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Abstract

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JEL Classification: F12, F23, H25, H73

Keywords: Foreign direct investment, tax and subsidy competition, efficiency

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1. Introduction

Attracting inward FDI is an important goal of government policy, given the perceived benefits that it generates in terms of employment (more and better jobs), technological spillovers to indigenous firms, increased demand for local services, etc. Consequently, a country may be willing to spend resources trying to persuade firms to locate their plants within its national frontiers. As production becomes increasingly mobile, countries will face an increasingly wide choice of which firms to target with their fiscal incentives.

Our analysis begins from the assumption that governments are constrained in the number of potential inward investors they can, in fact, target with investment incentives. Most obviously, such constraints might arise for budgetary reasons. For example, there may be a politically determined ceiling on the amount a government can spend, both on subsidising inward FDI and in employing public servants to research and negotiate incentive packages. Moreover, if incentive packages typically take forms that are specific to the FDI projects concerned (e.g. the provision of certain types of infrastructure that would complement the MNE's plant), then it seems natural that a public bureaucracy should be limited in terms of the number of such packages that it can devise annually.[1]

We assume that such a "targeting constraint" on government behaviour is binding. Consequently, it is infeasible for a national government to develop a project-specific incentive package for every potential inward investor. In this environment, we seek to answer the following two questions. First, which firm (or firms) will a government choose to target? Secondly, in what circumstances will more than one government compete to attract a particular firm's production facilities?

We examine these questions in a two-firm, two-country model, where both countries are constrained to target a single firm, with each firm being from a different industry. We assume that each country perceives one firm's FDI as being more valuable than that of the other firm, with the two potential host countries having different valuations of the firms' plants. We further assume that the two

[1] "State aid" rules, which limit the scope for simple cash subsidies, might increase the use of such project-specific bidding packages.

countries differ in terms of their "geographic advantage" such that a firm's pre-tax profits differ across production locations, where the pattern of geographic advantage is industry-specific and is initially known with certainty to all players.[2] In this setting, we show that subsidy competition, where both governments choose to target the same firm, will never arise in equilibrium. Where the outcome of each FDI contest is perfectly anticipated, the losing country is better to opt out of a contest and target the other firm.[3]

We consequently suggest that uncertainty about the pattern of geographic advantage may be important in explaining the occurrence in equilibrium of subsidy competition for FDI. Intuitively, when governments are unclear about international differences in a firm's pre-tax profits, subsidy competition can arise in equilibrium because both countries perceive a chance of winning the firm's FDI. Therefore, both countries have an incentive to participate in the contest. In this vein, we extend our basic model by injecting some uncertainty into the pattern of geographic advantage. Specifically, we assume that one of the firms operates in a sector where there is uncertainty on the part of governments concerning the international pattern of geographic advantage. We show that subsidy competition for this firm can arise in equilibrium, and we find a necessary condition for such subsidy competition is that the countries place a sufficiently high value on the FDI of the firm concerned.

We view a government's choice of the firm to target as being made prior to its decision as to the level and form of investment incentives to offer. Most of the existing literature on tax/subsidy competition for FDI in imperfectly competitive markets takes the identities of the targeted firm or firms as given, and thus our analysis is of a prior stage in the behaviour of governments. A central reference is Haufler and Wooton (1999), which examines the fiscal competition between two governments for a monopolist's plant. Fumagalli (2003) and Bjorvatn and Eckel (2006) both also consider the fiscal competition for a single firm's FDI, but in the presence of indigenous firms who are assumed to be immobile and thus not targeted with investment incentives. Ferrett and Wooton (2010a) relax the

[2] Formally, by "geographic advantage", we mean the difference in a firm's pre-tax profits between the two countries.

[3] The reasoning here is similar to that used to explain the persistence of monopoly in a homogeneous good market under Bertrand competition. With even infinitesimal entry costs, no firm would enter such a market because, under Bertrand competition, price is driven down to unit cost.

assumption that only one firm is targeted with subsidies and present a duopolistic model where each government makes a uniform offer to the two firms. These previous contributions all take the governments' targets as given. Our purpose in the present paper is to allow the governments to choose which firms to target.

