A Race beyond the Bottom: The Nature of Bidding for a Firm *

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August 2009

Abstract

This paper studies a tax competition over a foreign firm that is to decide its production location. In addition to the sealed-bid first price auction, we consider the English auction under both complete and incomplete information as to competiting countries' valuations of the firm, and show that countries may bid beyond their own valuations if their citizens own some shares of the firm.
Preliminary and incomplete

Keywords: tax competition; foreign direct investment; international ownership.

JEL classifications: F12; F23; H25; H73.

*We are grateful to the participants of Hitotsubashi COE one-day trade workshop for helpful comments.
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1 Introduction

There is now a well established literature on international competition for foreign direct investment (FDI) (e.g., Haaparanta 1996, Haaland and Wooton 1999, Haufler and Wooton 1999, Fumagalli 2003, Olsen and Osmundsen 2003, Bjorvatn and Eckel 2006, Ferrett and Wooton 2008). Of particular relevance to our analysis is Haufler and Wooton (1999). They examine the outcome of the competition between two governments to attract a single, foreign-owned firm's production facility that will manufacture goods for both national markets. With identical potential host nations bidding to attact the firm, each country is prepared to undercut its rival's offer such that, in equilibrium, this "race to the bottom" has transferred all of the winner's gains from the FDI to the firm. Thus the host country fares no better than the losing country, despite receiving the investment. This outcome changes when one nation is larger than the other. A size asymmetry will result in the larger country winning the bidding contest, as it is both more attractive to the investor and is prepared to pay a larger subsidy (or offer lower corporate taxation) in order to capture the FDI. Despite the larger country's greater willingness to pay to attract the FDI, it need only slightly improve upon the offer made by the rival, smaller country and thereby captures for itself some of the benefits of the FDI.

Ferrett and Wooton (2008) use the same framework to investigate whether the assumption that the firm is owned entirely by individuals who do not live either bidding country has an impact on the outcome of the competition. They establish an "invariance result" showing that the unique equilibrium of a tax/subsidy competition game between the two governments is independent of how the firm's ownership is distributed internationally. Their result applies both to the equilibrium location of the firm's plant and to the countries' equilibrium tax/subsidy offers. Thus the nationality of the firm is irrelevant to the strategy that a potential host country should follow in offering investment incentives. This conclusion is quite significant for the policymaker who can ignore the ownership of the firm. Indeed, the policymaker need never know who the firm belongs to.

As with Haufler and Wooton, Ferrett and Wooton treat the bidding contest as a si-

multaneous, complete information game, finding the subgame perfect equilibrium in pure strategies. In our analysis in this paper, we examine the impact of changing the contest from the sealed-bid auctions of the previous literature to a more-realistic, English auction, where the contestants react sequentially to their rivals' offers. We further consider the implications of introducing a degree of uncertainty on the part of each government regarding the benefits that the other nation will achieve from attracting the FDI. We shall show that Ferrett and Wooton's invariance result may break down in these settings, such that the distribution of the firm's ownership affects the outcome of the contest. One outcome of note is that, if a country's citizens own some share of the firm, its government may offer a bid beyond its valuation of the investment.

2 Model

There are two countries, A and B, bidding to attract the investment of a single firm. The government of country i ($i = A, B$) makes an offer of b_i to the firm in order to attract its investment. When $b_i > 0$ the country is prepared to subsidize the investment, while $b_i < 0$ is a tax on the firm. We make the simplification that, in the absence of these transfers, the firm is indifferent between the two potential host locations as its profits are identical and equal to π from producing in either country.[1] After the governments make their bids, the monopolist decides where to locate its plant while the product markets in A and B are served in the final stage.

