Competing for Foreign Direct Investment

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Abstract

We analyse "subsidy games" between countries in order to attract foreign direct investment (FDI) from a third country. We show that the winner of this game results from the interaction of two factors, relative size of each country and employment gains from FDI. We also show that a small country with higher employment gains can only benefit from engaging in a subsidy game. Moreover, *total welfare* of the countries engaged in the subsidy game may be higher in equilibrium than in the case when subsidies are not allowed. These results suggest that it may be difficult to reach a consensus on a prohibition against subsidies to FDI. In addition, a prohibition against subsidies, while beneficial in many circumstances, may in some cases be welfare reducing.

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2 The Model

Assume there are two countries, 1 and 2, each willing to attract the location by a producer from a third country. Because of high fixed costs, the producer chooses to locate in only one of the two countries, using this facility to supply (as a monopolist) both countries. Exports between countries incur in a transportation cost of t per unit. The demand functions in each country are given by

$$Q_1 = (a - P_1)S_1 \quad (1)$$

$$Q_2 = (a - P_2)S_2 \quad (2)$$

where Q_i is quantity in country i , P_i the associated market price, and S_i a measure of the size of country i .³

To simplify the presentation, we assume a very particular production technology: one unit of labor produces one unit of the good. 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: $w_1 = w_2$.⁴ However, due to unemployment, the shadow price of labor in country 2, ω_2 , is lower than the nominal wage in that country: $\omega_2 < w_2$. By contrast, in the large country, the shadow price of labor equals the nominal wage: $\omega_1 = w_1$.⁵ To economize on notation, we will denote by w the nominal wage (the same in both countries) and by $\beta \equiv w - \omega$ the difference between nominal wage

³For the purpose of the analysis that follows, country size is only relevant insofar as it affects total transportation cost. For this reason, following Krugman and Venables (1991), size can be viewed as a metaphor for peripherality—a larger country can be interpreted as a more centrally located country.

⁴Different 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.

⁵Again, this simplification is made at no significant cost in terms of the generality of the analysis. Allowing for the possibility that $\omega_1 < w_1$ would not change the results qualitatively.

and shadow price of labor in the small country; β is thus the measure of the employment gains derived from location in the small country.

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 one of the countries 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 monopolist foreign firm's profits in each possible location are given by

$$\Pi_1 = S_1 \left(\frac{a - w + z_1}{2} \right)^2 + S_2 \left(\frac{a - w - t + z_1}{2} \right)^2 - F \quad (3)$$

and

$$\Pi_2 = S_2 \left(\frac{a - w + z_2}{2} \right)^2 + S_1 \left(\frac{a - w - t + z_2}{2} \right)^2 - F. \quad (4)$$

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

$$z_2 < z_1 + t \left(\frac{S_1 - S_2}{S_1 + S_2} \right). \quad (5)$$

Define $\alpha \equiv S_1/S_2 > 1$. The parameter α is an index of the relative size of the two countries. Condition (5) can then be restated as

$$z_2 < z_1 + t \left(\frac{\alpha - 1}{\alpha + 1} \right). \quad (6)$$

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. In words, the winner of the subsidy game will result from the interaction of two factors: the relative size of each country and the level of subsidies offered to the foreign firm.

4 The Subsidy Game

Countries compete in subsidies to marginal costs in order to influence the location decision by the foreign firm. 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:

$$W_{ij} = \frac{S_i}{2} \left(\frac{a - w_i + z_j - t}{2} \right)^2. \quad (7)$$

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

$$W_{ii} = \frac{S_i}{2} \left(\frac{a - w_i + z_i}{2} \right)^2 + (w_i - \omega_i - z_i) \left(S_i \left(\frac{a - w_i + z_i}{2} \right) + S_j \left(\frac{a - w_i + z_i - t}{2} \right) \right). \quad (8)$$

The last term in brackets on the right-hand side is simply total output. The difference $w_i - \omega_i$ 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 given to the foreign firm.

