Export Subsidies and Retaliation under Conditions of Variable Marginal Costs*

Masayuki Hayashibara

Abstract

Can domestic retaliation deter foreign export subsidies? We investigate this issue using the model of a three-stage trade policy game developed in particular by Dixit (1988) and Collie (1991). The foreign government sets an export subsidy at stage one, and at stage two the home government responds with a production subsidy and a tariff. At stage three, one home firm and one foreign firm compete in the domestic market in a Cournot fashion. Related results regarding export subsidies and tariffs suggest that domestic retaliation can deter foreign export subsidies. However, as Qiu (1995) emphasizes, the co-existence of export subsidies and countervailing tariffs is observed quite often. Therefore, to show an example of the co-existence of an export subsidy and a countervailing tariff, we modify a model of three-stage trade policy game, allowing variable marginal costs of production. Then we can show that, though the home government responds to an increase in foreign export subsidies by increasing its tariffs and reducing its production subsidies, the overall protection that is defined as the sum of a tariff and a production subsidy may be increasing or decreasing in the foreign export subsidy. If the foreign export subsidy can reduce the overall protection, then, in fact, the foreign government should set a positive subsidy.

Key Words: Strategic Trade Policy, Export subsidy, Tariff, Retaliation, Decreasing costs

JEL Classification Numbers: F12, F13

1. Introduction

Can domestic retaliation deter foreign export subsidies? We investigate this issue using the model of a three-stage trade policy game, developed in particular by Dixit (1988) and Collie (1991). In the setup of the model, the foreign government sets an export subsidy at stage one, and at stage two the home government responds with...
a production subsidy and a tariff. At stage three, one home firm and one foreign firm compete in the domestic market in a Cournot fashion.

Before presenting our basic model, we need to briefly summarize some related results regarding export subsidies and tariffs. (1) When an industry is Cournot oligopolistic, a foreign export subsidy is positive, if the domestic country does not retaliate, and the number of foreign firms is less than that of domestic firms and demand is not too convex. (2) In a simultaneous move equilibrium, where both governments choose policy levels at the same stage, it can be shown that the home government sets a production subsidy and tariff and the foreign government sets a positive export subsidy in a Cournot duopoly case. Besides, in a Cournot oligopoly case, if the number of foreign firms is less than that of domestic firms, then a foreign export subsidy is positive. (3) Next, consider the model of a three-stage trade policy game. Collie (1991) shows three main results in the case of a homogeneous product Cournot oligopoly. (a) When the domestic country pursues an optimal trade policy, it will always gain from a foreign export subsidy. (b) When the domestic country uses a tariff and a production subsidy, the optimum domestic response to a foreign export subsidy is generally to increase its tariff and to reduce its production subsidy, and faced with such a response, the optimal foreign export subsidy is positive for non-linear demand but zero for linear demand. (c) If the domestic country can use only a tariff, the optimum domestic response is a less than fully countervailing tariff, and faced with such a response, the optimal foreign export policy is usually an export tax. Collie (1994b) shows that, in the case of a differentiated product linear demand Cournot oligopoly, when the domestic country pursues an optimal trade policy it cannot be harmed by a foreign export subsidy, and the optimum domestic response to a foreign export subsidy is generally to increase its tariff and to reduce its production subsidy. When the foreign country faces such a response, the optimal foreign policy is an export tax.

These results suggest that domestic retaliation can deter foreign export subsidies. However, as Qiu (1995) emphases, the co-existence of export subsidies and countervailing tariffs is observed quite often. Therefore, in order to show an example of the co-existence of an export subsidy and a countervailing tariff, we modify the model of a three-stage trade policy game, allowing variable marginal costs of production. Then we can show that, though the home government responds to an increase in the foreign export subsidy by increasing its tariff and reducing its production subsidy, the overall protection that is defined as the sum of a tariff and a production subsidy may be increasing or decreasing in the foreign export subsidy. If

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the foreign export subsidy can reduce the overall protection, then, in fact, the foreign government should set a positive subsidy. On the other hand, if the foreign export subsidy increases the overall protection, then the foreign government should set an export tax. If marginal costs are constant and the demand is linear, then the overall protection is not dependent on a foreign export subsidy, therefore, the optimal foreign export subsidy is zero, as shown by Collie (1991).

