

# Competing for Foreign Direct Investment

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## Abstract

The paper analyzes “subsidy games” between countries in order to attract foreign direct investment (FDI) from a third country. The winner of this game results from the interaction of two factors, relative country size and employment gains from FDI: a large (or “central”) country is more likely to attract FDI, and so is a country with high unemployment. The subsidy equilibrium is compared with two alternative solutions: zero subsidies and first-best subsidies. It is shown that total welfare may be greater under subsidy competition than under zero subsidies: the gains from efficient location implied by subsidy competition may more than outweigh the losses from higher subsidies. Moreover, departing from subsidy competition to zero subsidies or to first-best subsidies (without side payments) implies a gain to one country and a loss to the other. This suggests that it may be difficult to reach a consensus to move away from the status quo of subsidy competition.

## 1. Introduction

Government intervention in favor of foreign investment, namely the policy of granting subsidies in order to attract foreign firms, is a frequently observed phenomenon. The benefits from foreign investment include the possibility of transferring advanced technology, substituting imports, and creating jobs.

Normally, a firm contemplating a new investment abroad will consider possible countries in which to locate. Since all or most of these countries are eager to attract such an investment, “subsidy games” take place, whereby each country attempts to offer the foreign firm the most favorable conditions.

In this paper, we analyze “subsidy games” of this type. Specifically, we consider a game between two countries for the location of a firm from a third country.<sup>1</sup> To motivate the assumption that FDI is worth competing for, we suppose that each country suffers from problems of unemployment which are alleviated by foreign direct investment.<sup>2</sup> In particular, we assume that the shadow wage is lower than the nominal wage, so that employment expansion yields an increase in domestic surplus. The strategy used by each country in the game is, by assumption, a subsidy to marginal cost.

An example of the problem we address is provided by the decision of Hoover, a domestic-appliance maker owned by America’s Maytag, to relocate a factory from France to Scotland. French officials have accused the UK of “social dumping,” the policy of “eroding workers’ rights in a bid to attract foreign investment.” This is an example of a subsidy that lowers the foreign firm’s marginal cost, and thus falls under the general framework of our paper.<sup>3</sup> Subsidies to other inputs, or tax breaks, would provide alternative examples.

Our analysis of the game to attract foreign direct investment includes both positive and normative elements. The model extends previous research by considering unemployment gains and competition between governments.<sup>4</sup> We first show that the winner

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of the subsidy game results from the interaction of two factors: (i) the relative size of each country, and (ii) the relative importance of employment gains in each country. A larger country attracts a foreign firm more easily because location in a large country minimizes total transportation costs. On the other hand, a country with higher employment gains is more likely to attract a foreign firm because it is willing to offer a higher subsidy.

We also look at the impact of subsidy competition on welfare. We do so by comparing the equilibrium with two possible alternative solutions: one in which subsidies are set to zero ("fiscal harmonization") and one where the countries agree on setting jointly optimal subsidies (first best). Although total welfare is greater under the first best (by definition), the same is not true under the zero-subsidy equilibrium: the gains from efficient location implied by subsidy competition may more than outweigh the losses from higher subsidies.

Finally, we show that, with respect to the subsidy competition equilibrium, both the zero-subsidy solution and the first-best solution without side payments imply an increase in welfare for one country and a decrease in welfare for the competing country. This suggests that it may be difficult to reach a consensus on a prohibition against subsidies to foreign investment; or, in fact, a consensus on an optimal subsidy policy. In other words, the status quo of subsidy competition is quite stable.

## 2. The Model

Assume there are two countries, 1 and 2, each willing to attract a producer from a third country. By assumption, this producer cannot (or is not willing to) export from its country of origin. Moreover, it finds it profitable to invest and has already decided that it will invest in one of the two countries. Because of high fixed costs, it chooses to locate in only one of these countries, using this facility to supply both countries (as a monopolist).<sup>5</sup> Exports between countries incur a transportation cost of  $t$  per unit.