The benefit to country i of having local investment is assumed to be S_{ii}, while it gets S_{ij} ($i \neq j$) when the firm produces in country j and services its market through international trade. We assume that local investment is always preferred to imports and hence $S_i \equiv S_{ii} - S_{ij}$, country i's *valuation* of the FDI, is always positive.[2] We assume, without loss of

[1] Thus there is no "geographic advantage" to the firm locating in one market relative to the other. We make this assumption simply to reduce the notational complexity. Our results would be qualitatively unchanged if, for example, pre-tax profits were higher in country A (as is assumed in Ferrett and Wooton, 2008).

[2] This preference for local production can be attributed to a number of causes. In Haufler and Wooton (1999) it arises because locally produced goods are cheaper than imports from the other country. Among other justifications for the desire to attract FDI are the increased demand for domestic workers that it generates and the technological spillovers to indigenous industries from the increased the manufacturing

generality, that $S_A \geq S_B > 0$ in the case where countries' valuations are common knowledge. Thus country A values the investment at least as much as country B does.

In addition to the benefits of the FDI to the nation as a whole, country i's citizens are assumed to own a fraction e_i of the investing firm and consequently receive that share of the firm's after-tax profits. We write W_{ij} for country i's overall welfare benefit payoff from the firm locating in country j. Then, country i's welfare, dependent upon the location of the investment, is given by

$$W_{ii} = e_i(\pi + b_i) - b_i + S_{ii}, \tag{1}$$

$$W_{ij} = e_i(\pi + b_j) + S_{ij},\ i \neq j. \tag{2}$$

Let the net welfare benefit of hosting the firm be $W_i \equiv W_{ii} - W_{ij}$. Thus country i strictly prefers hosting the firm if and only if

$$W_i = e_i(b_i - b_j) - b_i + S_i > 0, \tag{3}$$

and is indifferent to the location of the firm if $W_i = 0$. As pre-tax profits are assumed to be the same for the firm regardless of where it locates, $(b_i - b_j)$ is the difference in the firm's net profits from choosing to invest in country i.

3 Simultaneous bidding under complete information

We start with a sealed-bid auction, identical to that of Ferrett and Wooton (2008), where the governments make their offers simultaneously and irreversibly. This yields a multiplicity of Nash equilibria. Ferrett and Wooton restrict their attention to outcomes where the countries do not make weakly dominated bids. Thus neither country ever makes a bid higher than its valuation of the investment.[3] We shall, at least initially not impose this limitation on the potential equilibria.

activity.

[3]This rules out cases where a country would lose if it were to succeed in attracting the firm and makes a high offer only because it is certain that the firm will reject the overly generous subsidy in favour of a better deal being offered by the other country which values the investment more highly. Indeed, it can be shown that country i's offering at its own valuation S_i weakly dominates any offer that is strictly higher than S_i.

Given that pre-tax profits of the firm are the same in both potential host countries, country A wins the auction only if

$$b_A \geq b_B.$$

Country A will surely win if it offers the firm a bigger subsidy or lower tax than its rival, country B.

Consider country A's best response to its rival's bid b_B. We show that country A should offer:

$$\text{(i)} \quad b_A = -\pi \text{ if } b_B < -\pi;$$

$$\text{(ii)} \quad b_A = b_B + \varepsilon \text{ if } -\pi \leq b_B < S_A;$$

$$\text{(iii)} \quad b_A \in (-\infty, b_B] \text{ if } b_B = S_A; \text{ and}$$

$$\text{(iv)} \quad b_A \in (-\infty, b_B) \text{ if } b_B > S_A,$$

where $\varepsilon > 0$ is an arbitrarily small number. These bids are explained as follows. (i) If country B were to set tax greater than the firm's pre-tax profits, the firm would make a loss if it were to locate in that country and would never invest there. All that country A needs to do in order to attract the firm is to make an offer that would allow it at least to break even, that is $b_A + \pi \geq 0$. Thus, country A's optimal strategy is to set tax such that it fully extracts the firm's profits from the FDI. (ii) Were country B to offer a smaller tax (or grant a subsidy) to the firm such that it would makes an after-tax profit from its FDI, country A would have to improve on its offer in order to win the auction. The winning offer is a tax/subsidy that gives the firm ε more in after-tax profits than it would get from locating in country B. (iii) There are limits to country A's generosity, however, as it will only be prepared to offer a subsidy up to its valuation of the investment when it has a chance of winning the auction. If country B were to offer a subsidy equal to country A's valuation such that $b_B = S_A$, country A has two options. It can either try to attract the FDI by matching country B's bid. In such a case, it follows from (3) that $W_A = 0$, meaning that country A receives no benefit from the investment. Otherwise, country A could make a lower bid that would ensure that it lost the auction. Thus, regardless of whether or not country A

wins the auction, it receives W_{AB}. (iv) If country B bids above country A's valuation of the investment, any bid that would beat country B's offer would result in $W_A < 0$ and consequently country A will ensure that it loses. Country B's best response function is derived in an identical fashion.

Figure 1 depicts the two countries' reaction curves in the case where $S_A > S_B$. There are multiple Nash equilibria, such that country B offers a subsidy in the range $b_B^* \in [S_B, S_A]$ while country A wins the auction by matching its rival's subsidy with $b_A^* = b_B^*$. It is easy to see that, given country A wins the auction, neither country has an incentive to deviate from their prescribed strategies. Country A's equilibrium bid can be viewed as the limit strategy as ε goes to zero. Country A attracts the investment at minimum cost, given its rival's bid, so has no incentive to deviate. Country B, on the other hand, wishes to lose the contest given country A's bid, and this is the outcome in equilibrium.

If the two countries had identical valuations of the firm, $S = S_A = S_B$, then each country would bid its valuation and the equilibrium bids would be identical, $b_A^* = b_B^* = S$. The firm would then be indifferent between locations and might invest in either country. The winning nation would be no better off than the loser, as all of the rent from the investment would be transferred to the firm in the subsidy. This is the familiar "race to the bottom" in taxes.

Ferrett and Wooton's (2008) result, that the international distribution of the firm's ownership is irrelevant to the outcome of the game, can be understood by considering the objective function of country i given by (3). The citizens' ownership of the firm e_i is multiplied by the difference in the two countries' bids; the citizens in country i capture the fraction e_i of their country's bid but lose the opportunity to capture the same fraction of the rival nation's bid. It might seem that this should influence the equilibrium offers and perhaps the location of the FDI. However, the bids made by the countries are such that the firm is only *just* persuaded to locate in one location over the other. Thus, in equilibrium, the bids are equal because the firm considers the two locations as being equally attractive. Consequently the first term in (3) is zero with domestic shareholders being unaffected by the equilibrium location of the FDI. Thus the distribution of ownership of the firm has no effect on the strength of national

bids nor on the eventual locational choice of the firm in equilibrium

Proposition 1 *In the sealed-bid, first-price auction, there exist multiple Nash equilibria unless* $S_A = S_B$. *If* $S_A > S_B$, *country* A *attracts the investment with a winning bid* $b_A^* \in [S_B, S_A]$. *If* $S_A = S_B$, *the location of the firm is indeterminate and the entire benefit of the investment is transferred to the firm through the equilibrium bids of* $b_A^* = b_B^* = S$. *Furthermore, the international distribution of the firm's ownership does not affect the countries' bidding strategies.*