The remainder of this paper is organized as follows: In section 2, a basic model is presented. In particular, we derive policy reaction functions by two governments. Section 3 deals with national welfare under an exogenously determined sequence of policy moves, and provides our main proposition. Section 4 provides a summary and conclusion.

2. Basic model

We consider a two-country model in which one home firm and one foreign firm compete in the domestic market in a Cournot fashion. The home government maximizes national welfare through a production subsidy and a tariff, and the foreign government maximizes national welfare (net profit) through an export subsidy.

The game considered here has three stages, as follows:

Stage 1: The foreign government sets its export subsidy
Stage 2: The home government sets its production subsidy and tariff
Stage 3: Firms choose outputs in a Cournot fashion.

The sub-game perfect equilibrium is obtained by a process of backward induction.

2.1 Demand for goods

The home country’s household utility function $U(Q, z)$ is differentiable and strictly concave in terms of the total consumption of the homogenous good $Q$, as shown by:

\[ U(Q, z) = aQ - \frac{bQ^2}{2} + z = u(Q) + z, \quad 0 < a, b \]

where $z$ denotes consumption of the numeraire good. From the first-order condition for utility maximization by a household, we obtain a linear inverse demand function:

\[ p = a - bQ, \]

(3)
where $p$ stands for the product price and $p = du(Q)/dQ$ holds. Defining the consumer surplus as $CS = U - (pQ + z)$, substitution obtains $CS = bQ^2/2 > 0$.

2.2 Production

Consider the third stage of the game. Taking the governments' policies as given, the home firm and the foreign firm produce $x$ and $y$, respectively. Thus $Q = x + y$ holds. Let $TC_s$ and $TC_y$ be the total costs of the home firm and the foreign firm, respectively. The gross profit of each firm is:

$\pi_x = px - TC_x + sx, \quad \text{and} \quad \pi_y = py - TC_y - ty + ey,$

where $s$ and $t$ denote a specific production subsidy to a home firm, and a tariff on imports levied by the home government, and $e$ denotes an export subsidy to a foreign firm provided by the foreign government. Further, we specify the total cost $TC_j$ of firm $j$ as:

$$TC_x = c_{x1}x + \frac{c_{x2}x^2}{2}, \quad \text{and} \quad TC_y = c_{y1}y + \frac{c_{y2}y^2}{2}.$$

where $c_{x1} > 0$ and $c_{y1} > 0$. From the total cost functions, we can obtain the marginal cost function for each firm as,

$$(2) \quad MC_x = c_{x1} + c_{x2}x, \quad \text{and} \quad MC_y = c_{y1} + c_{y2}y.$$

Under Cournot competition, assuming an interior solution, the first order condition (the reaction function) for the profit maximization by each firm will be:

$$\frac{\partial \pi_x}{\partial x} = p - MC_x + s - bx = 0, \quad \text{and} \quad \frac{\partial \pi_y}{\partial y} = p - MC_y - t + e - by = 0.$$ 

The second order conditions, $2b + c_{x2} > 0$ and $2b + c_{y2} > 0$, must hold. By solving the equations in (3) for Cournot-Nash outputs, we obtain:

$$x(s, y, e) = \frac{(a - 2c_{x1} + c_{y1} + 2s - t - e)b + (a - c_{x1} + s)c_{x2}}{D_0}$$

$$y(s, t, e) = \frac{(a + c_{y1} - 2c_{y1} - s - 2t + 2e)b + (a - c_{y1} - t + e)c_{y2}}{D_0}$$

where $D_0 = 3b^2 + 2b(c_{x2} + c_{y2}) + c_{x2}c_{y2}$.