The remainder of the paper is organised as follows. In section 2 we set out our model and preview how, given the countries' targeting choices, equilibrium fiscal offers and plant locations are determined. In section 3 we solve for the bidding equilibrium in the baseline version of our model, where the pattern of geographic advantage for both firms is known with certainty. We introduce uncertainty in section 4 and consider the implications for the subsidy-competition equilibrium. In section 5 we ask whether, in an uncertain investment environment, it is in the interest of the firm to reveal the full nature of its FDI and profitability. Finally, section 6 concludes.

2. The Model

2.1 Assumptions and notation

We build a two-firm, two-country model of international trade and fiscal (tax/subsidy) competition for inward FDI. The firms are indexed by $i \in \{1, 2\}$ and the countries by $j \in \{A, B\}$. We assume that the owners of both firms reside in the rest of the world (RoW) and not in either of the potential host countries and that each firm will establish at most one plant in either *A* or *B,* from which it will serve both of the host countries' product markets.[4] We further assume that, due to prohibitive trade costs, it is impossible to serve markets *A* and *B* from a plant located in RoW. Finally, for simplicity, we assume that there is no product market interaction between firms 1 and 2, and so each firm's pre-tax profit from producing in a particular location is independent of the other firm's location.[5]

Inward FDI generates social benefits for the host country. These might, for example, take the form of technological spillovers to domestic firms, the training of indigenous workers, the relief of

[4] Implicitly, we are assuming that plant fixed costs are sufficiently high to make two-plant entry unprofitable.

[5] We have looked at the consequences of relaxing some of these assumptions in our previous work. For example, Ferrett and Wooton (2010a) examines the effects of product market interaction in a duopolistic fiscal competition game, and Ferrett and Wooton (2010b) allows for firm ownership within the host countries.

involuntary unemployment, or the payment of wage premia.[6] We are not specific about the precise source of these social benefits, and we denote the value that country *j* places on firm 1's plant by V_j. In order to limit the taxonomy of cases, we assume throughout our analysis that $V_B \geq V_A > 0$. We further assume that the countries have a common valuation of firm 2's FDI, W, that exceeds the value that either of them places on firm 1's FDI. These assumptions are summarised in Table 1, below.

	Firm 1		Firm 2
Country *A*	V_A	$\leq$	W
	$\wedge\vert$		$\vert\vert$
Country *B*	V_B	$\leq$	W

Table 1. International valuations of FDI

Our assumptions are designed to allow for differences in the social benefits of inward FDI across both countries and firms.[7]

We denote by Π_{ij} the pre-tax profits of firm *i* when it locates in country *j*. We define country *A*'s "geographic advantage" over country *B* in sector *i* as $\Gamma_i \equiv \Pi_{iA} - \Pi_{iB}$, which can be positive or negative. This concept of geographic advantage will play a key role in our analysis. Suppose, for example, that there is a positive geographic advantage for firm *i* such that $\Gamma_i > 0$. This would give country *A* leverage in the competition to attract firm *i* in that, before any tax/subsidy incentives are offered, firm *i* would make higher profits from locating in country *A* than in country *B*.

In order to limit the number of cases under consideration, we impose the following restrictions on the geographic advantage parameters, relative to the countries' valuations of the firms' FDI.

$$\Gamma_1 \in [0, V_B] \text{ and } \Gamma_2 \in [-W, W]. \quad (1)$$

According to (1), country *A* always possesses a geographic advantage in sector 1, whereas either country might possess a geographic advantage in sector 2. (1) also implies that the absolute level of

[6] Ferrett and Wooton (2010a) focuses on the consumer surplus benefits of inward FDI, which arise whenever intra-regional trade costs result in local production leading to lower prices.

[7] We thus assume that separability exists between the two sectors in two respects: firms 1 and 2 do not compete with each other on the product market; and the value to either host country of a given firm's plant is independent of the location of the other firm's plant.

geographic advantage for a given firm is not "too large" relative to the countries' valuations of that firm's FDI, in the specific sense that either country is always able to attract either firm's plant if it doesn't face fiscal competition for that plant from the other country.

We assume throughout our analysis that Γ_1 is known with certainty by all players from the start of the game. On the other hand, both governments may be uncertain about the value of Γ_2, with consequent implications for their bidding strategies.

2.2 Sequence of moves

Within this setting, the fiscal competition for FDI takes the form of a three-stage game with the following sequence of moves. In stage one, the countries independently and simultaneously choose whether to target (or bid for) firm 1 or firm 2. This choice is irreversible, and it is impossible for a country to target both firms. If both countries choose to target the same firm in stage one, we say that that firm is the subject of "subsidy competition." In such a case, the other (untargeted) firm chooses its location solely on the basis of geographic advantage. Alternatively, if the countries choose to target different firms, then each firm will receive a single bid from one country.