The demand functions in each country are given by

$$Q_i = (a - P_i)S_i, \quad i = 1, 2 \quad (1)$$

where  $Q_i$  is quantity in country  $i$ ,  $P_i$  the associated market price, and  $S_i$  a measure of country  $i$ 's size.<sup>6</sup>

To simplify the presentation, we assume a very particular production technology: one unit of labor produces one unit of output. The firm's cost function is thus given by  $C = (w - z)Q + F$ , where  $Q$  is the quantity produced,  $F$  is the fixed cost,  $w$  is the wage rate, and  $z$  a subsidy to marginal cost.

The nominal wage is assumed to be equal in both countries:  $w_1 = w_2$ .<sup>7</sup> However, due to unemployment, the shadow price of labor in country 2,  $\omega_2$ , is lower than the nominal wage in that country:  $\omega_2 < w_2$ .<sup>8</sup> By contrast, in the large country, the shadow price of labor equals the nominal wage:  $\omega_1 = w_1$ .<sup>9</sup> To economize on notation, we will denote by  $w$  the nominal wage (the same in both countries) and by  $\beta \equiv w_2 - \omega_2$  the difference between nominal wage and shadow price of labor in the small country;  $\beta$  is thus the measure of the employment gains derived from location in the small country.<sup>10</sup> Note that because the subsidy lowers marginal cost, it also implies an increase in consumers' surplus from higher supply by the monopolist.

The timing of the game is the following. In a first stage, both countries simultaneously set the levels of subsidies to the foreign firm's marginal cost (conditional on it locating in its territory),  $z_i$ . In a second stage, the foreign firm selects the country in

which to locate, and sets both the quantity to produce and the quantity to export to the country not chosen for location.

### 3. Choice of Location by the Foreign Firm

Under the specified linear demand and cost functions, the foreign firm's profits in each possible location are given by

$$\Pi_i = S_i(a - w + z_i)^2 / 4 + S_j(a - w - t + z_i)^2 / 4 - F, \quad i = 1, 2; j = 3 - i. \quad (2)$$

The foreign firm therefore locates in country 1 if and only if

$$z_2 < z_1 + t(S_1 - S_2) / (S_1 + S_2). \quad (3)$$

Define  $\alpha \equiv S_1 / S_2 \geq 1$ . The parameter  $\alpha$  is an index of the relative size of the two countries. Condition (3) can then be restated as

$$z_2 < z_1 + t(\alpha - 1) / (\alpha + 1). \quad (4)$$

The intuition for this condition is apparent by considering two particular extreme cases. If both countries offer a zero subsidy ( $z_1 = z_2 = 0$ ), then the foreign firm locates in the large country and exports to the small country. On the other hand, if countries are of the same size ( $\alpha = 1$ ), then the monopolist chooses to locate in the country offering the highest subsidy. Finally, for given subsidies and relative size, higher transportation costs favor the larger country. In words, the winner of the subsidy game results from the interaction of three factors: the relative size of each country, transport costs, and the level of subsidies.

### 4. The Subsidy Game

Countries compete in subsidies to marginal cost in order to influence the location decision by the foreign firm and thereby receive employment gains.<sup>11</sup> Each country's objective function is total domestic welfare. Specifically, the welfare of country  $i$  when the monopolist locates in country  $j$ ,  $W_{ij}$ , is simply given by country  $i$ 's consumers' surplus:

$$W_{ij} = S_i(a - w + z_j - t)^2 / 8. \quad (5)$$

In turn, country  $i$ 's welfare when the firm locates in its territory is given by consumer's surplus minus total subsidies plus (possibly) gains from employment creation. In particular, notice that firm profits are not counted as we assume they are entirely repatriated by the foreign firm. We thus have

$$W_{ii} = S_i(a - w + z_i)^2 / 8 + (w - \omega_i - z_i)[S_i(a - w + z_i) / 2 + S_j(a - w + z_i - t) / 2]. \quad (6)$$

The last term in square brackets on the right-hand side is simply total output. The difference  $w - \omega_i$  thus reflects total gains from employment creation (shadow price of labor lower than nominal wage), whereas  $-z_i$  reflects the cost of the total subsidy paid to the foreign firm.