Assume that

(4)
\[(4) \quad \phi_0(c_{x2}) = -\frac{(3b + 2c_{x2})b}{(2b + c_{x2})} < c_{x2} \]

then \(D_0 > 0\) holds. The price of the product is shown as:
\[
p(s, t, e) = \frac{(a + c_{x1} + c_{x2} - s + t - e)b^2 + (a + c_{x1} + t - e)bc_{x2} + (a + c_{x1} - s)bc_{x2} + ac_{x2}c_{x2}}{D_0}.
\]

In this setup of the model, we can obtain the relation,
\[
\pi = \left(b + \frac{c_{x2}}{2}\right)x^2, \quad \text{and} \quad \pi^* = \left(b + \frac{c_{x2}}{2}\right)y^2.
\]

The above results summarize the output and price at the third stage in terms of policy variables.

The comparative static effects of a subsidy and tariff are obtained by differentiating \(x(s, t, e), y(s, t, e)\) and \(p(s, t, e)\) with policy variables. First, the effects of a production subsidy on output and price are:
\[
\frac{dx}{ds} = \frac{2b + c_{x2}}{D_0} > 0, \quad \frac{dy}{ds} = -\frac{b}{D_0} < 0, \quad \text{and} \quad \frac{dp}{ds} = -\frac{(b + c_{x2})b}{D_0} < 0.
\]

Second, the effects of a tariff can be obtained as:
\[
\frac{dx}{dt} = \frac{b}{D_0} > 0, \quad \frac{dy}{dt} = -\frac{2b + c_{x2}}{D_0} < 0, \quad \text{and} \quad \frac{dp}{dt} = \frac{(b + c_{x2})b}{D_0} > 0.
\]

Third, the effects of a foreign export subsidy can be obtained as:
\[
\frac{dx}{de} = -\frac{b}{D_0} < 0, \quad \frac{dy}{de} = \frac{2b + c_{x2}}{D_0} > 0, \quad \text{and} \quad \frac{dp}{de} = -\frac{(b + c_{x2})b}{D_0} < 0.
\]

An increase in \(s\) encourages home production but discourages foreign production. A production subsidy will increase the total supply and thus reduce the price. The effects of a tariff and a foreign export subsidy change can be interpreted in a similar way.

2.3 National welfare and policy reaction function

The national welfare of the home country is assumed to be the sum of the consumer surplus, the gross profit of the home firm and the net government revenue. The home country welfare is summarized as:
(5) \( SW(s, t, e) = CS + \pi - sx + ty. \)

Considering the third-stage competition and taking the foreign subsidy as given, the home government chooses a production subsidy and a tariff so as to maximize home welfare. By partially differentiating \( SW \) with respect to policy variables and substituting the comparative static results, we obtain:

\[
\frac{\partial SW(s, t, e)}{\partial s} = b(2b + c_{x2})x + b(b + c_{x2})y - (2b + c_{x2})s - bt \quad D_9
\]

and

\[
\frac{\partial SW(s, t, e)}{\partial t} = b^2x + (2b + c_{x2})(b + c_{x2})y - bs - (2b + c_{x2})t \quad D_9.
\]

Solving the reaction functions of the home government in the policy game, \( \partial SW/\partial s = 0 \) and \( \partial SW/\partial t = 0 \), for \( s \) and \( t \) gives:

\[
(6) \quad s(e) = \frac{((2a - 3c_{x1} + c_{x1} - e)b + 2(a - c_{x1})c_{x2}b)}{D_1} \quad D_1
\]

and

\[
(7) \quad t(e) = \frac{((a - c_{x1} + e)c_{x2} + (c_{x1} - c_{x1} + e)b)(b + c_{x2})}{D_1},
\]

where \( D_1 = 2b^2 + (3c_{x1} + 2c_{x2} + 2c_{x1}c_{x2} \) is positive under the second order condition for home welfare maximization. Assume that, under \( b + c_{x2} > 0 \),

\[
(8) \quad \varphi_1(c_{x2}) = \frac{(2b + 3c_{x2})b}{2(b + c_{x2})} < c_{x2},
\]

then \( D_1 > 0 \) holds. By differentiating \( s(e) \) and \( t(e) \) with respect to \( e \), we can obtain:

\[
(9) \quad \frac{ds(e)}{de} = \frac{b^2}{D_1} < 0, \quad \text{and} \quad \frac{dt(e)}{de} = \frac{(b + c_{x2})(b + c_{x2})}{D_1} > 0.
\]

That is, the home government responds to an increase in the foreign export subsidy by increasing its tariff and by reducing its production subsidy. The logic behind this result is shown by Collie (1991) on pp. 315–317.

