THE ROLE OF LOCATION CHOICE
IN STRATEGIC EXPORT PROMOTION POLICY *

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Abstract. This paper examines the properties of the equilibrium in the export subsidization warfare under international duopoly when a single firm is able to relocate its production base between the exporting countries. We show that unless all the firms have relocatability in production, the traditional export subsidization incentives may not only be unaffected but the incentive by the country with the relocating firm may find the stronger subsidization incentive also. Furthermore we clarify the significance of international coordination to promote inward direct investment liberalization.

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1. INTRODUCTION

The theory of strategic export subsidization has made a remarkable progress towards the end of the 20th century in international trade since the pioneering work by Brander and Spencer (1985). Their main contribution lies in that export subsidization may enhance the exporting country’s welfare in imperfect competition in the absence of interdependence

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with the other sectors in the economy. Their results soon led to the dispute on strategic subsidy theory. Markusen and Venebles (1988) indicated that the rent shifting effects of export subsidy become weak when cournot markets are integrated. Under the same assumption of integrated markets, Horstman and Markusen (1986) showed that welfare enhancing export subsidy may bring the inefficient entry. Their result is also challenged by Eaton and Grossman (1986); the so-called rent extraction effects of export subsidization hinges on the market structure of quantity competition à la Cournot with zero conjectural variations. Another challenge comes from relaxing the assumption of entry restrictions. As for the lack of information for the government, it is also pointed out that the free trade is the best policy instead of strategic subsidy by Dixit and Grossman (1986) when there are more than two oligopolistic export industries. However insofar as we are confined into the original Brander and Spencer (1985) framework and the long-run view of competition according to Kreps and Sheinkman (1983), one cannot neglect an exporting country’s incentive to subsidize its own domestic firms.

However such a view of export subsidization warfare has recently been challenged by Janeba (1998) once we take into account the firms’ opportunity of relocating their production bases. When the firms in the exporting countries can relocate their production bases, each exporting country is restrained from raising the export subsidies, for such high rates of subsidies attract the firm residing in the rival country home, leading to the outflow of subsidization. His result is, in a sense, surprising, for the resulting equilibrium entails free trade, i.e., zero export subsidies.

Of course, the result of Janeba (1998) should not be emphasized too much, for he disregards the benefits from domestic consumption and employment gains in the exporting countries.\(^1\) However, one should not misunderstand the essence of his contribution that

\(^1\)Barros and Cabral (2000) analyzed subsidy competition to attract FDI from the third country by considering domestic employment gains.
freedom of the firms’ relocating the production bases dampens the strategic export subsidization incentives of the export countries.

We explore this essence of his contribution, and clarify that the result critically hinges on the assumption that each firm in every exporting country has freedom in choosing its production base. In fact, as the succeeding analysis shows, within a framework of international duopoly, the equilibrium of export subsidization warfare may not be altered and it may even entail higher subsidization by the country having the firm with relocatability when the firm in a single country can relocate its production base.

Furthermore, to indicate the government incentive of liberalization for the inward direct investment, we further extend our model by letting the governments decide whether to open or close the inward direct investment abroad at the first-stage. In the equilibrium, though liberalization by both exporting countries leads to the Pareto-superior outcomes, closing is the dominant strategy in our inward direct investment liberalization game. The results of Prisoner’s Dilemma implies that both countries should coordinate to promote the inward direct investment liberalization.

The rest of our paper is organized as follows. We present our basic model following the framework of Brander and Spencer (1985) in Section 2. The standard comparative statics results of strategic export subsidy are examined in Section 3 and 4. We extend the basic model to the case in which the firm in the single exporting country can freely choose its production location in Section 5. We further analyze the inward direct investment liberalization game in Section 6. Some concluding remarks are summed up in Section 7.

2. Benchmark Case without Plant Relocations

In our benchmark case, no firms can relocat their production plants. This is the familiar case in the strategic export subsidy game for international oligopoly, which is first developed by Brander and Spencer (1985) (hereafter, the BS model hereafter). Consider a world
consisting of three countries, 1, 2 and 3. There is a firm residing in each of countries 1 and 2, producing a homogeneous product, and selling to country 3, which does not produce but only consume the product in question.

Let \( x_i \) denote the output produced by firm \( i \), \( c_i \) its unit cost of production, and \( s_i \) the unit export subsidy provided by country \( i \)’s government. Let \( p \) denote the market price in country 3, an importing country, \( X(= x_1 + x_2) \) its total consumption. The inverse import demand function in the third country is assumed to be linear throughout the paper:

\[
p = a - X
\]

where \( a \) is a positive constant and \( a > c_i \) \((i = 1, 2)\).

BS model examined governments’ incentives to subsidize the own exporting firms without considering the firms’ location choice. Given the subsidy rate \((s_i, s_j)\), each firm’s equilibrium output and profit in the market performance are expressed as below:

\[
x_i^* (s_i, s_j) = \frac{\beta_i + 2s_i - s_j}{3} \quad \text{(1)}
\]

\[
\pi_i^* (s_i, s_j) = \frac{(\beta_i + 2s_i - s_j)^2}{9} \quad \text{(2)}
\]

where \( \beta_i := a - 2c_i + c_j > 0 \). Without firms’ mobility, each country’s welfare is defined as producer surplus minus subsidy payment of the government:

\[
\tilde{W}_i (s_i, s_j) := \pi_i^* (s_i, s_j) - s_i x_i^* (s_i, s_j) = \left( \frac{(\beta_i + 2s_i - s_j)^2}{9} - s_i \frac{(\beta_i + 2s_i - s_j)}{3} \right). \quad \text{(3)}
\]

Each country’s reaction function denoted by \( R_i (s_j) \) is defined as a solution for maximizing net surplus in (3):

\footnote{It can be checked that the second order and stability conditions are always satisfied.}
Thus Nash equilibrium subsidy profile $s^B := (s^B_1, s^B_2)$ should satisfy

$$s^B_i = \frac{4\beta_i - \beta_j}{15} \quad (i = 1, 2),$$

which gives rise to the equilibrium outputs expressed by $x^*_i (s^B_1, s^B_2) = \frac{2(4\beta_i - \beta_j)}{15}$. Since the monopoly case is beyond the scope of our paper, we focus our attention only to the duopoly equilibria by imposing the following assumption.

**Assumption 1.** $\frac{\beta_1}{\beta_2}$ is satisfied as $\frac{1}{4} \leq \frac{\beta_1}{\beta_2} \leq 4$.

One should note that in view of 5, this assumption also assures that the non-cooperative equilibrium subsidy is non-negative for each exporting country. The associated equilibrium welfare of each exporting country, denoted by $W_{iCC}$, is given by

$$W_{iCC} := \frac{2(\beta_i + \beta_2)^2}{25} \quad (i = 1, 2).$$

For the later analysis, we further have the following lemma:

**Lemma 1.** For $\hat{s}_i \left(= \frac{\beta_i}{5} \right) \ (i = 1, 2)$, there holds $s \begin{cases} < \quad \Rightarrow \quad R_i \left(\hat{s}_i\right) \quad \text{for} \quad s \begin{cases} < \quad \Rightarrow \quad \hat{s}_i. \end{cases} \end{cases}$

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5 The superscripts attached to each country’s welfare shows the policy of each government on whether to closed or open the own market against the foreign firm’s entry. The first superscript $C$ (or $O$) shows the decision of the government in country 1 to close (or open) the domestic market, and the second one the counterpart for country 2’s government.
3. Perfectly Relocatable Plant Case

Janeba (1998) extends BS model to the case in which the firms in both exporting countries can freely choose their location for production, which we call the **perfectly relocatable plant case**, and obtains a subsidy race to the bottom in which the equilibrium subsidy rate is equal to zero for both exporting countries. When both firms are mobile, they target to locate in the country with higher subsidy (or lower tax). Subsidy competition makes each country to raise subsidy (or cut tax) slightly to maximize its net surplus. Therefore there can never exist an equilibrium with positive (or negative) subsidies. Janeba’s result elucidates how the relocatability of both firms affect the government’s subsidization incentives. He shows nondiscrimination (laissez-faire) is better than discrimination (subsidy intervention) for mutual benefits. Let us summarize his result for the convenience of reference in the succeeding discussion.

**Proposition 1.** When the two exporting countries open their domestic markets to the foreign firms’ entry, then the equilibrium subsidy of each exporting country becomes equal to zero.

The associated equilibrium welfare of each exporting country is then expressed by

\[ W_{i}^{OO} := \frac{(\beta_1 + \beta_2)^2}{18} \quad (i = 1, 2). \]

However his result critically hinges on the assumption that the firms in both exporting countries can move their locations for production. In our paper, we confine our assumption to single firm’s mobility. We focus on how partial mobility affects the governments’ strategic trade policy and induces different strategic behaviour of the exporting countries compared to Janeba (1998) in the next section.
4. RELOCATABLE PLANTS AND STRATEGIC EXPORT SUBSIDIES

The analysis of Janeba (1998) enables us to compare the welfare of each exporting country between the following two states.

- Total ban on the inward direct investment chosen by both countries
- Full liberalization on the inward direct investment chosen by both countries

Since capital liberalization is up to the government of each exporting country, the above two states are special cases in a more general framework in which each government can decide whether to open or close the domestic market against inward direct investment from abroad.

... should be explored in a more general case in which we consider in this paper what we may call the *imperfectly relocatable plant* case in which only one firm can relocate its production plant between the own country and the other exporting country. Without loss of generality, let us consider the case in which only firm 2 can relocate its plant because only the government of country 1 opens its domestic market against the foreign firms’ entry. More specifically, we explore the following three-stage sequential-move game.

1st stage:: The governments of the exporting countries simultaneously decide on the subsidy rates to the goods produced in the own country.

2nd stage:: After observing the subsidy rates, only firm 2 can choose its location in either of country 1 and 2.

3rd stage:: Firms compete à la Cournot in the third market.

To make the required changes in Janeba’s model as least as possible for our analysis, we further impose the following assumptions for the location choice of firm 2 in question:

**Assumption 2.** *When a firm can relocate its production plant between countries 1 and 2, it must be subject to the following constraints.*

(i) The firm cannot change the location for the headquarters for management.
(ii) The firm cannot undertake production simultaneously in both countries.

(iii) The same total production cost function is available for the firm to produce whether in country 1 or 2.

(iv) The firm stays in the own country when it is indifferent between countries 1 and 2 for location of its production base.\textsuperscript{4}

The above assumptions imply that the firm’s location decision depends on pecuniary benefits from subsidy differential, so that the country offering a higher subsidy (or imposing a lower tax) can attract the firm with plant relocatability.

5. Strategic Export Policy Under Single Firm’s Mobility

We have to capture the properties of each country’s reaction curve as well as its welfare function (i.e., the payoff) so as to obtain the equilibrium.

5.1. Country 1’s Best Response. Roughly speaking, there are two choices for country 1, either to attract firm 2 into the own country or to let it stay in country 2. Given country 2’s subsidy rate $s_2$, let $V_a^1(s_2)$ denote the supremum of country 1’s welfare when attracting firm 2 and $V_n^1(s_2)$ denote the welfare when not attracting firm 2 and leaving it within the origin country. The superscript $a$, $n$ stands for “attracting” and “not attracting” case respectively. More specifically they are defined as below:

\begin{align}
V_a^1(s_2) &= \sup_{s_1} \left\{ \bar{W}_1(s_1, s_1) - s_1 x_2^*(s_1, s_1) | s_1 > s_2 \right\} \\
V_n^1(s_2) &= \max_{s_1} \left\{ \bar{W}_1(s_1, s_2) | s_1 \leq s_2 \right\} .
\end{align}

We give a somewhat heuristic approach on our analysis. Let us draw the supremum of each payoff $V_a^1(s_2)$ and $V_n^1(s_2)$ as a function of $s_2$ in Figure 1.

\textsuperscript{4}We impose the same tie-breaking rule for zero transportation cost as in Janeba (1998). Without this rule, the equilibria should involve more complicated mixed strategies.
We first deal with $V_1(s_2)$. As (8) shows that insofar as country 1’s subsidy rate exceeds country 2’s, its payoff is independent of the latter’s policy. Thus, there exists a certain subsidy rate that maximizes country 1’s welfare given firm 2’s movement to country 1. We denote as $s^a_1$ and get the following result:\(^5\)

\begin{equation}
\begin{aligned}
s^a_1 &:= \arg \max_{s_1} \left\{ \tilde{W}_1(s_1, s_1) - s_1 x^*_2(s_1, s_1) \right\} = -\frac{\beta_1 + 3\beta_2}{10} < 0 \tag{10}
\end{aligned}
\end{equation}

The above result shows that when both firms locate in country 1, its best response is to tax both firms. Though taxation lowers the products of both firms, a definite increase in the tax revenue makes country 1’s welfare better off. Janeba (1998) also discussed such a positive tax incentive while the rival country sets the tax rate at 0.

When both firms locate in country 1, the equilibrium outputs should be assured to be non-negative. Substituting (10) into (1) yields the following expression:

\begin{align*}
x^*_1(s^a_1, s^a_2) &= \frac{3\beta_1 - \beta_2}{10} \\
x^*_2(s^a_1, s^a_2) &= \frac{7\beta_2 - \beta_1}{30}.
\end{align*}

\(^5\)The second-order condition is checked to be met.
Under Assumption 2, \( x^1_1(s^a_1, s^a_1) \) is non-negative if \( \beta_1/\beta_2 \) is no less than \( 1/3 \), while \( x^2_1(s^a_1, s^a_1) \) is always positive. We get the following lemma.

**Lemma 2.** *When firm 2 moves to country 1, firm 1’s production is non-negative if \( \beta_1/\beta_2 \geq 1/3 \).*

When \( s_2 \) is sufficiently small and thus strictly less than \( s^a_1 \), country 1’s best strategy is to set the subsidy rate at \( s^a_1 \) to attract firm 2 and extract its rent as much as possible. So its supremum (=maximum) payoff \( V^a_1(s_2) \) can be expressed as:

\[
V^a_1(s_2) \bigg|_{\{s_2 < s^a_1\}} = W_1(s^a_1, s^a_1) - s^a_1 x_2(s^a_1, s^a_1) \\
= -5(s^a_1)^2 - (\beta_1 + 3\beta_2)s^a_1 + \beta_1^2 \\
= -\frac{5(s^a_1)^2}{9} - (\beta_1 + 3\beta_2)s^a_1 + \beta_1^2
\]

Since \( s^a_1 \) is given by (10), \( V^a_1 \) in the above equation is constant shown by the thick flat line \( A_1A_2 \) in Figure 1.

But once \( s_2 \geq s^a_1 \), such a strategy is impossible to undertake. In fact, the strategy requires to set the subsidy rate slightly higher than country 2’s subsidy rate, for otherwise firm 2 will stay in country 2 and country 1 cannot extract any rent from firm 2. Country 1 will set its subsidy rate at \( s_1 = s_2 + \varepsilon \), where \( \varepsilon > 0 \) is a sufficient small unit. Country 1’s payoff can be expressed as follows:

\[
V^a_1(s_2) \bigg|_{\{s_2 \geq s^a_1\}} = W_1(s_2 + \varepsilon, s_2 + \varepsilon) - (s_2 + \varepsilon) x_2(s_2 + \varepsilon, s_2 + \varepsilon) \\
= -5s_2^2 - (\beta_1 + 3\beta_2)s_2 + \beta_1^2 - \xi \\
= -\frac{5s_2^2}{9} - (\beta_1 + 3\beta_2)s_2 + \beta_1^2 - \xi
\]

where \( \xi = \varepsilon[5(2s + \varepsilon) + (\beta_1 + 3\beta_2)] \) is sufficiently small to neglect. The above supremum payoff corresponds to the curve labeled \( A_0A_2BA_3 \), which attains its maximum point at
\(s_2 = s_1^a\) and decreases along with country 2’s subsidy rate when \(s_2 > s_1^a\). Thus, the supremum payoff curve \(V_1^a(s_2)\) is shown by the thick dotted curve labeled \(A_1A_2BA_3\) in Figure 1.

Next let us draw the supremum payoff curve given by \(V_1^n(s_2)\). When country 1 chooses not to attract firm 2, each firm locates in its own country and the market structure is the same as in BS model. Note by virtue of Lemma 1 that \(R_1(s_2) \leq \hat{s}_1\) holds if and only if \(s_2 \geq \hat{s}_1\). The supreme welfare can be expressed as:

\[
V_1^n(s_2) \big|_{s_2 \geq \hat{s}_1} = \tilde{W}_1(R_1(s_2), s_2) = \frac{(\beta_1 - s_2)^2}{8}
\]

which is depicted by the curve labeled \(N_1N_2N_3\). On the other hand, for \(\forall s_2 < \hat{s}_1\), \(R_1(s_2) > \hat{s}_1 > s_2\) holds and thus the supreme payoff

\[
V_1^n(s_2) \big|_{s_2 < \hat{s}_1} = \tilde{W}_1(s_2, s_2) = \frac{(\beta_1 - 2s_2)(\beta_1 + s_2)}{9}
\]

follows, depicted by the lower curve labeled \(N_1'BN_2N_3\). The above two curves are tangent at point \(N_2\) as \(s_2 = \hat{s}_1 = \beta_1/5\). Accordingly, the payoff curve \(V_1^n(s_2)\) is given by the thick curve labeled \(N_1'BN_2N_3\) in Figure 1.\(^6\)

The two payoff curves intersect at \(s_2 = 0\), for country 1 cannot extract firm 2’s rent through zero subsidy rate. It is also straightforward to establish\(^7\):

\[
\tilde{W}_1(s_2, s_2) - V_1^n(s_2) \big|_{s_2 \geq \hat{s}_1} = \frac{3s_2^3 + 3\beta_2s_2}{9} = 0
\]

\(^6\)In order to draw the curves in Figure 1, we set \(\beta_1 = 1\) and \(\beta_2 = 7/6\). It is harmless to set the other values of \(\beta_1\) and \(\beta_2\) under the constrain in Assumption 2 and get the same result. For example, if we set \(\beta_1 = \beta_2\), the curve \(A_2A_3\) will be tangent to \(N_1N_2N_3\) at the point \(s_2 = -\beta_1/7\).

\(^7\)Here we neglect \(\xi\) as zero.
if \( s_2 = 0 \) or \( s_2 = -\beta_2 \). Since \(-\beta_2 < s_1^a\) under Assumption 2, curve \( N_1'B \) is always below the curve \( A_1A_2B \) assuring a unique intersection of the two payoff curves at \( s_2 = 0 \).

Denote \( \Gamma_i(s_j) \) as country i’s best response subsidy rate against country j’s. In view of Country 1’s payoff curves in Figure 1, its best response can be characterized as follows.

**Corollary.** Country 1’s best response \( \Gamma_1(s_2) \) should satisfy

\[
\Gamma_1(s_2) = \begin{cases} 
    s_1^a & \text{for } s_2 \in (-\infty, s_1^a) \\
    s_2 + \varepsilon & \text{for } s_2 \in [s_1^a, 0) \\
    0 & \text{for } s_2 = 0 \\
    s_2 & \text{for } s_2 \in (0, \hat{s}_1) \\
    R_1(s_2) & \text{for } s_2 \in [\hat{s}_1, +\infty)
\end{cases}
\]

(11)

where \( \varepsilon(>0) \) is a sufficiently small unit of measuring the subsidy rates.

Country 1’s reaction curve is illustrated by the mixture of the thick real and broken curves in Figure 2, i.e., the curve labeled \( A_1A_2A_3R_1 \).

5.2. **Country 2’s Best Response.** We next examine country 2’s best response. For this purpose, define the following two functions:

\[
V_2^n(s_1) := \sup_{s_2} \left\{ \bar{W}_2(s_1, s_1) + s_1x_2^a(s_1, s_1) | s_2 < s_1 \right\}
\]

(12)

\[
V_2^a(s_1) := \max_{s_2} \left\{ \bar{W}_2(s_1, s_2) | s_2 \geq s_1 \right\}
\]

(13)

The supremum payoff \( V_2^n(s_1) \) and \( V_2^a(s_1) \) are drawn in Figure 3 in the same fashion.

For the latter case in which country 2 attracts firm 2 to keep in the own country, the supremum payoff \( V_2^a(s_1) \) can be expressed as:
Figure 2. Country 1’s Reaction Curve

Figure 3. Country 2’s Payoff Curve

\[ V_2^a(s_1) \mathrel{\mid} \{ s_1 \leq \hat{s}_2 \} = \overline{W}_2(s_1, R_2(s_1)) = \frac{(\beta_2 - s_1)^2}{8} \]

\[ V_2^a(s_1) \mathrel{\mid} \{ s_1 > \hat{s}_2 \} = \overline{W}_2(s_1, s_1) = \frac{(\beta_2 - 2s_1)(\beta_2 + s_1)}{9}. \]
which are depicted by the curves $A_1B_1C_2A_2'$ and $A_1'C_1A_2'$ respectively. The two curves are tangent at point C when $s_1 = \hat{s}_2 = \beta_2/5$. Thus the supremum payoff $V^n_2(s_1)$ corresponds to the thick curve labeled $A_1B_1C_2A_2'$ in Figure 3.

But insofar as country 2 decides to let firm 2 move to country 1, the supremum payoff $V^n_2(s_1)$ is given by

$$V^n_2(s_1) = \pi_2^*(s_1, s_1) = \frac{(\beta_2 + s_1)^2}{9}. $$

Evidently given that firm 2 locates its production base in country 1, country 1’s raise of subsidies increases firm 2’s equilibrium profit. Therefore the payoff curve associated with $V^n_2(s_1)$ is upward sloping, given by the curve labeled $N_1B_2N_2$ in Figure 3.\(^8\)

**Lemma 3.** There exists a unique value $\bar{s}_1 = (3 - 2\sqrt{2})/\beta_2 < \hat{s}_2$ which satisfies $V^n_2(\bar{s}_1) = \tilde{W}_2(\bar{s}_1, R_2(\bar{s}_1))$.

**Proof.** As with the strict monotonicity of $V^n_2(s_1)$ and $\tilde{W}_2(s_1, R_2(s_1))|_{s_1\leq \hat{s}_2}$ and interim value theorem, it assures a unique intersection of the two payoff curves.

$$V^n_2(s_1) - \tilde{W}_2(s_1, R_2(s_1)) = \frac{(\beta_2 + s_1)^2}{9} - \frac{(\beta_2 - s_1)^2}{8} = 0$$

We obtain the solutions that $s_1 = (3 \pm 2\sqrt{2})^2/\beta_2$. Since $(3 + 2\sqrt{2})^2/\beta_2 > \hat{s}_2$, it is out of our consideration. We get $\bar{s}_1 = (3 - 2\sqrt{2})^2$, proving the result. \(\square\)

\(^8\)We set $\beta_2 = 1$ to draw the payoff curves in Figure 3.
The above analysis implies that country 2’s best response $\Gamma_2(s_1)$ should satisfy:

$$
\Gamma_2(s_1) = \begin{cases} 
R_2(s_1) & \text{for } s_1 < \bar{s}_1 \\
\{R_2(\bar{s}_1)\} \cup (-\infty, \bar{s}_1) & \text{for } s_1 = \bar{s}_1 \\
\{s_2|s_2 < s_1\} & \text{for } s_1 > \bar{s}_1 
\end{cases}
$$

Therefore country 2’s best response curve is depicted as the segment $R_2D$ and the shaded region excluding the dotted boundary in Figure 4 and 5.

5.3. **Equilibrium in Single Firm Mobility Game.** The results in the previous section implies that there are several possible equilibria. But they are roughly classified into the following two cases.

- Case I: Nash equilibrium in pure strategy (See Figure 4)
- Case II: Nash equilibrium in mixed strategy (See Figure 5)

![Figure 4](image.png)
Figure 5. Mixed Strategy Equilibrium when $\beta_1/\beta_2 > \beta_{mix}$

Proposition 2. When $\beta_1/\beta_2 < \beta_{mix} = 64 - 45\sqrt{2}$ holds, the Nash equilibrium given firm 2’s mobility in production location coincides the one given its inability of relocating the production base. And if $\beta_1/\beta_2 \geq \beta_{mix}$ holds, then the Nash equilibrium is the one where country 1 chooses $\bar{s}_1$ with probability 1 and country 2 randomizes over $R_2(\bar{s}_1)$ and $(-\infty, \bar{s}_1)$.\(^9\)

Proof. Figures 4 shows the pure equilibrium case if $s_1^B < \bar{s}_1$ and Figure 5 shows the mixed equilibrium case if $s_1^B \geq \bar{s}_1$. From (5) and Lemma 3, we get:

$$s_1^B - \bar{s}_1 = \frac{4\beta_1 - \beta_2}{15} - (3 - 2\sqrt{2})^2\beta_2 = \frac{4\beta_2}{15} [\beta_1/\beta_2 - (64 - 45\sqrt{2})].$$

Thus $s_1^B < \bar{s}_1$ if $\beta_1/\beta_2 < 64 - 45\sqrt{2}$, while otherwise, proving the result. We define $\beta_{mix} = 64 - 45\sqrt{2} \approx 0.36$.\(\square\)

\(^9\)The proof for the mixed strategy equilibrium is just the same as in Krishna(1989)
The above proposition has several implications. First, the production relocatability of Firm 2 tends to dampen the strategic subsidization incentive of country 1, with a firm without production relocatability. This is because the higher subsidy attracts Firm 2 to relocate in country 1, leading to the outflow of subsidization to country 2’s residents.

Second, in view of the first implication, Country 2, the country holding the firms with production relocatability has the stronger incentive to strategically subsidize the own domestic firms, since the rival country is reluctant to raise the subsidy rate.

The resulting equilibrium tends to entail the lower welfare for country 1, the country holding the firms without production relocatability. However, country 2 may benefit from the mobility of Firm 2.

6. INWARD DIRECT INVESTMENT LIBERALIZATION

We have investigated the properties of possible equilibria given each government’s policy to accept foreign direct investment. In the real world, some countries may reject foreign direct investment to protect the domestic industries. Closing inward direct investment will make the foreign firms immobile. Let us further inquire into governments’ incentives to open its market towards the inward direct investment from abroad. We modify the timing of our model to let governments decide whether to open the market towards inward direct investment at Stage 0 and both firms have relocation ability at the 2nd Stage. Consider now the following four-stage game:

0th stage: Governments simultaneously decide whether to open or close inward foreign investment.

1st stage: Governments simultaneously decide on the subsidy rates.

2nd stage: Firms simultaneously choose their location of production.

3rd stage: Firms compete à la Cournot in the third market.
Firms’ location choices at the 2nd stage are constrained by the governments’ decisions whether to open or close inward foreign investment. In view of the governments’ decisions in the 0th stage, the reduced form of the game in question is given by the following payoff matrix.

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<td>Close</td>
<td>Open</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close</td>
<td>$W_{1CC}^C, W_{2CC}^C$</td>
<td>$W_{1CO}^C, W_{2CO}^C$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open</td>
<td>$W_{1OC}^C, W_{2OC}^C$</td>
<td>$W_{1OO}^C, W_{2OO}^C$</td>
<td></td>
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</tr>
</tbody>
</table>

We summarize the model into three regimes: Both countries close, both countries open, only Country 1 (or Country 2) opens inward foreign investment.

6.1. **Both countries close: (close, close).** No firm can move to relocate the production location in the 3rd stage. The equilibrium is represented by point E in Figure 4 as in Brander and Spencer (1985). Each exporting country’s welfare is expressed by:
\[ W_{i}^{CC} = \overline{W}_i(s_i^B, s_j^B) = 2 \left( \frac{4\beta_i - \beta_j}{15} \right)^2 \quad (i, j = 1, 2; j \neq i) \]

6.2. **Both countries open: (open, open).** Both firms are mobile and the result follows Janeba (1998) that laissez-faire is the only subgame perfect equilibrium, i.e., \( s_1 = s_2 = 0 \).\(^{10}\)

Then each country’s welfare can be derived as

\[ W_{i}^{OO} = \frac{\beta_i^2}{9} \quad (i = 1, 2) \]

6.3. **Only Country 1 (or Country 2) opens: (open, close) or (close, open).** Next let us ascertain the welfare when only country 1 liberalizes inward direct investment from abroad. In view of Proposition 2, each country’s welfare coincides the welfare when both countries close, i.e., \( W_i^{OC} = W_i^{CC} (i = 1, 2) \) in the pure strategy when \( \beta_1/\beta_2 < \beta^{mix} \). Let us focus our attention to the mixed-strategy when country 2 randomizes over \( R_2(\bar{s}_1) \) and \((-\infty, \bar{s}_1)\) with the same welfare level. We first obtain country 2’s welfare as follows:

\[ W_{2}^{OC} = V_2^n(\bar{s}, \bar{s}) = \frac{(\beta_2 + \bar{s}_1)^2}{9} \]

Symmetrically, it also yields \( W_1^{CO} = \frac{(\beta_1 + \bar{s}_2)^2}{9} \) where \( \bar{s}_2 = (3 - 2\sqrt{2})/\beta_1 \). Then we can soon establish the following result in the matrix game.

\[ W_1^{CO} > W_1^{OO}, \quad W_2^{OC} > W_2^{OO} \]

What about country 1’s welfare when only country 1 opens its market? From Figure 5, it is clear that when point \( C \) emerges at equilibrium, country 1 cannot attract firm

\(^{10}\)The readers can verify this laissez-faire result by using our approach in the previous section.
2. However when the equilibrium points are below the Line $BB'$, country 1 sets the own subsidy rate at $\bar{s}_1$ and attracts the two firms to locate in. Let us denote $\rho \in (0, 1)$ as the probability that country 2 chooses $R_2(\bar{s}_1)$ and $1 - \rho$ the probability that country 2 chooses $s_2 < \bar{s}_1$. Thus country 1’s welfare can be expressed as:

\[(18) \quad W_{1OC} = \rho W_{1CC}(\bar{s}_1, R_2(\bar{s}_1)) + (1 - \rho)V_1^a(\bar{s}_1, \bar{s}_1)\]

where $1 - \rho = F(\bar{s}_1) = \int_{-\infty}^{\bar{s}_1} f(s_1)ds_1$.

Comparing welfare $W_{1CC}$ with $W_{1OC}$, we get the following result (See Appendix for details):

\[(19) \quad \begin{cases} W_{1CC} < W_{1OC} & \text{if } \beta < \beta_1/\beta_2 < \overline{\beta} \\ W_{1CC} = W_{1OC} & \text{if } \beta_1/\beta_2 = \overline{\beta} \text{ or } \overline{\beta} \\ W_{1CC} > W_{1OC} & \text{otherwise} \end{cases} \]

By using the same approach, we can get the similar results for $W_{2CC}$ and $W_{2CO}$:

\[(20) \quad \begin{cases} W_{2CC} < W_{2CO} & \text{if } \overline{\beta} < \beta_1/\beta_2 < \beta' \\ W_{2CC} = W_{2CO} & \text{if } \beta_1/\beta_2 = \overline{\beta} \text{ or } \beta' \\ W_{2CC} > W_{2CO} & \text{otherwise} \end{cases} \]

where $\beta' = 1/\beta$ and $\overline{\beta} = 1/\overline{\beta}$.

6.4. Equilibrium. In view of Lemma ??, we constrain $\beta_1/\beta_2$ in the range of $[1/3, 3]$. The results in (17)(19)(20) and Proposition 2 can be summarized into the following figure.
The shadow regions show the pure strategy case when only one country opens. Corresponding to $\beta_{mix}^{1}$ for country 1, $\beta_{mix}^{1} = 1/\beta_{mix}^{2}$ is the threshold value for country 2. We discuss the equilibrium into five cases.

6.4.1. Case I: when $1/3 \leq \beta_1/\beta_2 < \beta_{mix}$ or $\beta_1/\beta_2 = \beta$. Country 2’s dominant strategy is Closing, while country 1 is indifferent between closing and opening. (Close, Close) and (Open, Close).

6.4.2. Case II: when $\beta_{mix} \leq \beta_1/\beta_2 < \beta$. Dominant strategy is (Open, Close).

6.4.3. Case III: when $\beta < \beta_1/\beta_2 < \beta_{mix}$. Dominant strategy is (Close, Close).

6.4.4. Case IV: when $\beta_{mix} < \beta_1/\beta_2 \leq 3$ or $\beta_1/\beta_2 = \beta_{mix}$. Country 1’s dominant strategy is Closing, while Country 2 is indifferent between closing and opening. (Close, Close) or (Close, Open).

6.4.5. Case V: when $\beta_{mix} < \beta_1/\beta_2 \leq 3$ or $\beta_1/\beta_2 = \beta_{mix}$. Country 1’s dominant strategy is Closing, while Country 2 is indifferent between closing and opening. (Close, Close) or (Close, Open).

We summarize the above results into the following figure.

We find that in the most values of $\beta_1/\beta_2$, i.e., $\beta < \beta_1/\beta_2 < \beta_{mix}$, (Close, Close) is dominant strategy in the Nash equilibrium. But following from (14)(15), we can establish:
We define $\beta_{\text{con}} = \frac{8 - 5\sqrt{2}}{2}$ and $\beta'_{\text{con}} = \frac{8 + 5\sqrt{2}}{7}$ in Figure 6. Therefore, when $\beta_{\text{con}} < \beta_1/\beta_2 < \beta'_{\text{con}}$ in the shadow region, neither country has an incentive to liberalize inward foreign investment, while liberalization by both countries leads to Pareto-superior outcomes. Janeba (1998) showed liberalization leads to Pareto-superior outcomes under concave demand and symmetric cost functions. In our paper, we obtain the results under asymmetric cost function and show that the message of Janeba (1998) should not always be accepted optimistic. Liberalization leads to Pareto dominant only when $\beta_{\text{con}} < \beta_1/\beta_2 < \beta'_{\text{con}}$.