Based on our particular assumption about  $\omega_i$ , we can write

$$W_{11} = S_1(a - w + z_1)^2 / 8 - z_1[S_1(a - w + z_1) / 2 + S_2(a - w + z_1 - t) / 2], \quad (7)$$

$$W_{22} = S_2(a - w + z_2)^2 / 8 + (\beta - z_2)[S_2(a - w + z_2) / 2 + S_1(a - w + z_2 - t) / 2]. \quad (8)$$

The subsidy game has the nature of Bertrand competition.<sup>12</sup> In particular, at “interior points,” the best-response functions of each country are given by

$$z_2^*(z_1) = z_1 + t(\alpha - 1)/(1 + \alpha) + \varepsilon, \tag{9}$$

$$z_1^*(z_2) = z_2 - t(\alpha - 1)/(1 + \alpha) + \varepsilon, \tag{10}$$

where  $\varepsilon$  is a small value.<sup>13</sup> Basically,  $z_i^*(z_j)$  is the minimum subsidy, given  $z_j$  and (3), that country  $i$  has to offer in order to attract the foreign firm.

Country  $i$  will be interested in overcutting country  $j$  only up to the level when  $W_{ij}$  is equal to  $W_{ii}$  given that  $z_i = z_i^*(z_j)$ ; that is, the point such that country  $i$  is indifferent between winning and not winning the subsidy game. Let  $z'_j$  be the corresponding critical value of  $z_j$  and let  $\bar{z}_i \equiv z_i^*(z'_j)$ . For higher values of  $z_j$ , firm  $i$ 's optimal response is to offer  $\bar{z}_i$ .<sup>14</sup> To summarize: the best-response functions are given by (9)–(10) if  $z_j < z'_j$ , where  $z'_j$  is defined by  $W_{ii}(z_i^*(z'_j)) = W_{ij}(z'_j)$ . Otherwise,  $z_i^*(z_j) = \bar{z}_i$ .

Putting the best-response functions together, two nondegenerate equilibrium possibilities arise. First, if  $\bar{z}_1 > z'_1$ , then country 1 is willing to subsidize up to higher levels than country 2. In equilibrium, the firm locates in country 1 and receives a subsidy  $z_1 = z'_1$  (case A in Figure 1). If, on the other hand,  $\bar{z}_2 > z'_2$ , then country 2 is willing to subsidize up to higher levels than country 1. In equilibrium, the firm locates in country 2 and receives a subsidy  $z_2 = z'_2$  (case B). There is still a third, degenerate case, case C, which corresponds to the possibility that  $\bar{z}_2$  is very low,

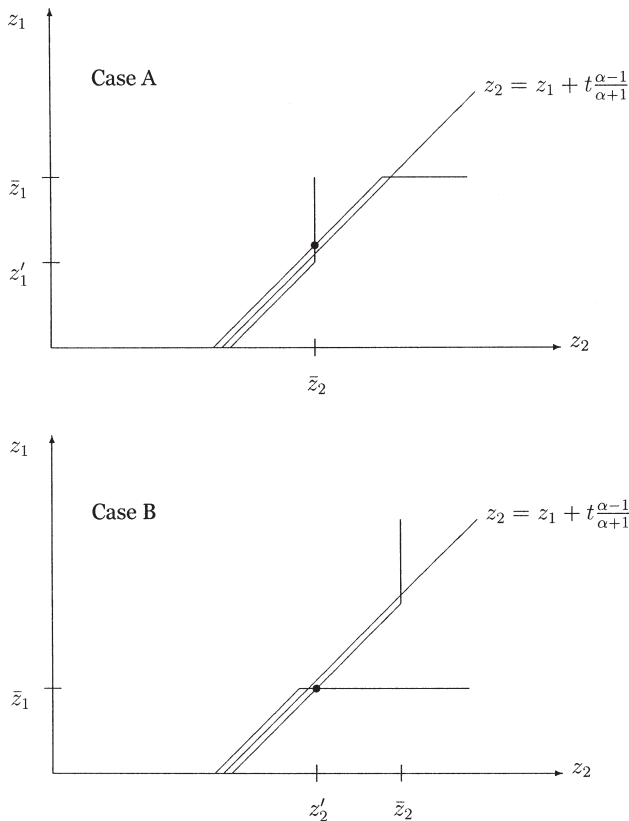


Figure 1. Equilibrium in the Subsidy Game

specifically  $\bar{z}_2 < t(\alpha - 1)/(\alpha + 1)$ . In this case, the foreign firm would locate in country 1 even if country 1 were to offer no subsidy. In fact, country 1 can tax the foreign monopolist without inducing relocation. This occurs when employment benefits are low, transportation costs are high and markets are very different in size. In the remainder, we will assume this degenerate case does not occur.