On the reaction functions for the home government, relations,

\[
s(e) = bx(s(e), t(e), e), \quad \text{and} \quad t(e) = (b + c_{x2})y(s(e), t(e), e),
\]

hold, the first of which implies \( p(s(e), t(e), e) = MC_e(s(e), t(e), e) \). Hereafter, we

\[
(6)
\]
utilize \( x(.) \) instead of \( x(s(e), t(e), e) \), etc.

The national welfare of the foreign country can be defined as the net profit of the foreign firm, that is:

\[
(10) \quad SW^*(s, t, e) = py - TC_r - ty.
\]

The reaction function of the foreign government in the policy game is characterized in a similar fashion. Partially differentiating \( SW^* \) with respect to policy variable \( e \) gives

\[
\frac{\partial SW^*(s, t, e)}{\partial e} = \frac{b^2y - (2b + c_{x2})e}{D_2}.
\]

Thus, the first order condition is \( \frac{\partial SW^*}{\partial e} = 0 \). Reference to the comparative static results obtains:

\[
(11) \quad e(s, t) = \frac{(a + c_{x1} - 2c_{x1} - 2t)b + (a - c_{x1} - t)c_{x2}}{D_2} b^2.
\]

where \( D_2 = (2b^2 + 2(c_{x2} + c_{y2})b + c_{x2}c_{y2}) (2b + c_{x2}) \) is positive for the second order condition for foreign welfare maximization. Assume that

\[
(12) \quad \varphi_2(c_{x2}) = -\frac{2(b + c_{x2})b}{2b + c_{x2}} < c_{x2}.
\]

then \( D_2 > 0 \) holds. On the reaction function for the foreign government, relation

\[
e(s, t) = \frac{b^2}{2b + c_{x2}} y(s, t, e(s, t))
\]

holds.

If both governments choose the same stage of the policy game, by solving reaction functions (6), (7) and (11) simultaneously for \( s, t, \) and \( e \), the following relations can be obtained:

\[
(13) \quad s^* = bx^* > 0, \quad t^* = (b + c_{y2})y^* > 0 \quad \text{and} \quad e^* = \frac{b^2}{2b + c_{x2}} y^* > 0.
\]

The superscript \( S \) denotes a simultaneous move policy game. Thus, in the simultaneous move policy equilibrium, even if the marginal costs are variable, the home government sets its production subsidy and tariff and the foreign government sets an export subsidy.
3. The case in which the foreign government plays the Stackelberg leader

This case applies to the countervailing duties allowed by the GATT (the General Agreement on Tariffs and Trade) and the WTO (the World Trade Organization). The response by the home government is optimal given the export subsidy set by the foreign government, and the foreign government anticipates the optimal response by the home government when it sets an export subsidy at stage one.

In this case, first by solving \( \partial SW(s, t, e)/\partial s = 0 \) and \( \partial SW(s, t, e)/\partial t = 0 \) for \( s \) and \( t \), the reaction functions of the home government at the second stage are obtained as a function of \( e : s(e) \) and \( t(e) \) in equations (6) and (7). That is, the home government responds to an increase in the foreign export subsidy by increasing its tariff and by reducing its production subsidy.

