

$$t^* = (A - c + s)/3 \tag{17}$$

Then $I = \{(s, t) \mid s \le (A - 2c + c^* - 2t)/4, t \ge (A - c + s)/3\}$.

By partially differentiating W^* with respect to s, we obtain

$$W_s^* = (t + c^* + s - c)/3. \tag{18}$$

Thus, $W_s^* > (<)\, 0$ as $t + c^* + s > (<)\, c$.

One can show that W_s^* can have any sign when $t < t^*$. Take $A = 100$, $c = 20$, $s = 1$, $c^* = 15$ so that $t^* = 27$. Insert these values into (18) to obtain $W_s^* = (t-4)/3$. Then $W_s^* < 0$ when $t < 4$ and $W_s^* > 0$ when $t > 4$.

To show that the proposition of Mai and Hwang[14] need not hold, let $c = c^*$. From (12) and (13), $x > (<) y$ as $s > (<) t$. From (18),

$$W_s^* > (<) 0 \quad \text{as} \quad t + s > (<) 0.$$

Assume $t > s > 0$. Then, $x < y$ and $W_s^* > 0$. This result contradicts the proposition of Mai and Hwang[15] which states that W_s^* is negative (positive) when $x < (>) y$. Thus, the proposition of Mai and Hwang[16] is found to be inapplicable in a more general model including an import tariff.

Ⅲ. Concluding Remarks

We have identified the region in which an increase in export subsidy or a decrease in import tariff improves world welfare without hurting any country. In such a region an importing country will not be against an increase in export subsidy of an exporting country even when there is domestic production in the importing country. At the same time the importing country has an incentive to lower the import tariff even without the corresponding tariff reduction of the other country.

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14) Mai and Hwang [9].
15) Mai and Hwang [9] p. 187.
16) Mai and Hwang [9].

The analysis in this paper is confined to the simple duopoly case. However, the number of firms does not change the result qualitatively. It can also easily be verified that the same results are obtained in an ad valorem subsidy-tariff regime as well.

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