In stage two, each country simultaneously announces its bid for the firm that it has chosen to target, where the bid is either positive (a subsidy) or negative (a lump-sum tax). Firms view these bids as location-specific fixed costs (to be incurred in stage three). It is important to note that our concept of a "bid" encompasses a broader range of incentives than simple cash transfers between the host government and the inward investor. Specifically, a bid can be any policy measure that both imposes a cost on the host country and increases the firm's after-tax profits, should it locate in the country. Thus, the provision of public infrastructure (or investment grants) and a skilled workforce (or training grants to achieve this) could both qualify as bids under our definition. Indeed, the very fact that cash subsidy payments can be problematic (e.g. under EU "state aid" rules) provides a justification for our targeting constraints, as it implies that FDI-incentive packages must be *specific* to the firm or industry concerned.

Essentially, public servants must find more creative ways to encourage an inward FDI project than the simple offer to the MNE of a cash payment.[8]

Finally, in stage three, each firm chooses where to locate its plant, by comparing prospective after-tax profits, and produces and sells its output. We solve the game backwards to isolate its subgame-perfect Nash equilibria in pure strategies.

We study two distinct games, distinguished by the assumption we make about the countries' knowledge of Γ_2. In our baseline case in section 3, Γ_2 is common knowledge. This means that the pattern of geographic advantage in both sectors is known with certainty by the countries when making their targeting choices in stage 1 of the game. In section 4, we consider instead the situation in which there is uncertainty over the pattern of geographic advantage, as the precise value of Γ_2 is unknown by the countries.

2.3 Equilibrium fiscal incentives and plant locations under certainty

We begin our analysis by deriving the outcomes of stages two and three of our game in the baseline case (where both Γ_1 and Γ_2 are known to all players with certainty), taking as given the countries' targeting choices in stage one. We shall exploit the assumptions in (1), which limit the size of geographic advantage and ensure that if only one country targets a firm then it is guaranteed to attract the FDI. In other words, any geographic disadvantage a country may face is less than the maximum subsidy that it is prepared to offer the MNE.

There are essentially three cases to consider, which vary according to how many countries target a given firm. In the "*laissez-faire*" scenario, a firm is targeted by neither of the countries. In this case, if firm 1 receives no bids then it will follow geographic advantage and locate in country A as $\Gamma_1 > 0$, resulting in country A getting a payoff of V_A while country B gets nothing. If, on the other hand, firm 2

[8] The prevalence of non-monetary, project-specific bids for inward FDI also justifies the fact that we do not allow the host countries to post the same (non-discriminatory) bid for inward FDI from both firms. Indeed, it is unclear what such a "non-discriminatory" or common bid would look like. For example, the appropriate project-specific bid for firm 1 might take the form of the provision of a new highway, while that for firm 2 might be a publicly provided training course.

receives no bids, then the firm will follow its geographic advantage to country A if $\Gamma_2 > 0$ and to country B if $\Gamma_2 < 0$. The host will gain its valuation of the FDI, W, while the other country gets nothing.

The second case involves subsidy competition, where both countries target the same firm.[9] In our model, subsidy competition is a private-value, first-price, sealed-bid auction with a twist. The presence of geographic advantage typically means that the firm is *not* indifferent between locations when the countries' bids are equal. Thus, country A wins the subsidy competition for firm 1 if and only if $\Theta \equiv V_A + \Gamma_1 - V_B \geq 0$, where A makes a winning bid of (just above) $V_B - \Gamma_1$, while B unsuccessfully bids its full valuation of the firm, V_B. This highlights the fact that the possession of a geographic advantage gives country A an advantage in the competition such that it can bid less than B and still attract firm 1. Therefore, under subsidy competition, country A's payoff when it wins the competition for firm 1 is Θ while country B's payoff should it win the FDI is $-\Theta$. The losing country misses out on the FDI but does not have to pay any subsidy, so has a net payoff of zero from that sector.