**Proposition 3.** In the inward direct investment liberalization model with firms’ mobility, both exporting countries need to coordinate inward direct investment to improve the own welfare when $\frac{8 - 5\sqrt{2}}{2} < \beta_1/\beta_2 < \frac{8 + 5\sqrt{2}}{7}$.

For the third country, which is a country only consuming the goods imported from the Country 1 and 2, its welfare can be expressed as:

$$W_3^{CC} = \frac{2(\beta_1 + \beta_2)^2}{25}, \quad W_3^{OO} = \frac{(\beta_1 + \beta_2)^2}{18}$$
Clearly, \( W_{3}^{CC} > W_{3}^{OO} \), the third country is always better off when both exporting countries close the foreign investment markets. Furthermore, the world welfare under both cases yields:

\[
\sum_{i=1}^{3} W_{i}^{CC} > \sum_{i=1}^{3} W_{i}^{OO}
\]

It conveys a message that nondiscrimination is not a better device than discrimination for the world benefits. Coordination to open inward direct investment does not seem to improve world welfare.

**Proposition 4.** To improve world welfare, both exporting countries should close the inward investment markets. It lowers the exporting countries’ welfare, while leading the third country much better off.

7. Conclusions

In this paper, we reexamined the strategic subsidy policies under international duopoly by introducing a single firm’s freedom in location choice between the exporting countries. We discussed the interaction between the strategic trade policy and foreign direct investment liberalization and made some different viewpoint from the results in Janeba (1998). We clarified that unless all the exporting countries liberalize the inward direct investment abroad, the country regulating the inward direct investment may strengthen the subsidization incentive and it further leads to increase welfare distortion as a whole. Our results stimulated international coordination among the exporting countries to liberalize the inward direct investment together.

To simplify our analysis and present clear-cut policy implications, we employed several crucial assumptions which are satisfied when the demand function is linear. We also neglected the domestic consumption and employment gains in the welfare analysis. It is more natural to assume the two countries to export each other with domestic consumption
and examine the employment gains from direct investment liberalization. It would also be interesting to apply the present model into environmental policies to analyze government emission tax competition. We will take these research into the future agenda.

**Appendix A. Proof for Equation (19)**

Differentiating (18) with respect to $s_1$ yields:

$$0 = \frac{\partial W_1^{OC}}{\partial s_1} \bigg|_{s_1 = \bar{s}_1} = \rho \frac{\partial W_1^{CC}(\bar{s}_1, R_2(\bar{s}_1))}{\partial s_1} + (1 - \rho) \frac{\partial V_1^{a}(\bar{s}_1, \bar{s}_1)}{\partial s_1}$$

$$= \frac{4\beta_1 - \beta_2 - 9\bar{s}_1}{24} + (1 - \rho) \left( \frac{-\beta_1 - 3\beta_2 - 10\bar{s}_1}{9} \right)$$

with the solution $\rho = \frac{8(\beta_1 + 3\beta_2 + 10\bar{s}_1)}{20\beta_1 + 21\beta_2 + 53\bar{s}_1}$ where $\bar{s}_1 = (3 - 2\sqrt{2})\beta_2$. Then country 1’s welfare is expressed as following by using the results of $\bar{s}_1$ and $\rho$:

$$W_1^{OC} = \rho \frac{(4\beta_1 - \beta_2 - 3\bar{s}_1)(4\beta_1 - \beta_2 + 9\bar{s}_1)}{144} + (1 - \rho) \frac{\beta_1^2 - \bar{s}_1(\beta_1 + 3\beta_2) - 5\bar{s}_1^2}{9}.$$

Comparing welfare $W_1^{CC}$ with $W_1^{OC}$ yields:

$$W_1^{CC} - W_1^{OC} = 2 \left( \frac{4\beta_1 - \beta_2}{15} \right)^2 - \rho \frac{(4\beta_1 - \beta_2 - 3\bar{s}_1)(4\beta_1 - \beta_2 + 9\bar{s}_1)}{144}$$

$$- (1 - \rho) \frac{\beta_1^2 - \bar{s}_1(\beta_1 + 3\beta_2) - 5\bar{s}_1^2}{9}$$

The above equation is a complicated cubic equation in $(\beta_1, \beta_2)$. We use Mathematica Computation Soft to derive the solutions for $\beta_1/\beta_2$ depicted in the following figure. Since $\beta_1$ is always positive, we delete one solution in negative form and denote the other two solutions as $\beta$ and $\beta'$. We obtain the approximation as follows.

$$\beta \approx 0.28 \quad \beta' \approx 0.38$$


MARKUSEN, J., AND A. VENEBLES (1988): “Trade policy with increasing returns and