Our first result characterizes the main parameters influencing the equilibrium outcome of the subsidy game. (Proofs of propositions are given in the Appendix.)

**PROPOSITION 1.** *For any  $\alpha > 1$ , there exists a  $\beta^*(\alpha)$  such that the foreign firm locates in country 2 if and only if  $\beta > \beta^*(\alpha)$ .<sup>15</sup> The value  $\beta^*(\alpha)$  is given by*

$$\beta^*(\alpha) = t(\alpha - 1)/(\alpha + 1) \quad (11)$$

In words, Proposition 1 states that the equilibrium of the subsidy game results from the interaction of two factors, namely employment gains and country size. A country with higher employment gains is more likely to attract the foreign firm because it is willing to pay the foreign firm higher subsidies. A country of larger relative size, in turn, attracts the foreign firm more easily because location in the larger country minimizes transportation costs. It is therefore not surprising that  $\beta^*(\alpha)$  is increasing in  $t$ : the higher the cost of transportation, the greater the relative advantage of the larger country, and thus the greater employment gains must be in order for country 2 to attract the foreign firm.

The above analysis is also suggestive of the equilibrium comparative statics with respect to relative size, employment gains and transportation costs ( $\alpha$ ,  $\beta$ , and  $t$ ). The greater the size asymmetry between countries, the more likely FDI takes place in the large country. Likewise, the greater the employment gains (for the small country), the more likely FDI takes place in the small country. Finally, the greater unit transportation costs, the more likely FDI takes place in the large country; moreover, the lower the subsidy paid by the large country (or a higher the subsidy paid by the large country).

## 5. Uniform Subsidies and Equilibrium Subsidies

It is usually thought that “subsidy games” have the nature of a prisoner’s dilemma, namely that (a) it is a dominant strategy for a country to offer subsidies, but (b) the equilibrium outcome is worse than the situation in which no subsidies are given. In this section, we show that this result fails to be true when we consider asymmetric games like the one presented in the previous sections. First, we show that total welfare in equilibrium may be higher than in the situation when no subsidies are allowed. Second, we show that equilibrium welfare for the smaller country *cannot* be lower in equilibrium than in the situation when no subsidies are allowed.

Although we focus on the case when no subsidies are given to the foreign firm, similar results would be obtained in the case when both countries establish the same level of subsidies, a setting which we might label as “fiscal harmonization.” We will return to this interpretation in section 7.

The first result in this section relates to total welfare.

**PROPOSITION 2.** *For any  $\alpha$ , there exists a  $\beta^{**}(\alpha)$  such that, if  $\beta > \beta^{**}(\alpha)$ , then total welfare is greater in equilibrium than in the situation when no subsidies are allowed. The value of  $\beta^{**}(\alpha)$  is given by*

$$\beta^{**}(\alpha) = t(\alpha - 1)/(\alpha + 1) + t\alpha/(\alpha + 1)^2. \quad (12)$$

The right-hand side of (12) is the subsidy paid by country 2 in equilibrium when it wins the subsidy game (which happens if  $\beta$  is high enough). The condition in the proposition implies that the gains from employment expansion ( $\beta$  times total output) are greater than the losses from subsidies granted to the foreign firm (equilibrium subsidy times total output). This condition is then *sufficient* for total welfare to increase, since the only other effect to consider is consumer surplus, and this is higher under the subsidy equilibrium (as shown in the proof).

We now focus on countries' welfare.

**PROPOSITION 3.** *The smaller country's welfare is greater in equilibrium than in the situation when no subsidies are allowed. Conversely, the larger country's welfare is lower than in the situation when no subsidies are allowed.*

Intuitively, the first part of the result follows from the fact that, absent any subsidies, location is determined solely by relative size. That is, the foreign firm locates in the large country. In the equilibrium of the subsidy game, the worst that can happen for the small country is that location occurs in the large country. But, since the large country offers a positive subsidy in equilibrium, the small country benefits from cheaper imports than in the no-subsidies situation.