A very similar story holds when both countries target firm 2. The difference for this sector is that our parameter choices allow either country to have the geographic advantage while both value the FDI equally. Each country is prepared to bid its valuation, but only the losing country does so in equilibrium. The winner of the FDI is the country with the geographic advantage in sector 2, and its payoff is its level of geographic advantage.[10]

The final possibility is for each firm to be targeted by a single country. When only country B targets firm 1, it will attract the FDI if its bid offsets country A's geographic advantage, such that $V_B \geq \Gamma_1$. Thus B must pay a subsidy of (just above) Γ_1 and will get a payoff from sector 1 of $V_B - \Gamma_1$. When only country A targets firm 1, it is able to appropriate its geographic advantage by imposing a tax of Γ_1 on firm 1. Country A's payoff from sector 1 is therefore $V_A + \Gamma_1$. The bidding for firm 2 is similar, except that either country may enjoy the geographic advantage in that sector; but, again, firm 2

[9] This case always accompanies the *laissez-faire* case. If neither country targets a particular firm, then the other firm must be the subject of subsidy competition.

[10] The outcomes of the subsidy competition for firm 2 can be straightforwardly derived by considering the competition for firm 1 when $V_A = V_B$. Our analysis of the equilibrium under subsidy competition follows Bjorvatn and Eckel (2006), and Ferrett and Wooton (2010b). Readers are referred to those papers for further details.

is won by the (sole) country that bids for it, either with a tax that appropriates its geographic advantage or with a subsidy that compensates for its geographic disadvantage.

We summarize, in Table 2, the firms' location decisions, given the countries' choices as to which firm each chooses to target, where the first (second) element refers to the firm that country *A (B)* targets.

(1, 1)	**(1, 2)**
Firm 1 goes to winning country: $\Theta > 0$ or $\Theta < 0$ Firm 2 follows geographic advantage Γ_2	A offers tax of Γ_1 and gets benefit of $V_A + \Gamma_1$ B offers subsidy/tax of Γ_2 and gets $W - \Gamma_2$
(2, 1)	**(2, 2)**
A offers tax/subsidy of Γ_2 and gets $W + \Gamma_2$ B offers subsidy of Γ_1 and gets benefit of $V_B - \Gamma_1$	Firm 2 goes to winning country: $\Gamma_2 > 0$ or $\Gamma_2 < 0$ Firm 1 follows geographic advantage to A

Table 2. Equilibrium locations and taxes/subsidies under certainty

3. Bidding under certainty

We turn now to consider the host countries' equilibrium targeting choices in our baseline model where there is no uncertainty over geographic advantage in either sector. The objective of governments is to maximise the combined benefits from FDI and the tax revenues from investing firms (where the latter will be negative when a firm is paid a subsidy). The payoff matrix is shown in Table 3, below.

***B*'s payoff** ***A*'s payoff**		Country *B* targets	
		Firm 1	Firm 2
Country *A* targets	Firm 1	$\max\{-\Theta, 0\} + \Lambda_B$ **(1, 1)** $\max\{\Theta, 0\} + \Lambda_A$	$W - \Gamma_2$ **(1, 2)** $V_A + \Gamma_1$
	Firm 2	$V_B - \Gamma_1$ **(2, 1)** $W + \Gamma_2$	$\max\{-\Gamma_2, 0\}$ **(2, 2)** $V_A + \max\{\Gamma_2, 0\}$

Table 3. Payoffs under certainty

In Table 3, we use the term Λ_i to capture country i's payoff from sector 2 when both countries target firm 1. We define $\Lambda_A \equiv W$ if $\Gamma_2 > 0$ and $\Lambda_A = 0$ otherwise while $\Lambda_B \equiv W$ if $\Gamma_2 < 0$ and $\Lambda_B = 0$ otherwise.

In (2, 2), when both countries target firm 2, firm 1 locates in country *A,* given *A*'s assumed geographic advantage in the sector.

3.1 Equilibria under certainty

The following result is both interesting in itself and will simplify our subsequent search for equilibria.

Proposition 1: Subsidy competition, in the sense of both countries targeting the same firm, never arises in equilibrium when the pattern of geographic advantage in both industries is known with certainty at the start of the game.