In absence of any domestic intervention, a foreign export subsidy may reduce domestic welfare.\(^1\) In fact, we can obtain

\[
\frac{\partial SW(0, 0, e)}{\partial e} = (p - MC_e) \frac{\partial x}{\partial e} - y \frac{\partial p}{\partial e} = \frac{(b + c_e) y - bx}{p_0} b,
\]

which is negative if \( (b + c_e) y < bx \) holds. However, if the domestic country pursues an optimal policy, then

\[
(14) \quad \frac{dSW(s(e), t(e), e)}{de} = \{p(\cdot) - MC_e(\cdot)\} \frac{dx(\cdot)}{de} - y(\cdot) \left[ \frac{dp(\cdot)}{de} - \frac{dt(e)}{de} \right] + t(e) \frac{dy(\cdot)}{de}
\]

holds, which implies that a foreign export subsidy always increases domestic welfare, even under variable marginal costs of production.\(^2\)

Now consider the optimal policy for the foreign country. The home government's countervailing tariff will reduce foreign welfare and the reduction in the production subsidy will increase foreign welfare. The overall effects of an export subsidy may be ambiguous. By substitution, \( SW^*(s(e), t(e), e) \) are obtained. Totally differentiating this \( SW^*(\cdot) \) with respect to \( e \), we can obtain

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\[
\frac{dSW^*(e)}{de} = -\frac{((c_{12}+c_{22})b+c_{22}c_{21})y(e) + (b+c_{22})e}{2b^2 + (3c_{12}+2c_{22})b + 2c_{12}c_{22}}.
\]

For welfare maximization by the foreign government in the first stage, solving \(dSW^*(e)/de=0\) for \(e\) yields:

\[
e^* = -\frac{((c_{12}-c_{22})b + (a-c_{11})c_{21})(c_{12}+c_{22})b + c_{12}c_{22}}{(b+c_{22})D_i},
\]

where \(D_i = (2b^2 + (4c_{12}+3c_{22})b + 3c_{12}c_{22}) > 0\) for the second order condition for foreign welfare maximization. Assume that

\[
\phi_i(c_{22}) = -\frac{2(b+2c_{22})b}{3(b+c_{22})} < c_{22},
\]

then \(D_i > 0\) holds. Moreover, because we can obtain \(\phi_i(c_{22}) > \phi_j(c_{22})\) for \(j=0, 1, 2, D_j > 0\) hold, under the assumption in (17). Further, an optimum foreign export subsidy \(e^F\) can be positive or negative, but for constant marginal costs and linear demand, the optimal export subsidy by the foreign government is zero. Using (16), the optimal subsidy and tariff calculations for the home government are:

\[
s^F = \frac{((2a-3c_{11}+c_{21})b^2 + (3a-4c_{11}+c_{21})bc_{22} + 3(a-c_{11})(b+c_{22})c_{22}b)}{D_i},
\]

and

\[
t^F = \frac{(c_{12}-c_{22})b + (a-c_{11})c_{21}(b+c_{22})}{D_i}.
\]

Combining the above results with the reaction functions for the home government, we can obtain the following relations:

\[
s^F = bx^F > 0, \quad t^F = (b+c_{12})y^F > 0, \quad \text{and} \quad e^F = -\frac{(c_{12}+c_{22})b + c_{12}c_{22}y^F}{b+c_{22}}.
\]

From the above argument, we can obtain the following proposition.

**PROPOSITION**: Suppose the foreign government sets an export subsidy at stage one and the home government sets both a production subsidy and a tariff at stage two. Further, at stage three, firms choose outputs in a Cournot fashion. Then the sub-game perfect equilibrium policy is obtained as follows. If \((c_{12}+c_{22})b + c_{12}c_{22} < 0\) holds, then the foreign export subsidy is positive, whereas if \((c_{12}+c_{22})b + c_{12}c_{22} > 0\) holds, then it is negative. To the foreign subsidy, the domestic government always
responds with a positive production subsidy and tariff.

In this equilibrium, the foreign government sets an export subsidy (positive or negative) at stage one, and the home government responds to it by setting its production subsidy and tariff at stage two. This sub-game can be used to examine the use of countervailing duties by the home government in response to the foreign export subsidy.