Let $S_A > S_B$. If country B's equilibrium bid is equal to its valuation of the investment, $b_B^* = S_B$, then country A will win the auction with the minimum subsidy by matching country B's subsidy. If $b_B^* \in (S_B, S_A)$, country B's equilibrium bid is strictly greater than its valuation of the firm, S_B. Country B can make such a bid because it "knows" that country A will match the bid in order to win the auction. Although this argument is important in understanding the equilibrium in later sections, one may argue that such Nash equilibria are not appealing. Indeed, any bid b'_B that is strictly greater than S_B is dominated by $b_B = S_B$, for (i) if $b_A < b'_B$, then $b_B = S_B$ is strictly preferable to $b_B = b'_B$ because winning the auction in this case entails a loss for country B, (ii) if $b_A = b'_B$, then $b_B = S_B$ is strictly preferable to $b_B = b'_B$ should country B win the auction while it would be indifferent between them when country A wins, and (iii) if country A bids $b_A > b'_B$, then country B is indifferent between $b_B = S_B$ and $b_B = b'_B$. Similarly, country A's bid that exceeds S_A is dominated by $b_A = S_A$. Each country offers at most its valuation of the firm in its undominated strategies. Consequently, the undominated Nash equilibrium, which is the Nash equilibrium with a pair of undominated strategies, is uniquely determined as $b_A^* = b_B^* = S_B$ with country A winning the auction.[4]

Proposition 2 *There exists a unique undominated Nash equilibrium in which* $b_A^* = b_B^* = S_B$ *and the firm locates itself in country A. The winning bid is the minimum bid of all the Nash equilibrium bids.*

[4]The undominated Nash equilibrium is the outcome considered by Ferrett and Wooton (2008).

4 English auction under complete information

We now change the first stage of the game to that of an English auction in which each country has the opportunity to respond to the bid of its rival. It might be argued that this better reflects the reality of inter-governmental competition for investment, in that the firm can play potential host countries off against each other and thereby extract the highest offer from them. We therefore allow each country the chance to bid an amount Δ above the standing bid of its rival. Recall that we are assuming that pre-tax profits are the same in both locations for the firm, consequently the winner is the country whose standing bid does not attract an improved bid from the other nation.

Let country j's standing bid be b_j. Given country i's net welfare benefit of hosting the firm given by (3), it will raise its bid to $b_i = b_j + \Delta$ if and only if

$$S_i \geq b_j + (1 - e_i)\Delta. \tag{4}$$

That is, country i will improve its bid as long as the additional cost (that part of the extra incentive that does not accrue to shareholders in country i) does not push the cost of the subsidy beyond the country's valuation of the FDI should it become the host nation. Whenever (4) holds for country i, following a bid by its rival, it will bid again and the cycle will continue. We derive the limit equilibrium as Δ goes to zero. It follows from (4) that in the limit equilibrium, country i raises its bid as long as $S_i > b_j$.

Consider the case in which $S_A > S_B$ and examine whether or not country B has an incentive to raise its bid beyond its valuation when $b_A \in (S_B, S_A)$. Country B knows that country A will reply to its bid of $b_B = b_A + \Delta$ for a small Δ as long as the counterbid does not exceed country A's valuation, that is $b_A + 2\Delta \leq S_A$. Therefore, country B can raise A's winning bid from b_A to $b_A + 2\Delta$ if it offers $b_A + \Delta$ and make no bid in the suceeding round. In following this strategy, country B gains $2\Delta e_B$ relative to its having stopped bidding in the earlier round.

If citizens of country B have no ownership shares in the firm ($e_B = 0$), there exist multiple subgame perfect equilibria whose outcomes are the same as in the case of the sealed-bid

auction. Country A's winning bid must be at least S_B otherwise country B would continue to bid. Moreover, B is indifferent to any $b_A \in [S_B, S_A]$ so long as it loses, since it gets S_{BA} in any event. Country B also knows that its bid will be countered if country A's bid is in this range. So the eventual loser can raise country A's winning bid to any level in this range. As with simultaneous bidding, the undominated subgame perfect equilibrium outcome is that country A wins the auction with its winning bid of S_B.

On the other hand, if some of the firm is owned by citizens of country B (that is, $e_B > 0$), the subgame perfect equilibrium will be unique and characterized by country A winning with a bid of S_A. This is because country B knows that country A will be prepared to raise its bid as long as $b_A < S_A$. Consequently country B will bid beyond its own valuation of the investment in order to force up the payment to the firm, as a share of this subsidy is paid to its own citizens. This result contrasts sharply with those in the previous literature, such as Haufler and Wooton (1999), in which the winning nation need only offer as much as the rival's valuation of the firm. Moreover, it is also different from the result of Ferrett and Wooton (2008) in that the firm's ownership structure affects the equilibrium outcome significantly.

If $S_A = S_B \equiv S$, then either country A or B wins the auction with its winning bid of S.

Proposition 3 *In an English auction under complete information when $S_A > S_B$, the subgame perfect equilibrium depends on the value of e_B. If $e_B = 0$, the equilibrium outcomes are the same as in the case of sealed-bid first-price auction with multiple subgame perfect equilibria, although the undominated subgame-perfect equilibrium is uniquely determined with country A's winning bid of S_B. If $e_B > 0$, there exists a unique subgame perfect equilibrium in which country A wins the auction with its winning bid of S_A. If $S_A = S_B = S$, the location of the firm is indeterminate and the entire benefit of the investment is transferred to the firm through an equilibrium bid of S.*

5 English auction under incomplete information

Finally, we consider what might be one of the most applicable forms of tax competition. Here, we assume that the benefits received both from attracting FDI and from importing are a country's private information. That is, S_{ii} and S_{ij} are known only to country i. However, we assume that the probability distribution of country i's valuation of the investment S_i ($\equiv S_{ii} - S_{ij}$) is common knowledge. Let $F_i[S_i]$ be the cumulative distribution function with a corresponding continuous density function of $f_i[S_i]$.

Country i's strategy is characterized by its threshold of dropping out of the auction. Country i will only counterbid if the expected payoff from raising the standing bid by Δ is not less than the guaranteed payoff from dropping out of the auction and letting its rival attract the FDI. This permits us to determine country i's *threshold bid* as $\bar{b}_i(S_i)$, the value of the standing bid at which the expected returns from staying in the auction and from dropping out are equalized. Thus, country i will only stay in the auction, making a counterbid to country j if the latter's last bid is below country i's threshold bid, that is $b_j \leq \bar{b}_i(S_i)$.

Country A, for example, counters the standing bid b_B if the expected payoff from making a bid of $b_A = b_B + \Delta$ is greater than or equal to that from dropping out of the auction immediately. If country A does make a new bid, there are two possible outcomes. First of all it would win the auction if country B chose not to respond with its own counterbid. This would arise with probability

$$\begin{aligned} P_B(b_B + \Delta) &\equiv \text{Prob}[b_B + \Delta > \bar{b}_B(S_B) | b_B - \Delta \leq \bar{b}_B(S_B)], \\ &= \frac{F_B[\bar{b}_B^{-1}(b_B + \Delta)] - F_B[\bar{b}_B^{-1}(b_B - \Delta)]}{1 - F_B[\bar{b}_B^{-1}(b_B - \Delta)]}, \end{aligned} \tag{5}$$

the probability that country A's bid $b_A = b_B + \Delta$ exceeds B's threshold bid $\bar{b}_B(S_B)$ conditional on the event that S_B is large enough that B has countered A's previous bid of $b_B - \Delta$, that is $b_b - \Delta \leq \bar{b}_B(S_B)$. The second outcome is where country B does respond to country A's bid with a higher offer (after which country A will have to decide once again whether to make a further bid), which would arise with probability $1 - P_B(b_B + \Delta)$. Country A calculates

the expected payoff that it would receive from making a new bid and compares this to the guaranteed payoff from dropping out of the auction without further bidding.

Since country A's expected payoff from making a new bid is at least as large as the expected payoff from making a new bid and dropping out of the auction in its next turn if the new bid is countered by B, it will stay in the auction and make a new bid if and only if

$$[e_A(\pi + b_B + \Delta) - (b_B + \Delta) + S_{AA}]P_B(b_B + \Delta) + [e_A(\pi + b_B + 2\Delta) + S_{AB}][1 - P_B(b_B + \Delta)]$$
$$\geq e_A(\pi + b_B) + S_{AB}. \tag{6}$$

If $P_B(b_B + \Delta) = 0$, the first term of (6) is zero and country B will definitely continue to bid. In this case, it is certainly worthwhile for country A to make a further bid, even if it eventually loses the auction, as the payment made to citizens owning a share of the firm is driven up. If, at the other extreme, $P_B(b_B + \Delta) = 1$ and country A's next bid would certainly win the auction, the decision as to whether to make a further bid depends upon country A's valuation of the investment relative to the cost of attracting it, that is whether S_A exceeds $b_B + (1 - e_A)\Delta$. This argument is made more transparent if we rewrite (6) by subtracting the right-hand side from the left-hand side as

$$[e_A\Delta - (b_B + \Delta) + S_A]P_B(b_B + \Delta) + 2\Delta[1 - p_B(b_B + \Delta)] \geq 0. \tag{7}$$

Substituting (5) into (7), we obtain a new condition for country A to be prepared to make a further bid

$$\frac{[e_A\Delta - (b_B + \Delta) + S_A]}{1 - F_B[\bar{b}_B^{-1}(b_B - \Delta)]} \frac{F_B[\bar{b}_B^{-1}(b_B + \Delta)] - F_B[\bar{b}_B^{-1}(b_B - \Delta)]}{2\Delta} + e_A \frac{1 - F_B[\bar{b}_B^{-1}(b_B + \Delta)]}{1 - F_B[\bar{b}_B^{-1}(b_B - \Delta)]} \geq 0.$$

Once again, we let $\Delta \to 0$ to obtain

$$(S_A - b_B)\frac{f_B[\bar{b}_B^{-1}(b_B)]\bar{b}_B^{-1\prime}(b_B)}{1 - F_B[\bar{b}_B^{-1}(b_B)]} + e_A \geq 0,$$

where $\bar{b}_i^{-1\prime}(b_i) = d\bar{b}_i^{-1}(b_i)/db_i > 0$. This can be rewritten as

$$b_B \leq S_A + \frac{\bar{b}_B'(\bar{b}_B^{-1}(b_B))\{1 - F_B[\bar{b}_B^{-1}(b_B)]\}}{f_B[\bar{b}_B^{-1}(b_B)]} e_A, \tag{8}$$

where we have used $\bar{b}_B^{-1\prime}(b_B) = 1/\bar{b}_B'(\bar{b}_B^{-1}(b_B))$. Thus country A would be prepared to make a further bid if (8) is satisfied.

The threshold bid for country A, $\bar{b}_A(S_A)$, is determined implicitly as b_B that satisfies (8) with equality. Thus, country A's threshold bid can be written as

$$\bar{b}_A(S_A) = S_A + \frac{\bar{b}'_B(\bar{b}_B^{-1}(\bar{b}_A(S_A)))\{1 - F_B[\bar{b}_B^{-1}(\bar{b}_A(S_A))]\}}{f_B[\bar{b}_B^{-1}(\bar{b}_A(S_A))]} e_A. \tag{9}$$

Similarly, we obtain country B's threshold bid as

$$\bar{b}_B(S_B) = S_B + \frac{\bar{b}'_A(\bar{b}_A^{-1}(\bar{b}_B(S_B)))\{1 - F_A[\bar{b}_A^{-1}(\bar{b}_B(S_B))]\}}{f_A[\bar{b}_A^{-1}(\bar{b}_B(S_B))]} e_B. \tag{10}$$

Observe that if $e_A = 0$, then $\bar{b}_A(S_A) = S_A$. Country A has no incentive to bid above its valuation of S_A and risk "winning" the auction in order to push up country B's bid, as none of this will benefit citizens in country A. If on the other hand $e_A > 0$, country A is willing to take a risk to try to raise the winning bid hoping that B eventually wins the auction. The threshold bid balances the cost of possible winning the auction beyond its own valuation and the benefits of an increase in the value of the firm's shares that country A owns in case of losing the auction.

Proposition 4 *In the English auction under incomplete information, each country i continues to bid until the standing bid reaches its own valuation of the firm S_i if $e_i = 0$, whereas it bids beyond the valuation if $e_i > 0$. The higher is e_i, the higher is the threshold bid. A country may lose by winning the auction.*

5.1 An example

To gain more insights of the result, let us specify the probability distribution as the exponential distribution with the support $[a, \infty)$, i.e.,

$$F_i[S_i] = 1 - e^{-\lambda_i(S_i - a_i)},$$
$$f_i[S_i] = \lambda_i e^{-\lambda_i(S_i - a_i)}.$$

This probability distribution has a mean of $a_i + 1/\lambda_i$ and a variance of $1/\lambda_i^2$. Moreover, we have for $i = A, B$

$$\frac{1 - F_i[\bar{b}_i^{-1}(b_j)]}{f_i[\bar{b}_i^{-1}(b_j)]} = \frac{1}{\lambda_i},$$

for any b_i. Thus, threshold bids expressed in (9) and (10) can be rewritten as

$$\bar{b}_A(S_A) = S_A + \frac{e_A}{\lambda_B},$$
$$\bar{b}_B(S_B) = S_B + \frac{e_B}{\lambda_A}.$$

The larger the share of the firm held by a country, the greater its willingness to continue in the auction, in order to push up the expected redistribution of after-tax profits to its own citizens. Moreover, the higher the mean (and hence the variance) of the rival country's valuation, the greater its willingness to continue the auction, since the risk of winning the auction is smaller when it raises the bid at any stage of the auction.

Toexamine the properties of the equilibrium, let us look at several specific cases one by one.

1. $S_A > S_B$ and $e_A = e_B = 0$.

   Country A wins with the winning bid of S_B. The outcome is the same as the one in the simultaneous bidding under complete information and the undominated subgame perfect equilibrium outcome when $e_B = 0$ in the English auction under complete information. It is worthwhile to note that in the English auction, making the information about countries' valuations private (as opposed to public) eliminates all of the subgame perfect equilibria whose winning bids by country A is higher than its evaluation S_A. This is because country B is no longer confident that country A would match B's bid beyond S_A when the information is incomplete.

2. $S_A > S_B$ and $e_A/\lambda_B = e_B/\lambda_A > 0$.

   Country A wins with the winning bid of $S_B + (e_B/\lambda_A)$. The winning bid may exceed country A's valuation S_A if e_B is large or λ_A is small; country B's threshold bid is high if B has a large incentive to raise the rival country's winning bid (i.e., e_B is large) or if the risk of B's winning with a bid beyond S_B is small (i.e., λ_A is small). Note also that this outcome is more likely to occur if e_A is large or λ_B is small so that A's threshold bid is more likely to exceed B's. (Note that in this example, $e_A/\lambda_B = e_B/\lambda_A$.)

3. $S_A = S_B$ and $e_A/\lambda_B = e_B/\lambda_A > 0$.

   Either country A or B wins the auction with the winnning bid of $S_A + (e_A/\lambda) = S_B + (e_B/\lambda)$, which certainly exceeds the winner's valuation of the FDI. The two countries "race beyond the bottom" if they turn out to be symmetric.

4. $S_A > S_B$ and $S_A + (e_A/\lambda_B) < S_B + (e_B/\lambda_A)$.

   Country B wins the auction even though A's valuation of the FDI is higher than B's. The resulting location of the firm is inefficient, and country B certainly loses by winning the auction.

We record some of the above findings in the following proposition.

Proposition 5 *In the English auction under incomplete information, a country may lose by winning the auction. This "race beyond the bottom" is more likely to occur if e_A and e_B are large and λ_A and λ_B are small so that the countries' threshold bids are large. The country with a lower valuation of the FDI than the other may win the auction if its citizens hold a large share of the firm or if the mean of the other country's valuation of the FDI is large.*

6 Concluding remarks

This paper has considered whether the results of Ferrett and Wooton (2008), that the international distribution of a firm's ownership has no impact on the competition to attract its investment, are robust to the nature of the competition (the design of the auction) and the knowledge structure of the game. We show that ownership makes a difference whenever an English auction is used to determine the outcome (as opposed to simulataneous bids).

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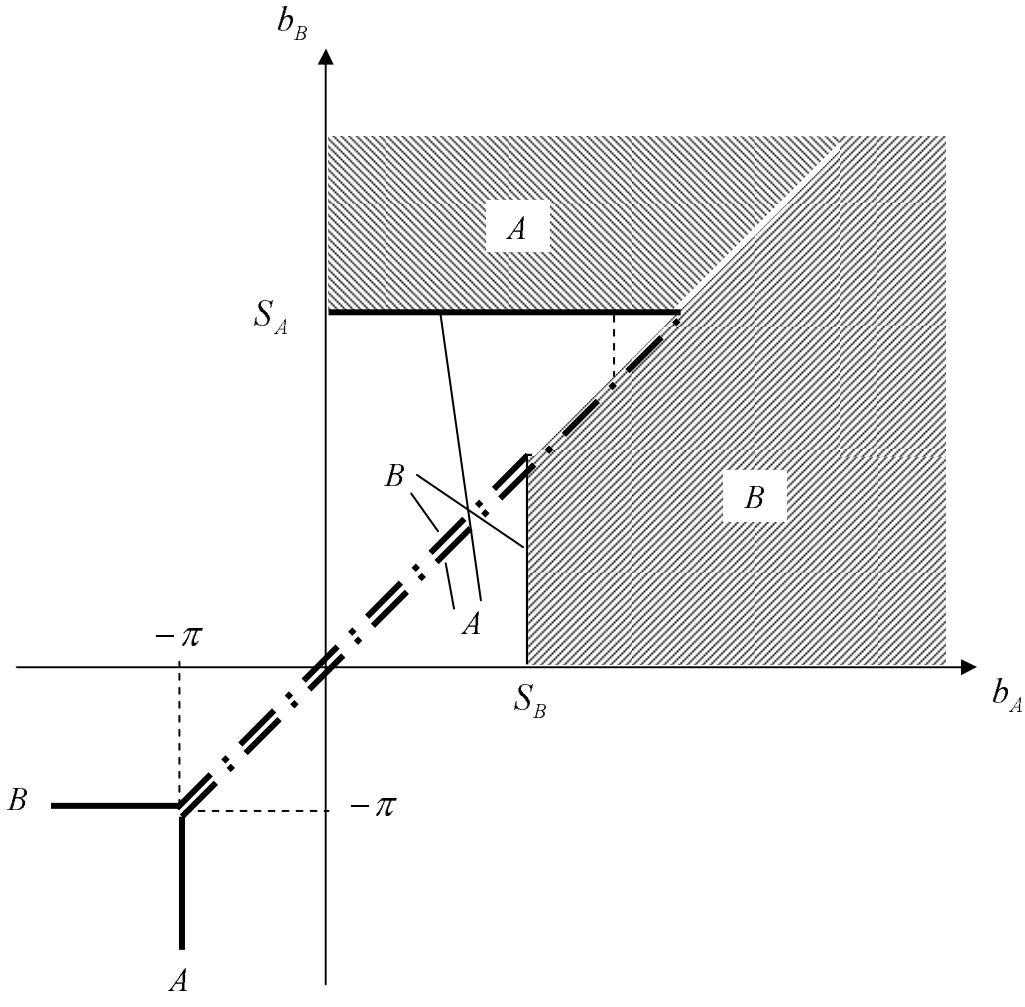

Figure 1. Nash Equilibrium