Proof: We show that the losing country would do better by avoiding a subsidy competition for firm 1 and choosing to target firm 2 instead.[11] There are two possibilities. If $\Theta > 0$, then country *A* will win a subsidy competition for firm 1. In such a situation, country *B* has to decide whether to target firm 1 or firm 2, given that it would make nothing in sector 1 from targeting firm 1 (as it would lose that competition). If $\Gamma_2 > 0$, then *B* would gain $W - \Gamma_2 > 0$ from targeting and winning firm 2. Alternatively, if $\Gamma_2 < 0$, then *B* makes *W* from targeting firm 1 (because it wins firm 2), but it would get the greater benefit of $W - \Gamma_2$ from targeting and winning firm 2. Thus country *B*'s welfare is always higher from targeting firm 2. A similar argument will hold for the case where $\Theta < 0$ and country *B* would win the subsidy war for firm 1. In such circumstances, country *A* would be better off by targeting and attracting firm 2. ■

The result in Proposition 1 is a consequence of our assumption that the countries know the pattern of geographic advantage before making their targeting choices. Because of this, both countries know the outcome of any given subsidy competition and the losing country realises that it would do better by targeting the other firm, and attracting it with a tax or a subsidy that is below its valuation.

The formal consequence of Proposition 1 is that the only possible pure-strategy equilibria are (1, 2) and (2, 1**)**. We now consider the conditions for the existence of these two equilibria, focusing

[11] A similar argument can be used to show that the losing country would opt out of a subsidy competition for firm 2.

initially on **(**1, 2). Country *A* optimally targets firm 1 in response to a choice of firm 2 by country *B* if and only if:

$$\Gamma_1 \geq \max\{\Gamma_2, 0\}. \tag{2}$$

Essentially, country *A* chooses to target the sector with the larger geographic advantage and consequently higher tax revenue. Country *B* optimally targets firm 2 in response to *A*'s choice of firm 1 if and only if

$$\begin{aligned} \Gamma_2 > 0: \quad W - \Gamma_2 &\geq \max\{-\Theta, 0\}, \\ \Gamma_2 < 0: \quad \Gamma_2 &\leq \min\{\Theta, 0\}. \end{aligned} \tag{3}$$

Therefore, for (1, 2) to be the equilibrium targeting choices and resulting firm locations, we require both (2) and (3) to hold. Next, we set out the conditions for (2, 1) to be an equilibrium. Country *A* optimally targets firm 2 in response to *B*'s choice of firm 1 if and only if:

$$\begin{aligned} \Gamma_2 > 0: \quad \Gamma_2 &\geq \max\{\Theta, 0\}, \\ \Gamma_2 < 0: \quad W + \Gamma_2 &\geq \max\{\Theta, 0\}. \end{aligned} \tag{4}$$

Country *B* optimally targets firm 1 in response to *A*'s choice of firm 2 if and only if

$$V_B - \Gamma_1 \geq \max\{\Gamma_2, 0\}. \tag{5}$$

Figure 1 uses conditions (2) to (5) to plot the equilibrium targeting and location choices in (Γ_1, Γ_2)-space. Figure 1 maintains our assumption that $\Gamma_1 > 0$, while the geographic advantage in sector 2 can lie with either country. Broadly speaking, outcome (1, 2) tends to be an equilibrium as we move upwards and to the left in Figure 1, while (2, 1) tends to be an equilibrium towards the lower right. Both of these outcomes are intuitive. In equilibrium, country *A* will target the sector where it enjoys the greater geographic advantage, whereas country *B* targets the sector where its geographic disadvantage is lower.