On the other hand, the larger country always loses from the subsidy game; either it has to give a subsidy to maintain location decisions, or it loses the firm to the smaller country. The subsidy given, in equilibrium, by the small country is never high enough to compensate for the transport cost it now must be paid by the large country. This is true even though subsidies to marginal cost have a positive effect on consumers' surplus.<sup>16</sup>

## 6. First-best Subsidies and Equilibrium Subsidies

In the previous section, we considered a zero-subsidy equilibrium as the counterfactual with respect to the subsidy game. The zero-subsidy equilibrium is a natural counterfactual; in fact, in the European Union it has been proposed that subsidies to FDI be outlawed, which corresponds to the situation  $z_1 = z_2 = 0$ . There are, however, other counterfactuals equally worth considering. Notice in particular that the zero-subsidy equilibrium is not a first-best situation. In fact, while it reduces the rents given away to the foreign firm, it may also induce inefficient location decisions.

In this section, we consider the first-best solution for the two countries taken together. This is a situation where subsidies are minimized while efficient location decisions are induced.<sup>17</sup> There are two possible interpretations of this solution. One is that the two countries collude in the way they create incentives for FDI. An alternative interpretation is that there are two *regions*, not two countries, and a central government that decides which subsidy each region is allowed to promise the foreign firm. This distinction is important in that, under the two-region interpretation, side payments are possible (decreed by the central government), whereas under the collusion interpretation agreeing on side payments may present difficulties.

If employment gains in the small country are high enough, then the optimal solution consists of a subsidy which is high enough to induce the foreign firm to locate in the small country; and a zero subsidy for location in the large country. Absence of competition implies that the subsidy paid by the small country is lower than it would be under a subsidy game.

PROPOSITION 4. *The first-best solution is characterized by the following offers:*

$$(z_1 = 0; z_2 = 0) \text{ if } \beta < \beta^*(\alpha),$$

$$(z_1 = 0; z_2 = \beta^*(\alpha)) \text{ if } \beta \geq \beta^*(\alpha),$$

where

$$\beta^*(\alpha) = t(\alpha - 1)/(\alpha + 1). \quad (13)$$

Comparing Proposition 4 with Proposition 1, we observe that the critical values of  $\beta$  are the same. This implies that *the equilibrium location of FDI under the subsidy game is optimal*. In other words, the only difference is that *subsidies are (uniformly) higher under the equilibrium of the subsidy game than they are under the first-best solution*.

How does the first-best compare to the subsidy equilibrium in terms of welfare? By definition, *total* welfare is greater under the first-best. Moreover, if side payments between the countries are possible (as is probably the case of two regions within the same country), then a distribution of gains exists such that both countries prefer the first-best solution to the equilibrium with subsidies. In this sense, avoiding subsidy competition is optimal; and subsidy competition should not be observed in equilibrium.

Suppose, however, that side payments between the different countries are impossible. Then we are also interested in each country's welfare under the first best. The following proposition establishes that there is an important difference between this situation and the previous one.

PROPOSITION 5. *Absent side payments, one of the countries prefers the equilibrium with subsidies to the first-best solution.*

The intuition for this result is very similar to that of Proposition 3, only that it now extends to the large country in addition to the small one. From Proposition 4, FDI location decisions are the same under the equilibrium with subsidy competition as they are under the first best. The only difference, from the perspective of each country's welfare, is therefore the level of subsidies. But if a higher subsidy is worse for the host country, the opposite is true for the other country: a higher subsidy implies a lower import price. Since side payments are not allowed, this is all that the "losing" country cares about: the higher the subsidy, the better off the "losing" country is.

Specifically, if employment gains are small ( $\beta$  small), then FDI is located in the large country; the large country prefers the first-best solution, but the small country prefers the equilibrium with subsidy competition. Conversely, if employment gains are large ( $\beta$  large), then FDI is located in the small country; the small country prefers the first-best solution, but the large country prefers the equilibrium with subsidy competition. In summary, for any value of  $\beta$  one of the countries prefers the equilibrium with subsidy competition.

## 7. Final Remarks

In a recent survey of eminent economists, the *Wall Street Journal* inquired whether tax harmonization in the European Union would be a good thing. Milton Friedman, sharing the sentiment of several of his colleagues, argued:

Competition, not identity, among countries in government taxation and spending is highly desirable. How can competition be good in the provision

of private goods and services but bad in the provision of governmental goods and services? A Governmental tax and spending cartel is as objectionable as a private cartel.<sup>18</sup>

Our analysis suggests that subsidy competition for FDI may induce significant efficiency gains with respect to a “tax harmonization” solution whereby subsidies are disallowed or equalized across countries. In fact, FDI location is optimal under subsidy competition, whereas the same is not necessarily true under zero subsidies; and the gains from efficient location may outweigh the costs from higher subsidies under competition.

Our analysis is also suggestive of why the status quo of subsidy competition may be quite stable: both a move towards zero subsidies and a move towards the solution that maximizes joint country welfare imply a gain for one of the countries and a loss to the competing country. Therefore, unless side payments are possible, consensus on moving away from subsidy competition would be difficult to reach.

### Appendix

#### *Proof of Proposition 1*

Substituting from (5) and (7), the condition  $W_{11} = W_{12}$  can be written as

$$\alpha(a - w + z_1)^2 / 4 - z_1[\alpha(a - w + z_1) + (a - w + z_1 - t)] = \alpha(a - w + z_2 - t)^2 / 4. \tag{A1}$$

Imposing  $z_1 = z_1^*(z_2)$ , and simplifying, yields

$$z_2 = z_2' = t(\alpha - 1) / (1 + \alpha) + t\alpha / (1 + \alpha)^2, \tag{A2}$$

and correspondingly

$$\bar{z}_1 = z_1^*(z_2') = t\alpha / (1 + \alpha)^2. \tag{A3}$$

Similarly, substituting from (5) and (8), the condition  $W_{22} = W_{21}$  can be written as

$$(a - w + z_2)^2 / 4 + (\beta - z_2)[\alpha(a - w + z_2 - t) + (a - w + z_2)] = (a - w + z_1 - t)^2 / 4. \tag{A4}$$

Imposing  $z_2 = z_2^*(z_1)$ , and simplifying, yields

$$z_1 = z_1' = \beta + t\alpha / (1 + \alpha)^2 - t(\alpha - 1) / (1 + \alpha), \tag{A5}$$

and correspondingly

$$\bar{z}_2 = z_2^*(z_1') = \beta + t\alpha / (1 + \alpha)^2. \tag{A6}$$

From the text, we saw that the condition for location to occur in country  $i$  is  $\bar{z}_i > z_i'$ . Substituting from the above equations, the critical value  $\beta^*$  results.  $\square$

#### *Proof of Proposition 2*

Total consumer welfare (divided by  $S_2/2$ ) when no subsidies are allowed is equal to

$$CW^0 = \alpha(a - w)^2 / 4 + (a - w - t)^2 / 4. \tag{A7}$$

Make the equilibrium hypothesis that the small country (country 2) wins the subsidy game. The resulting total consumer welfare is then



$$CW^* = \alpha(a - w + z_2 - t)^2 / 4 + (a - w + z_2)^2 / 4, \tag{A8}$$

where  $z_2$  is the equilibrium subsidy. From the proof of Proposition 1, we know that

$$z_2 = t \left[ (\alpha - 1) / (\alpha + 1) + \alpha / (\alpha + 1)^2 \right]. \tag{A9}$$

Substituting into  $CW^* - CW^o$  and simplifying, we get

$$CW^* - CW^o = 0.5t\alpha / (\alpha + 1) [a - w + (z_2 - t) / 2], \tag{A10}$$

which is positive. (In fact, the term in square brackets is greater than the quantity in the small country, which is positive.)

Total welfare equals total consumer welfare in the no-subsidy situation. In the equilibrium with subsidies, total welfare equals total consumer welfare plus net employment gains (divided by  $S_2/2$ ):

$$(\beta - z_2) [\alpha(a - w + z_2 - t) + (a - w + z_2)]. \tag{A11}$$

Therefore, a sufficient condition for total welfare to be greater in the equilibrium with subsidies is that  $\beta > z_2$ , which corresponds to the condition in the proposition (in fact,  $\beta^{**}(\alpha) = z_2$ ). Finally, notice that  $\beta^{**}(\alpha) > \beta^*(\alpha)$ , which confirms the equilibrium hypothesis that the small country wins the subsidy game.  $\square$

*Proof of Proposition 3*

From (4), we conclude that, if no subsidies are given to the foreign firm, then location occurs in country 1. Country 2's welfare is then given by

$$W_{21}^o = S_2(a - w - t)^2 / 8. \tag{A12}$$

In the subsidy equilibrium, if location occurs in country 1, then country 2's welfare is given by

$$W_{21} = S_2(a - w + z_1 - t)^2 / 8, \tag{A13}$$

which is clearly greater than the value in (A12). If location occurs in country 2, then country 2's welfare must be greater than if location were to occur in country 1 given country 1's equilibrium subsidy, and this in turn is greater than the value given by (A12).

Welfare of country 1 always decreases in the subsidy equilibrium. If location occurs in country 1, a subsidy is now necessary to keep the firm. When country 2 wins the subsidy game, welfare of the larger country is also lower since the equilibrium subsidy given by country 2 is lower than the transport cost to be incurred.  $\square$

*Proof of Proposition 4*

Maximization of the host countries' joint welfare (or host country, in the low-region interpretation) implies offering the minimum total subsidy that is consistent with inducing the desired FDI location. Therefore, if the desired location is in the large region (region 1, or country 1), then ( $z_1 = 0; z_2 = 0$ ), for no subsidy difference implies location in the larger country. If the desired location is in the small region, however, then ( $z_1 = 0; z_2 = (\alpha - 1)t / (1 + \alpha)$ ), where  $(\alpha - 1)t / (1 + \alpha)$  is the minimum subsidy difference that induces the foreign firm to locate in the small region.

The choice of these two alternatives is made according to the comparison of  $W(z = 0)$  with  $W(z = (\alpha - 1)t / (1 + \alpha))$ , where  $W$  is the sum of the welfare in the two

regions. From our previous definitions, these welfare measures are given by (divided by  $S_2/2$ ):

$$W(z=0) = \alpha(a-w)^2/4 + (a-w-t)^2/4, \quad (\text{A14})$$

and

$$W(z=t(\alpha-1)/(1+\alpha)) = \alpha(a-w+z-t)^2/4 + (a-w+z)^2/4 + (\beta-z)[(a-w+z)(1+\alpha) + \alpha]. \quad (\text{A15})$$

Defining  $\Delta W = W(z=0) - W(z=t(\alpha-1)/(1+\alpha))$ , and simplifying, we obtain

$$\Delta W = -[(a-w)(1+\alpha) - t][\beta(1+\alpha) + t(1-\alpha)]/(1+\alpha).$$

As we require positive quantities to be consumed in each country, the sign of  $\Delta W$  depends solely on  $\beta(1+\alpha) + t(1-\alpha)$ . Hence the optimal subsidy structure is

$$z_1 = 0 \quad \forall \beta \quad (\text{A16})$$

$$z_2 = 0 \quad \text{if } \beta < t(\alpha-1)/(1+\alpha) \quad (\text{A17})$$

$$z_2 = t(\alpha-1)/(1+\alpha) \quad \text{if } \beta \geq t(\alpha-1)/(1+\alpha) \quad (\text{A18})$$

□

### *Proof of Proposition 5*

Since the critical value of  $\beta$  is the same in Propositions 1 and 5, it follows that the foreign firm's location decision is the same under subsidy equilibrium and under the first best. The only difference between the two situations is therefore the level of subsidies. The country that attracts FDI prefers the situation with lower subsidies (first best), whereas the country that does not attract FDI prefers the situation with higher subsidies (equilibrium). In fact, from the perspective of the country that loses location, the only thing that matters is the price of imports from the other country; and price is lower the higher the level of subsidies. □

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## Notes

1. Various authors, including Brander and Spencer (1987), Horstmann and Markusen (1991), Motta (1992), and Rowthorn (1992) have also addressed problems of international investment from a game theoretic perspective. However, the issue there is that of the choice between investment and exports. In contrast, we consider the decision of investing in one of two possible countries. Somewhat closer to our paper, but still quite different, are the recent papers by Haaparanta (1996) and Adams and Regibeau (1998). Haaparanta (1996) looks at the effects of subsidies on the allocation of an exogenous investment level across countries. Adams and Regibeau (1998) consider a bidding game, with lump-sum subsidies, among regions of a country, in the context of the tariff-jumping argument.
2. This clearly places our problem in the realm of second-best policy: there may be better ways to reduce unemployment other than FDI. But either because they are politically impossible or for some other reason, FDI may be the best solution within the feasible set. We should also add that unemployment is not the only way to motivate our analysis. What is important is that different countries receive different gains from FDI. Different rates of unemployment are one way of doing it, but not the only one.
3. The issue in this example is one of relocation rather than location; but the main ideas in the paper are extensive to this alternative setting, provided we adjust the foreign firm's decision rule to account for the (sunk) relocation cost.
4. Much of the previous literature on strategic trade policies is reviewed in Brander (1995).
5. In a more general setting, we could consider FDI as entry in an imperfectly competitive industry. The welfare effects would then have to include the cost of displaced production of existing domestic firms by the foreign firm. This is done in Barros (1994), in the context of subsidies given by a single country. Since we want to focus on subsidy competition between countries, we opt to keep production-displacement effects out of our analysis.
6. For the purpose of the analysis that follows, country size is relevant only insofar as it affects total transportation cost. For this reason, following Krugman and Venables (1991), size can be viewed as a metaphor for centrality—a larger country can be interpreted as a more centrally located country.
7. Different nominal wages across countries and competition in this variable could have been considered, but the main features of the analysis are not affected by our assumption.
8. As mentioned in section 1, while we focus on employment gains, benefits from FDI can result from other factors, such as technology transfer or agglomeration externalities. The qualitative nature of our results would remain unchanged so long as benefits are positively related to output.
9. The assumption is made for expositional reasons. Allowing for the possibility of unemployment in the large country, that is,  $\omega_1 < w_1$ , would not change the results qualitatively. It would reinforce the larger country's willingness to subsidize.
10. This is a measure of employment gains at the margin. We assume that employment resulting from investment is small relative to total employment in the country. Brander and Spencer (1987), Haaparanta (1996), and Adams and Regibeau (1998) use similar measures of unemployment gains. Other ways of defining employment gains can be found in Cordella and Grilo (1994) and Motta and Thisse (1994).

11. As mentioned in section 1, subsidizing FDI in order to reduce unemployment is clearly a second-best policy; whenever possible, governments should address the problem by implementing direct employment policies. Our modeling assumption is motivated by the fact that, in practice, employment gains are frequently invoked as one of the benefits from FDI.

12. In order to focus exclusively on subsidies as a device to influence location decisions, we impose that no country would want to subsidize the foreign firm if it were to locate in that country anyway. This amounts to imposing  $\partial W_{il} / \partial z_i < 0$  at  $z_i = 0$ . Under these conditions (which are nontrivial and involve a complex relation between  $w$ ,  $\omega$ ,  $t$  and  $S_j$ ), the efficiency effect of inducing the foreign monopolist to increase production is lower than the required subsidy transfer (which counts negatively in domestic welfare). The only rationale for offering subsidies to the foreign firm is then to attract FDI, as we consider here.

13. We will ignore the problems of equilibrium existence common to asymmetric Bertrand games. As shown by Harrington (1989), an equilibrium exists if the strategy values must fall on a small but positive grid of width  $\varepsilon$ , but not otherwise. In the remainder of the paper, we will omit the value of  $\varepsilon$ .

14. In fact, for  $z_j > z'_j$ , country  $i$ 's best response is set valued. However, the analysis is not affected by selecting the particular value  $z_i^*(z'_j)$ .

15. If  $\alpha < 1$ , then the foreign firm locates in country 2 regardless of the value of  $\beta$ .

16. The conditions stated in note 12 guarantee that this effect is small.

17. We assume that no taxes on FDI (negative subsidies) are possible. This corresponds to the assumption that the outside option of the foreign firm is such that taxing FDI would induce location in a fourth country. The results below would be equally valid in the case when the foreign firm's participation constraint corresponds to a positive or a negative subsidy.

18. *Wall Street Journal Europe*, 29 July 1998.