Based our particular assumption about ω_i , we can write

$$W_{11} = \frac{S_1}{2} \left(\frac{a - w + z_1}{2} \right)^2 - z_1 \left(S_1 \left(\frac{a - w + z_1}{2} \right) + S_2 \left(\frac{a - w + z_1 - t}{2} \right) \right) \quad (9)$$

$$W_{22} = \frac{S_2}{2} \left(\frac{a - w + z_2}{2} \right)^2 + (\beta - z_1) \left(S_2 \left(\frac{a - w + z_2}{2} \right) + S_1 \left(\frac{a - w + z_2 - t}{2} \right) \right) \quad (10)$$

The subsidy game has the nature of Bertrand competition.⁶ In particular, at "interior points," the best-response functions of each firm are given by

$$z_2^*(z_1) = z_1 + t \left(\frac{\alpha - 1}{1 + \alpha} \right) + \varepsilon \quad (11)$$

$$z_1^*(z_2) = z_2 - t \left(\frac{\alpha - 1}{1 + \alpha} \right) + \varepsilon, \quad (12)$$

where ε is a small value.⁷ Basically, $z_i^*(z_j)$ is the minimum subsidy, given z_j and (5), that firm i has to offer in order to attract location by the foreign firm.

Firm i will only be interested in overcutting firm j up to the level when W_{ij} is equal to W_i given that $z_i = z_i^*(z_j)$, that is, the point such that firm 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 $\bar{z}_i$.⁸ To summarize: the best response functions are given by (11)–(12) if $z_j < z'_j$. Otherwise, $z_i^*(z_j) = \bar{z}_i$.

Putting the best response functions together, two non-degenerate 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 $z_1 = z'_1$ (cf. Figure 1A). 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

⁶In 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 anyways. This amounts to imposing $\partial W_i / \partial z_i < 0$ at $z_i = 0$. Under these conditions (which are non-trivial and involve a complex relation between w , ω , t and S_i), 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.

⁷We 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 ε , but not otherwise. In the remainder of the paper, we will omit the value of ε .

⁸In fact, for $z_j > z'_j$, firm i 's best response is set valued. However, the analysis is not affected by picking the particular value $z_i^*(z'_j)$.

Figure 1: Equilibrium in the subsidy game. Case A is characterized by $\bar{z}_1 > z'_1$, whereas Case B corresponds to $\bar{z}_2 > z'_2$.

a subsidy $z_2 = z'_2$ (cf. Figure 1B).⁹

Our first result characterizes the main parameters influencing the equilibrium outcome of the subsidy game.

Proposition 1 *For any $\beta < t$, there exists an $\alpha^*(\beta)$ such that the foreign firm locates in Country 1 if and only if $\alpha > \alpha^*(\beta)$. Likewise, for any $\alpha > 1$, there exists a $\beta^*(\alpha)$ such that the foreign firm locates in Country 2 if and only if $\beta > \beta^*(\alpha)$.*

The values of $\alpha^(\beta)$ and $\beta^*(\alpha)$ are given by*

⁹There is still a third, degenerate case, Case C, which corresponds to the possibility that $\bar{z}_2$ is very low, 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 the remainder, we will assume this degenerate case does not occur.

$$\alpha^*(\beta) = \frac{\beta + t}{t - \beta} \quad (13)$$

and

$$\beta^*(\alpha) = t \frac{\alpha - 1}{\alpha + 1}, \quad (14)$$

respectively.¹⁰

In words, Proposition 1 states that the equilibrium of the subsidy game results from the interaction of two factors, namely employment gains and 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 allows for a lower total cost of transportation. It is not surprising, therefore, 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.

5 Welfare analysis

It is usually thought that “subsidy games” have the nature of a prisoners’ dilemma, namely that it is a dominant strategy for a country to offer subsidies but the equilibrium 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.

¹⁰Naturally, $\alpha^*(\beta)$ is the inverse of $\beta^*(\alpha)$. If $\alpha < 1$ or $\beta > t$, then the foreign firm locates in Country 2 regardless of the value of β and α , respectively.

Proposition 2 *For any α , 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*

$$\beta^{**}(\alpha) = t \left(\frac{\alpha - 1}{\alpha + 1} + \frac{\alpha}{(\alpha + 1)^2} \right). \quad (15)$$

The right-hand side of (15) is the subsidy paid by Country 2 in the equilibria when it wins the game (which happens if β is high enough). The condition in the proposition implies that the gains from employment expansion (β 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).

Proposition 3 *The smaller country's welfare is greater in equilibrium than in the situation when no subsidies are allowed.*

Intuitively, the result follows from the fact that, absent any subsidies, location is solely determined by relative size. That is, the foreign firm locates in the large country. By contrast, in the equilibrium of the subsidy game, the worst that can happen 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.

From a policy perspective, these results suggest that it may be difficult to reach a consensus on a prohibition against subsidies to foreign investment. In fact, not all countries would necessarily gain from such prohibition. In addition, a prohibition against subsidies, while beneficial in many circumstances, may be welfare reducing in cases when potential employment gains are significant.

6 Final Remarks

We have considered a model of competition (by means of subsidies) for the location of foreign direct investment (FDI). We have assumed that FDI is desirable because it substitutes for imports, and, more importantly, because it creates employment.

We have shown that (i) the winner of the subsidy game results from the interaction of two factors, the relative size of each country and the potential gains from increased employment; (ii) a small country with higher potential employment gains can only gain by engaging in a subsidy game; (iii) total welfare of the countries engaged in the subsidy game may be higher in equilibrium than in the case when subsidies are not allowed.

From a policy perspective, these results suggest that it may be difficult to reach a consensus on a prohibition against subsidies to foreign investment. In fact, not all countries would necessarily gain from such prohibition. In addition, a prohibition against subsidies, while beneficial in many circumstances, may be welfare reducing in cases when potential employment gains are significant.

Appendix

Proof of Proposition 1: Substituting from (7) and (9), the condition $W_{11} = W_{12}$ can be written as

$$\alpha \left(\frac{a - w + z_1}{2} \right)^2 - z_1(\alpha(a - w + z_1) + (a - w + z_2 - t)) = \alpha \left(\frac{a - w + z_2 - t}{2} \right)^2. \quad (16)$$

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

$$z_2 = z_2' = \frac{\alpha - 1}{1 + \alpha}t + \frac{\alpha}{(1 + \alpha)^2}t, \quad (17)$$

and, correspondingly,

$$\bar{z}_1 = z_1^*(z_2') = \frac{\alpha}{(1 + \alpha)^2}t. \quad (18)$$

Similarly, substituting from (7) and (10), the condition $W_{22} = W_{21}$ can be written as

$$\left(\frac{a - w + z_2}{2} \right)^2 + (\beta - z_2)(\alpha(a - w + z_2 - t) + (a - w + z_1)) = \left(\frac{a - w + z_1 - t}{2} \right)^2. \quad (19)$$

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

$$z_1 = z_1' = \beta + \frac{\alpha}{(1 + \alpha)^2}t - \frac{\alpha - 1}{1 + \alpha}t, \quad (20)$$

and, correspondingly,

$$\bar{z}_2 = z_2^*(z_1') = \beta + t \frac{\alpha}{(1 + \alpha)^2}. \quad (21)$$

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 values α^* and β^* result. ■

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

$$CW^\circ = \alpha \left(\frac{a - w - t}{2} \right)^2 + \left(\frac{a - w - t}{2} \right)^2. \quad (22)$$

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

$$CW^* = \alpha \left(\frac{a - w + z_2 - t}{2} \right)^2 + \left(\frac{a - w + z_2 - t}{2} \right)^2, \quad (23)$$

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

$$z_2 = t \left(\frac{\alpha - 1}{\alpha + 1} + \frac{\alpha}{(\alpha + 1)^2} \right). \quad (24)$$

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

$$CW^* - CW^\circ = \frac{1}{2} \frac{\alpha}{\alpha + 1} t \left(a - w + \frac{z_2 - t}{2} \right), \quad (25)$$

which is positive. (In fact, the term in brackets is greater than 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 $S_2/2$)

$$(\beta - z_2) \left(\alpha(a - w + z_2 - t) + (a - w + z_2) \right). \quad (26)$$

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. ■

Proof of Proposition 3: From (6), 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

$$W_{21}^o = \frac{S_2}{2} \left(\frac{a - w - t}{2} \right)^2. \quad (27)$$

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

$$W_{21} = \frac{S_2}{2} \left(\frac{a - w + z_1 - t}{2} \right)^2, \quad (28)$$

which is clearly greater than the value in (27). Finally, 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 (27). ■

References

- Harrington, Jr., J.E. (1989). "A re-evaluation of perfect competition as the solution to the Bertrand price game." *Mathematical Social Sciences*, 17: 315–328.
- Horstmann, I. and Markusen, J. (1991). "Endogenous market structures in international trade." *Journal of International Economics*, 32: 109–129.
- Krugman, P. and Venables, A. (1991). "Integration and the competitiveness of peripheral industry," in C. Bliss and J. Macedo, eds., *Unity with Diversity in the European Community*, Cambridge: Cambridge University Press.
- Motta, M. (1992). "Multinational firms and the tariff-jumping argument — a game theoretic analysis with some unconventional conclusions," *European Economic Review*, 36: 1557–1571.
- Rowthorn, R. (1992). "Intra-industry trade and investment under oligopoly: the role of market size," *The Economic Journal*, 102: 402–414, March.