What are the conditions for the positive export subsidy by the foreign government? By adding the effects of a foreign export subsidy on a domestic production subsidy and tariff, we can obtain the effects of an export subsidy on the overall protection, that is:

\[
\frac{d\{s(e) + t(e)\}}{de} = \frac{(c_{q2} + c_{q2})b + c_{q2}c_{q2}}{D_1}.
\]

That is, though the home government responds to an increase in the foreign export subsidy by increasing its tariff and by reducing its production subsidy, the overall protection may be increasing or decreasing in \(e\). If the foreign export subsidy reduces the overall protection, then in fact, the foreign government should set a positive subsidy. On the other hand, if the foreign export subsidy increases the overall protection, then the foreign government should set an export tax. If marginal costs are constant and the demand is linear, then \(ds(e)/de = -1/2 < 0\) and \(dt(e)/de = 1/2 > 0\), thus \(d\{s(e) + t(e)\}/de = 0\) holds. That is, the optimal foreign export subsidy is zero for linear demand, as shown by Collie (1991). Besides, Collie (1991) showed that even under the constant marginal costs, if the demand is non-linear, the overall effect of retaliation can be to encourage the foreign country to subsidize its exports. Thus we provided another example, with the co-existence of both a positive export subsidy and a countervailing tariff.

Let us sketch the above argument graphically. The dotted curve \(\varphi_1(c_{q2})\) in Figure 1 defines \(D_1 = 0\) which intersects with the horizontal line at \(-b/2\), and with the vertical line at \(-2b/3\). The condition \(D_1 > 0\) holds in the upper right-hand region of curve \(D_1 = 0\). Define a vertical real line \(y^F = 0\) in Figure 1 as:

\[
\frac{(c_{a1} - c_{a1})b}{(a - c_{a1})} < 0
\]

Under \(D_1 > 0\), the foreign supply is positive, \(y^F > 0\), if \(c_{a1} < c_{a2}\) holds, which defines an intersection in the right-hand region of line \(y^F = 0\) and the upper and right hand region of curve \(D_1 = 0\). Next, define a declining real curve \(x^F = 0\) as:

(10)
\[ \varphi_t(c_{x2}) = -\frac{(2a - 3c_{x2} + c_{x1})b + (3a + 4c_{x1} + c_{x2})c_{x2}}{3(a - c_{x1})(b + c_{x2})}. \]

Then the domestic output is positive, \( x^f > 0 \) under \( D_t > 0 \), if and only if \( \varphi_t(c_{x2}) < c_{x2} \) holds, which defines the upper right-hand region from \( x^f = 0 \). Further, we can obtain:

\[ \varphi_t(c_{x2}) - \varphi_t(c_{x2}) = \frac{(c_{x1} - c_{x2})b + (a - c_{x1})c_{x2}}{3(a - c_{x1})(b + c_{x2})}. \]

From these relationships, the following is clear. First, \( c_{x2} = c_{x2}^* \), \( \varphi_t(c_{x2}) \) and \( \varphi_t(c_{x2}) \) intersect at point \( Q \) in Figure 1. Second, if \( c_{x2}^* < c_{x2}^* \), that is, \( y^f > 0 \), then \( \varphi_t(c_{x2}) < \varphi_t(c_{x2}) \) holds. Thus we can obtain the region for positive outputs as the intersection on the right-hand side of line \( y^f = 0 \) and the right-hand side of curve \( x^f = 0 \). \( D_t > 0 \) also holds in this region. On the other hand, below curve \( e^f = 0 \), a foreign export subsidy can be positive. Thus, the intersection of the set for positive outputs and that for a positive export subsidy can be shown as non-empty.

Figure 1  The set of feasible outputs with a positive export subsidy
4. Summary and conclusion

In this paper, we have shown that in the Cournot duopoly model where one home firm and one foreign firm compete in a home market, the sub-game perfect equilibrium policy implies the following result. If \((c_x + c_2)b + c_x c_2 < 0\) holds, then the foreign export subsidy is positive, whereas if \((c_x + c_2)b + c_x c_2 > 0\) holds, then it is negative. To the foreign subsidy the domestic government always responds with a positive production subsidy and tariff. Economic intuition indicates that if the foreign export subsidy reduces the overall protection, then the foreign government should set a positive subsidy. On the other hand, if the foreign export subsidy increases the overall protection, then the foreign government should set an export tax. If marginal costs are constant and the demand is linear, then the optimal foreign export subsidy is zero for linear demand, as shown by Collie (1991).

References:


