Empirical Analysis of Economic Institutions
Discussion Paper Series

No.19

Export Subsidies versus Export Quotas with Incompletely Informed Policy Makers

Jota Ishikawa
And
Tomohiro Kuroda

July 2003

This discussion paper series reports research for the project entitled “Empirical Analysis of Economic Institutions”, supported by Grants-in-Aid for Scientific Research of the Ministry of Education and Technology.
Export Subsidies versus Export Quotas with Incompletely Informed Policy Makers

Jota Ishikawa†
Faculty of Economics
Hitotsubashi University

Tomohiro Kuroda
Graduate School of Economics
Hitotsubashi University

July 28, 2003

Abstract

This paper compares export subsidies (price incentives) with export quotas (quantity controls) in Brander-Spencer (1985) model when the policy makers have limited information on demand and cost structures. We examine necessary or sufficient information for the policy makers to determine the right policies. In both unilateral and bilateral intervention, it is crucial whether they know the values of the elasticity of the slope of the inverse demand curve and the market share. It is shown that for the policy makers, export quotas may be superior to export subsidies.

Keywords: Export subsidies; Export quotas; Strategic trade policy; Asymmetric information

JEL Classification Numbers: F12, F13

---

*We would like to thank Taiji Furusawa, Makoto Ikema, Naoto Jinji, Kazuharu Kiyono, Makoto Okamura, Tony Venables and seminar participants at Hitotsubashi University for useful comments on earlier drafts. Any remaining errors are our own responsibility. Jota Ishikawa acknowledges the Grant-in-Aid for Science Research from the Japan Society of the Promotion of Science.

†Corresponding author: Jota Ishikawa, Faculty of Economics, Hitotsubashi University, Kunitachi, Tokyo 186-8601, Japan; Phone: +81-42-580-8794, Fax: +81-42-580-8882; E-mail: jota@econ.hit-u.ac.jp
1 Introduction

Since Brander and Spencer (1985) demonstrated that domestic export subsidies can raise domestic welfare due to rent shifting from the foreign country to the domestic country, the strategic roles for trade policies in oligopolistic industries have drawn considerable attention. The model of strategic trade policy has been extended in a number of directions (see Brander (1995)). One of the directions is to deal with the presence of asymmetric information among players in the model. In particular, as Brander (1995) mentions, it is reasonable to believe that the government does not know the cost and demand structures as much as the producers themselves.

There is a large literature that analyzes trade policies with incomplete information using the third market model developed by Brander and Spencer (1985) (BS model hereafter). Those studies are based on two approaches. One is to tailor optimal policies (e.g., Qiu (1994); Maggi (1996,1999); Brainard and Martimort (1996,1997)). The other is to make a comparison among various policies under various situations (e.g., Cooper and Riezman (1989); Qiu (1995); Grossman and Maggi (1999)).

This paper investigates export subsidies (price incentives) and export quotas (quantity controls) in BS model when policy makers have limited information on demand and cost structures. The purpose of this paper is twofold. The first purpose is to compare export subsidies with export quotas. Regarding this aim, a seminal work is Cooper and Riezman (1989) which compares export quotas with export subsidies in the presence of uncertainty in demand. They specifically assume that the firms have complete knowledge about the market demand, while the governments do not. It is shown that export subsidies dominate export quotas when the uncertainty is severe, while export quotas dominate when the uncertainty is not very severe. Following Cooper and Riezman (1989), Hwang and Schulman (1993) have introduced non-intervention as well as export quotas and export subsidies and made a comparison among them. Shivakumar (1993) endogenizes both the choice of policy and the timing of its implementation. It is shown that depending on the degree of uncertainty, the governments move either simultaneously or sequentially.

---

1 Export subsidies could be negative (i.e. export taxes). In this paper, export quotas mean direct export quantity controls. We deal with export expansions through quotas as well as export restraints.

2 In practice, firms may not have complete information on the market, either. Then firms’ perception of demand uncertainty as well as governments’ plays a significant role in determining the optimal policy. See Caglayan (2002), for example.
In those models, however, what the governments may not observe is only one parameter, i.e., the intercept of the demand curve. It is assumed that the shapes of the demand and cost functions, which are linear, and the distribution of the random intercept are common knowledge. By contrast, we consider situations where the information the governments possess may be much coarser. What the governments surely know in our analysis is that a single domestic firm and a single foreign firm supply a homogeneous good to the third market and compete in a Cournot fashion. Because of this informational restriction, however, we focus on a simple situation where the government introduces a single policy, which increases or decreases its exports by a small amount,\(^3\) under free trade. We examine what information is necessary or sufficient to carry out right policies in this situation. This is the second purpose of our analysis. Therefore, our analysis is an extension of the work by Furusawa et al. (2003), which investigates policies related to imports (such as tariffs and production subsidies) when policy makers are less informed than producers, to the case of export policies.

We show that whether the policy makers know the values of the elasticity of the slope of the inverse demand curve and the market share is crucial to determine whether exports should be encouraged or discouraged. It is also shown that for the policy makers, export quotas may dominate export subsidies from the viewpoint of acquiring information. That is, the policy makers may be able to obtain useful information from the firm when export quotas are adopted as policy measures.

It should be noted that Maggi (1996) specifically introduces capacity constraints into BS model and shows that a small capacity subsidy (weakly) raises domestic country’s income regardless of the demand and cost parameters of the model. However, his focus is on uncertainty that a government faces about the mode of oligopolistic competition. In contrast, the mode of competition is exogenously given in our model. We would rather compare export subsidies with export quotas when the policy makers are less informed about costs and demand than the firms.

We consider not only the unilateral intervention but also the bilateral intervention, which is assumed away in Furusawa et al. (2003). When both governments intervene, the timing of policy implementation matters in the case of export quotas, whereas it does not matter in the case of export subsidies. We also show that the government needs to know at least the value of the elasticity of the slope of the inverse demand curve or the market share when

---

\(^3\) This method is often used to analyze piecemeal or partial policy reforms. See Dixit (1985) and Vousden (1990), for example.
retaliating by export subsidies.

The rest of the paper is organized as follows. Section 2 provides the basic model. Section 3 considers unilateral intervention with asymmetric information between producers and policy makers. Section 4 examines the case of bilateral intervention. Section 5 provides concluding remarks.

2 Basic Model

We consider BS model in which a domestic firm (firm $d$) and a foreign firm (firm $f$) export a homogeneous good to a third-market. The demand in the third-market is given by the following inverse-demand function which is twice continuously differentiable:

$$P = P(X), \quad P'(X) < 0,$$

where $P$ and $X$ are, respectively, the consumer price and the total demand. We define the elasticity of the slope of the inverse demand function $\epsilon(X) \equiv [-XP''(X)/P'(X)]$ for the following analysis.

The inverse demand curve is concave if $\epsilon(X) \leq 0$ for all $X$ and convex if $\epsilon(X) \geq 0$ for all $X$. A prime (resp. double prime) denotes the derivative of the first (resp. second) order.

The firms compete in quantities with Cournot conjectures. The governments introduce specific export subsidies or export quotas before firms act. Thus, taking those policies as given, the firms set their outputs. The profit function of firm $i$ is given by

$$\Pi^i(x^d, x^f; s^d, s^f) = (P + s^i)x^i - C^i(x^i), \quad i = d, f,$$

where $x^i$ and $s^i$ ($i = d, f$) are, respectively, firm $i$’s output and the specific subsidy provided to firm $i$. $C^i(\cdot)$ is the cost function of firm $i$. The marginal cost may not be constant.

$X = x^d + x^f$ holds. We assume that the profit function is strictly concave in $x^i$ for each fixed $x^j$ ($i, j = d, f; i \neq j$). We focus on the equilibrium with $x^i > 0$. The first-order conditions under the Cournot assumption are

$$\frac{\partial \Pi^i}{\partial x^i} = (P + s^i) + P'x^i - C''^i = 0, \quad i = d, f.$$

It is well known that this elasticity plays a crucial role in various analyses of monopoly and oligopoly. See Greenhut and Ohta (1976), Seade (1980b), Brander and Spencer (1984), and Ishikawa and Spencer (1999), for example. When $\epsilon$ is constant, the inverse demand function is given by $P = a_1X^{1-\epsilon}/(\epsilon - 1) + a_2$ for $\epsilon \neq 1$ and $P = -b_1\ln X + b_2$ for $\epsilon = 1$ (where $a_1$, $a_2$, $b_1$, and $b_2$ are positive parameters); and the price elasticity $\eta(X) \equiv -XP''(X)/P(X)$ is given by $\eta = a_2X^{\epsilon - 1}/a_1 + 1/(\epsilon - 1)$ for $\epsilon \neq 1$ and $\eta = -\ln X + b_2/b_1$ for $\epsilon = 1$. In the case of iso-price-elastic demand, it can easily be verified that $\epsilon$ is also constant and is given by $\epsilon = 1 + 1/\eta$. 

3
The second-order sufficient conditions hold globally:

\[ 2P' + P''x^i - C'' < 0, \quad i = d, f. \]  \hspace{1cm} (4)

The welfare measure we adopt is the standard total surplus function. Thus, welfare of
country \( i \) \((i = d, f)\) consists of profits and tax revenue in country \( i \):

\[ W^i(x^d, x^f; s^d, s^f) = \Pi^i(x^d, x^f; s^d, s^f) - sx^i = P x^i - C^i(x^i). \]  \hspace{1cm} (5)

### 3 Unilateral intervention with limited information

We introduce asymmetric information between the producers and the governments into our
analysis. Specifically, we assume that the firms have full information on cost and demand
structures, whereas the governments are not fully informed about them. What the gov-
ernments certainly know is that a single domestic firm and a single foreign firm supply a
homogeneous good to the third market and compete in a Cournot fashion; and that the firms
have full information. We also assume that the firms know what information the governments
have.

The objective of the domestic government is to improve its welfare by introducing an
export subsidy or an export quota to raise or reduce exports by a small amount under free
trade. Thus, the conditions in our results need not hold globally. We suppose that they hold
at least in the neighborhood of the free trade equilibrium.

In this section, we examine the case where only domestic government introduces a policy.
To this end, we consider the following one-shot game. In stage 1, only domestic government
intervenes by using either an export subsidy or an export quota. In stage 2, the firms compete
in outputs taking the domestic policy as given.

First, we analyze the case of domestic export subsidies. To determine the effect of a
domestic export subsidy, we set \( s^f = 0 \) and totally differentiate (3) to obtain

\[
\begin{pmatrix}
2P' + P''x^d - C'' \\
-2P' + P''x^d - C''
\end{pmatrix}
\begin{pmatrix}
dx^d/ds^d \\
dx^f/ds^d
\end{pmatrix} = \begin{pmatrix}
-1 \\
0
\end{pmatrix}
\]  \hspace{1cm} (6)

with the solution

\[
\begin{pmatrix}
dx^d/ds^d \\
dx^f/ds^d
\end{pmatrix} = \frac{1}{\Omega} \begin{pmatrix}
2P' + P''x^d - C'' \\
-(P' + P''x^d)
\end{pmatrix} \begin{pmatrix}
-1 \\
0
\end{pmatrix}
\]
where $\Omega \equiv (2P' + P''x^d - C''') (2P' + P''x^f - C''') - (P' + P''x^d)(P' + P''x^f)$. The following stability conditions are assumed to hold.\footnote{See Seade (1980a, 1985) for a discussion on the local stability of dynamics of the strategic behavior.}

$$2P' + P''x^d - C''' < 0, \quad 2P' + P''x^f - C''' < 0, \quad \Omega > 0. \quad (7)$$

Thus, the effects of a change in $s^d$ on outputs are given by

$$\frac{dx^d}{ds^d} = -\frac{1}{\Omega} (2P' + P''x^d - C''') > 0, \quad (8)$$

$$\frac{dx^f}{ds^d} = \frac{1}{\Omega} (P' + P''x^f), \quad (9)$$

$$\frac{dX}{ds^d} = -\frac{1}{\Omega} (P' - C''') > 0. \quad (10)$$

The output of firm $f$ falls (resp. rises) if and only if $P' + P''x^f < 0$ (resp. $P' + P''x^f > 0$).

Differentiating (5) with respect to $s^d$ and evaluating it at $s^d = 0$, we have

$$\frac{dW^d}{ds^d} \bigg|_{s^d=0} = -P'x^d d\frac{dx^d}{ds^d} + P'X^d d\frac{dX}{ds^d} = P'x^d d\frac{dx^f}{ds^d}. \quad (11)$$

A small export tax raises domestic welfare if and only if $P' + P''x^f > 0$, whereas a small export subsidy raises domestic welfare if and only if $P' + P''x^f < 0$. We should note that $P' + P''x^f > 0$ (resp. $P' + P''x^f < 0$) holds if outputs are strategic complements (resp. substitutes).

Next, we examine export quotas. Setting $s^d = s^f = 0$, we differentiate (5) with respect to the supply of the domestic firm, $x^d$, and obtain

$$\frac{dW^d}{dx^d} = (P - C^d) + P' X^d d\frac{dX}{dx^d} = P' x^d d\frac{dx^f}{dx^d}. \quad (12)$$

Thus, a small export decrease (resp. increase) by an export quota raises domestic welfare if and only if $P' + P''x^f > 0$ (resp. $P' + P''x^f < 0$) holds.

We should notice that whether the sign of $(P' + P''x^f)$ is positive or negative is crucial to determine the right export quota as well as the right export subsidy. We thus examine under what conditions $P' + P''x^f > 0$ or $P' + P''x^f < 0$ holds. Noting

$$P' + P''x^f = -P'[(1 - \sigma^d)\epsilon - 1], \quad (13)$$

where $\sigma^d = x^d/X$ (i.e. the market share of the domestic firm), we can draw the relationship between $\sigma^d$ and $\epsilon$ which leads to $P' + P''x^f = 0$ (i.e. $ff$ in Figure 1). $P' + P''x^f > 0$ holds above $ff$ curve, whereas $P' + P''x^f < 0$ holds below $ff$. Then the following lemma is straightforward:
Lemma 1 If \( P' + P''x^f > 0 \), then \( \epsilon > 1 \). \( P' + P''x^f < 0 \) holds if \( \epsilon < 1 \).

Thus, if \( \epsilon < 1 \), a small export subsidy or a small increase in exports by an export quota unambiguously enhances domestic welfare. It should be emphasized that this result requires information on only demand structure. On the other hand, if \( \epsilon \geq 1 \), the government needs information on the market share as well as the demand structure to determine the right policy. We should note that information on the market share in turn requires detail information on the cost and demand structures; and that a domestic export expansion harms the foreign country, while a domestic export restriction benefits the foreign country.

We thus obtain the following proposition.

Proposition 1 If \( \epsilon < 1 \) holds and if this is known to the domestic government, then it can raise domestic welfare by a small export subsidy or a small increase in exports by an export quota. If \( \epsilon \geq 1 \), the domestic government needs to know the values of both \( \epsilon \) and \( \sigma^d \) to certainly improve domestic welfare.

This proposition implies that it is not easy for the policy makers to determine the right strategic export policies, because they need a lot of information. Even if \( \epsilon < 1 \), it is probably difficult for the domestic government to acquire information on demand in the third country.

In the rest of this section, we compare export subsidies with export quotas from the viewpoint of acquiring information. For this, we specifically consider the case where the domestic government tries to obtain necessary information from the domestic firm. It is expected that the domestic firm provides the government with true information only if the policy which is based on the provided information benefits the domestic firm.

In the following, therefore, we examine under what situation the interests of the domestic firm coincide with those of the domestic government. First, we consider the effects of an export subsidy on the profits:

\[
\frac{d\Pi^d}{ds^d} = x^d \left( 1 + P' \frac{dx^f}{ds^d} \right),
\]

(14)

\[
\frac{d\Pi^f}{ds^d} = P' x^f \frac{dx^d}{ds^d} = dW^f \quad < 0.
\]

(15)

It is obvious from (14) and (15) that the profits of firm \( d \) rise and those of firm \( f \) fall when the right policy is an export subsidy (i.e. when \( P' + P''x^f < 0 \)). Thus, as long as the equilibrium is located below \( ff \), the domestic firm has an incentive to inform the domestic government.
of the true values of $\epsilon$ and $\sigma^d$. If the right policy is an export tax (i.e. if $P' + P''x^f > 0$), however, the domestic firm may cheat. This is the case when $-1 \leq P'(dx^f/ds^d) < 0$ (i.e. the equilibrium is located just above $f_f$). In this case, there is a conflict in interests between the domestic government and the domestic firm. In the case of export quota, its effects on the profits are

$$\frac{d\Pi^d}{dx^d} = P'_x dx^f \frac{dx^f}{dx^d} = \frac{dW^d}{dx^d},$$

(16)

$$\frac{d\Pi^f}{dx^d} = P'_x dx^f = \frac{dW^f}{dx^d} < 0.$$  

(17)

Obviously, the interests of the domestic firm coincide with those of the domestic government. Thus, the following proposition is immediate:

**Proposition 2** If the domestic government tries to acquire necessary information from the domestic firm, export quotas are superior to export subsidies.

4 Bilateral intervention with limited information

In the last section, only domestic government introduces an export policy and the foreign government is passive. In this section, we consider the case of bilateral intervention. To investigate this case, we need to specify what information the foreign government has. Depending on the information both governments have, there are many cases to examine. In this section, we specifically consider the following two cases. In the first case, both governments have the same information. In particular, each government knows whether its exports should be increased or decreased under unilateral intervention and this is common knowledge. In the second case, one government has less information than the other. In particular, the more informed government knows the right intervention, whereas the less informed government does not. Thus, the less informed government moves after the intervention of the other government.

We begin with the case where the both governments have the same information. We first consider the simultaneous intervention by export subsidies. That is, both governments simultaneously decide whether they intervene or not by using small export subsidies before the firms move. We consider the Nash equilibrium of this intervention. Exchanging the

---

6 In fact, the domestic firm does not have to tell the values of $\epsilon$ and $\sigma^d$. What the firm needs to inform is that the free trade equilibrium is located below $f_f$ in this case.
labels d and f in the analysis of Section 3, we can immediately claim that in the case of unilateral intervention by the foreign government, it will raise its exports when \( P' + P''x^d < 0 \) and reduce them when \( P' + P''x^d > 0 \). Noting

\[
P' + P''x^d = -P'[\sigma^d\epsilon - 1],
\]

we can draw \( P' + P''x^d = 0 \), which is labeled dd in Figure 1. The two curves dd and ff generate four regions A, B, C, and D. By assumption, both governments know where the free trade equilibrium is located in Figure 1.

Using Tables 1, we can easily verify that both governments provide (resp. impose) export subsidies (resp. taxes) in region A (resp. C) and that the domestic government imposes (resp. provides) an export tax (resp. subsidy) and the foreign government provides (resp. imposes) an export subsidy (resp. tax) in region B (resp. D). Since an export expansion (resp. restriction) by one country harms (resp. benefits) the other country, at least one country loses in region A; the foreign country gains in region B; at least one country gains in region C; and the domestic country gains in region D.\(^7\)

We next examine the simultaneous intervention by export quotas. It should be noted that the Nash equilibrium with export quotas is different from that with export subsidies. With Cournot competition and the domestic (resp. foreign) quota, any intervention by the foreign (resp. domestic) government necessarily lowers the profits of firm f (resp. d). That is,

**Lemma 2** Once one government imposes an export quota, the other government has no incentive to impose an export quota.

Using Tables 2, we can confirm that there are two Nash equilibria in each region. In each equilibrium, one government imposes an export quota while the other government does not. We can verify that the country which sets the export quota always gains, whereas the other country loses in region A and gains in region C. In region B (resp. D), both countries gain when the domestic (resp. foreign) government decreases its exports by an export quota, while the domestic (resp. foreign) country loses and the foreign (resp. domestic) country gains when the foreign (resp. domestic) country increases its exports by an export quota.

Next, we consider the sequential intervention. That is, one government chooses between the intervention using the same policy instrument or no intervention after observing the

\(^7\) In the tables, * denotes the best response to the rival’s strategy.
policy taken by the other government. In the case of export subsidies, the following lemma is straightforward, because we consider only small export subsidies:

**Lemma 3** In the case of export subsidies, the simultaneous intervention and the sequential intervention generate the same results.

When export quotas are used, the follower does not intervene. The country whose government moves first necessarily gains. The other country may or may not gain. It gains if the leader restricts its exports and loses if the leader expands its exports.

We now consider the case where one government is less informed than the other and the less informed government moves after the intervention of the other government. That is, the less informed government does not have enough information to intervene simultaneously. It is assumed to be common knowledge that the foreign government is sure whether the free trade equilibrium is located above or below \( dd \), while the domestic government is not sure whether the free trade equilibrium is located above or below \( ff \).\(^8\) \(^9\) It is obvious from the above analysis that if the foreign government sets an export quota, the domestic government does not intervene.

In the case of export subsidies, the domestic government may intervene after observing the foreign intervention. Suppose that the foreign government provides an export subsidy. Then the domestic government can infer that the free trade equilibrium is located below \( dd \). If \( \epsilon \geq 2 \) and if the domestic government knows this, the domestic government is now sure that the free trade equilibrium is in region \( B \) and imposes an export tax to mitigate the detrimental effect caused by the foreign export subsidy. Alternatively, if the domestic government knows \( \sigma^d \geq 1/2 \), it is sure that the free trade equilibrium is in region \( A \) and provides an export subsidy.\(^10\)

Similarly, if the foreign government imposes an export tax, the domestic government can infer that the free trade equilibrium is located above \( dd \). If the domestic government knows \( \epsilon \leq 2 \), it is sure that the free trade equilibrium is in region \( D \) and provides an export subsidy. Alternatively, if the domestic government knows \( \sigma^d \leq 1/2 \), it is sure that the free trade equilibrium is in region \( C \) and imposes an export tax. We should note that a foreign

---

\(^8\) The reverse case can be examined symmetrically.

\(^9\) If \( \epsilon < 1 \) and if the domestic government knows it, the domestic government is sure that the free trade equilibrium is in region \( A \). Since both governments have the same information in this case, we exclude this case here.

\(^10\) The domestic reaction by an export subsidy may make the foreign country worse off relative to free trade. If this is the case, the foreign government may not intervene in the first place.
export tax benefits the domestic country as well as the foreign country. Thus, the correct reaction by the domestic government further enhances domestic welfare.

The analysis in this section leads to the following propositions.

**Proposition 3** The country which correctly sets an export quota in equilibrium necessarily benefits. If this quota is to restrict (resp. expand) the exports, the other country also gains (resp. loses).

**Proposition 4** Suppose that one government is sure whether its exports should be raised or reduced to enhance its welfare by unilateral intervention, while the other is not. When the former government intervenes with export subsidies, the latter needs at least the information on $\epsilon$ or $\sigma^d$ in order to react correctly.

### 5 Concluding Remarks

In the framework of BS model, we have compared export subsidies with export quotas when policy makers have limited information on demand and cost structures. In the case of unilateral intervention, the information required to conduct the right export subsidies is the same with that required to conduct the right export quotas. We have shown that the values of the elasticity of the slope of the inverse demand curve and the market share are crucial to determine the right policies.

The domestic values of those also play a crucial role in the case of import policies analyzed in Furusawa et al. (2003). However, their notable result is that a small production subsidy always improves domestic welfare regardless of both cost and demand structures. By contrast, the value of the elasticity of the slope of the inverse demand function is indispensable for the policy makers in the present study. If the demand curve is very convex in the sense that $\epsilon > 1$, the government needs additional information on the market share. Therefore, we can claim that the practical use of strategic export policies is not easy.

However, it should be noted that the government may be able to obtain the information from the firm when they adopt export quotas as their policy measures, because the interests of the government coincide with those of the firm. In the case of export subsidies, those interests may conflict to each other. In this sense, for policy makers, export quotas are superior to export subsidies as strategic export policies.
We have also examined the case of bilateral intervention. In the case of simultaneous intervention, export subsidies lead to a unique Nash equilibrium, whereas export quotas generate multiple Nash equilibria. In the case of sequential intervention, the equilibrium under export subsidies is identical to that of the simultaneous intervention. When the domestic policy makers are not sure about the right intervention and faces the foreign intervention by export subsidies, they need to know at least the value of the elasticity of the slope of the inverse demand curve or the market share to react correctly.

In our study, we have considered the introduction of a small tax/subsidy or a small export-decrease/increase by a quota under free trade. In addition to the practical difficulty to introduce a large tax/subsidy or a large export-decrease/increase by a quota, there are two reasons why we focus on this case. First, if this is not the case, the corner solution, in which there are no domestic or foreign exports, could arise. Second, in the case of a small change in exports, it is not required that the conditions in some of our results should globally hold. They are required in the neighborhood of the free trade equilibrium.

It should be noted that our main message remains valid even in more general models. First, it is not crucial for our analysis to assume that the initial equilibrium is free trade. If there exists some export subsidy or quota in the initial equilibrium, our analysis is modified as follows. In the case of export subsidies, we cannot set \( s^d = 0 \) when we evaluate the effect on welfare of a change in the export subsidy. That is, (11) should be modified as follows:

\[
\left. \frac{dW^d}{ds^d} \right|_{s^d = s^d_0} = P' x^d d x^f \frac{dx^d}{ds^d} - s^d_0 \frac{dx^d}{ds^d},
\]

where \( s^d_0 \) is the initial level of the subsidy. Suppose \( s^d_0 > 0 \). Then a decrease in the subsidy raises welfare when \( P' + P'' x^f > 0 \), whereas an increase in the subsidy may not improve welfare when \( P' + P'' x^f < 0 \). This result is reversed when \( s^d_0 < 0 \). Thus, the government needs more information to decide whether the subsidy should be raised or lowered when \( s^d_0 > 0 \) and \( P' + P'' x^f < 0 \) or when \( s^d_0 < 0 \) and \( P' + P'' x^f > 0 \). In the case of export quotas, (12) remains to hold. Therefore, we can claim that export quotas require less information than export subsidies when some export subsidy or quota already exists in the initial equilibrium.

Second, even if the good is differentiated, we can obtain similar conditions. Suppose that the inverse demand for the good produced by firm \( i \) (\( i = d, f \)) is given by \( P_i = P_i(x^d, x^f) \) and that the goods are substitutes, i.e., \( P_{ij} \equiv \partial P_i / \partial x^j < 0 \) (\( i \neq j \)). Then, it can be verified that it is crucial whether \( P_j + P_{ij} x^i < 0 \) or \( P_j + P_{ij} x^i > 0 \) (where \( P_{ij} \equiv \partial^2 P_i / \partial x^i \partial x^j \)).
Third, although we have confined ourselves to the case where there is a single firm in each country, the essence of our analysis would not alter much even if the numbers of firm increase. The modification in our analysis stems from a well-known fact that as the number of firms increases, the government has more incentive to restrict exports. The domestic (resp. foreign) government may not have an incentive to raise its exports even in the region below $ff$ (resp. $dd$) in Figure 1. Moreover, facing a foreign (resp. domestic) export quota, the domestic (resp. foreign) government now has an incentive to reduce its exports. In the case of bilateral intervention, therefore, both governments are likely to restrict their exports as the numbers of firms rise.

We should note that in our model, the policy makers cannot observe the market share before they decide the policies. If the firms compete in the third market before the policies are introduced, the governments can observe the market share. In this case, however, if the firms anticipate the introduction of policies based on the market share, they may have incentive to manipulate the market share. This is an interesting extension, but is beyond the scope of this paper and is left for future research.

As a final remark, we should emphasize that this paper in no way to advocates the use of strategic trade policy. We would argue that it is rather difficult for the policy makers to determine the right strategic trade policies as well as to correctly react against the foreign strategic trade policies.

\[\text{\footnotesize 11} \text{ The shapes of } dd \text{ and } ff \text{ are somewhat modified with general numbers of firms.}\]
References


Figure 1: $ff$ and $dd$ curves
### Table 1: Price incentive policies

<table>
<thead>
<tr>
<th>Region A</th>
<th>Tax</th>
<th>No Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>D, F</td>
<td>Subsidy</td>
<td>No Subsidy</td>
</tr>
<tr>
<td>Subsidy</td>
<td>(?, ?)</td>
<td>(+*, -)</td>
</tr>
<tr>
<td>No Subsidy</td>
<td>(-, +*)</td>
<td>(0, 0)</td>
</tr>
</tbody>
</table>

(a) Export subsidies vs. export subsidies

<table>
<thead>
<tr>
<th>Region B</th>
<th>Tax</th>
<th>No Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>D, F</td>
<td>Subsidy</td>
<td>No Subsidy</td>
</tr>
<tr>
<td>Tax</td>
<td>(?, +*)</td>
<td>(+*, +)</td>
</tr>
<tr>
<td>No Tax</td>
<td>(-, +*)</td>
<td>(0, 0)</td>
</tr>
</tbody>
</table>

(b) Export taxes vs. export subsidies

<table>
<thead>
<tr>
<th>Region C</th>
<th>Tax</th>
<th>No Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>D, F</td>
<td>Tax</td>
<td>No Tax</td>
</tr>
<tr>
<td>Tax</td>
<td>(+*, +)</td>
<td>(+*, +)</td>
</tr>
<tr>
<td>No Tax</td>
<td>(+, +)</td>
<td>(0, 0)</td>
</tr>
</tbody>
</table>

(c) Export taxes vs. export taxes

<table>
<thead>
<tr>
<th>Region D</th>
<th>Tax</th>
<th>No Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>D, F</td>
<td>Subsidy</td>
<td>No Subsidy</td>
</tr>
<tr>
<td>Subsidy</td>
<td>(+*, ?)</td>
<td>(+*, -)</td>
</tr>
<tr>
<td>No Subsidy</td>
<td>(+, +)</td>
<td>(0, 0)</td>
</tr>
</tbody>
</table>

(d) Export subsidies vs. export taxes
| Region A | | | |
| --- | --- | --- | |
| D, F | Quota | No Quota | |
| Quota | $(-, -)$ | $(+^*, -^*)$ | |
| No Quota | $(-^*, +^*)$ | $(0, 0)$ | |

(a) Export quotas vs. export quotas

| Region B | | | |
| --- | --- | --- | |
| D, F | Quota | No Quota | |
| Quota | $(-, ?)$ | $(+^*, +^*)$ | |
| No Quota | $(-^*, +^*)$ | $(0, 0)$ | |

(b) Export quotas vs. export quotas

| Region C | | | |
| --- | --- | --- | |
| D, F | Quota | No Quota | |
| Quota | $(?, ?)$ | $(+^*, +^*)$ | |
| No Quota | $(+^*, +^*)$ | $(0, 0)$ | |

(c) Export quotas vs. export quotas

| Region D | | | |
| --- | --- | --- | |
| D, F | Quota | No Quota | |
| Quota | $(?, -)$ | $(+^*, -^*)$ | |
| No Quota | $(+^*, +^*)$ | $(0, 0)$ | |

(d) Export quotas vs. export quotas

Table 2: Direct quantity control policies