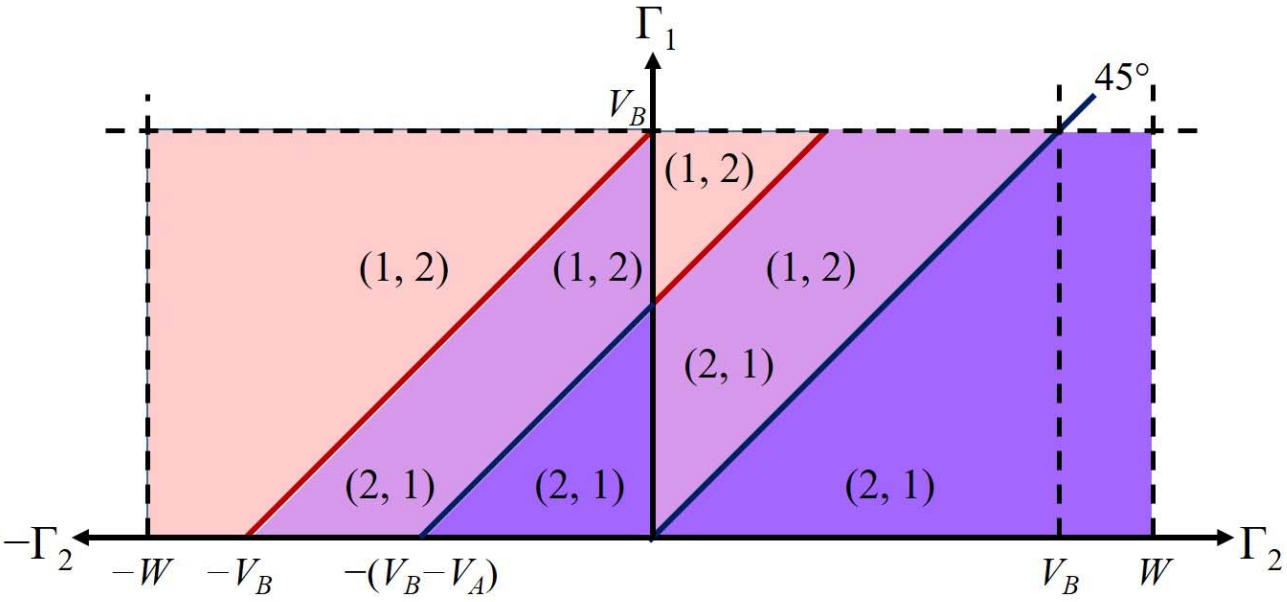

Figure 1. Equilibrium locations under certainty

We can summarize the central result of this section with the following. Subsidy competition, where both countries target the same firm, never arises in equilibrium in the baseline version of our model: The country that would lose the competition would always do better by opting out of a head-to-head contest and targeting the other firm instead. Consequently, in equilibrium, the two countries target and win different firms, and the firms never co-locate.

When there are multiple equilibria, it will generally be the case that countries will not be indifferent between the two equilibria. For example, whenever both (1, 2) and (2, 1) exist as equilibria in Figure 1, country *B* will prefer (1, 2).[12] Intuitively, country *B* prefers the equilibrium where it targets firm 2 whenever $\Gamma_1 > \Gamma_2$, because it both pays a lower subsidy (to overcome *A*'s geographic advantage) and receives a higher benefit than in the equilibrium where it targets firm 1.

On the other hand, country *A* prefers (2, 1) to (1, 2) if $\Gamma_1 < \Gamma_2 + W - V_A$. This holds throughout the region where there are two equilibria in the first quadrant of Figure 1. Therefore, when Γ_1 and Γ_2 are both positive and two equilibria exist, the targeting game is characterised by conflict, in the sense

[12] Country *B* prefers (1, 2) to (2, 1) if $\Gamma_1 > \Gamma_2 + V_B - W$, which holds above the 45° line in Figure 1.

that both countries would prefer to target firm 2 in the equilibrium.[13] If $\Gamma_2 < 0$, then all of the region where there are two equilibria is characterised by the same conflict if W is sufficiently large, which ensures that country A prefers (2, 1) to (1, 2) throughout the relevant space.[14] However, if W is lower, then the upper part of the two-equilibria strip in the second quadrant will see both countries preferring (1, 2) and (2, 1). This makes intuitive sense as the Pareto-dominant equilibrium has each country targeting the sector where it enjoys a geographic advantage.

3.2 Industrial profits under certainty

We have determined that, in equilibrium, each country targets a single firm but that there are ranges of the $\{\Gamma_1, \Gamma_2\}$ space in which there are multiple equilibria where, in general, the two nations will not be indifferent between these equilibria. We were, however, able to establish a particular parameterisation of the model in which there was a clear international ranking of the equilibria. We now consider the impact of international competition for FDI on the after-tax profitability of the firm's investments, in order to establish whether the firms' preferences with respect to investment locations might be comparably ranked.

In the first quadrant of Figure 1, where country A has geographic advantage in both industries, the firm that is targeted by A gets higher pre-tax profits from locating there but these are taxed away in equilibrium, such that the firm earns the equivalent of its pre-tax profits had it located in country B. The firm that is targeted by country B in equilibrium gets lower pre-tax profits from locating there but is compensated by a subsidy such that its after-tax profits are the same as the pre-tax profits it would have earned from locating in country A. The tax and subsidy offers in equilibrium therefore mean that both firms would prefer to be targeted by country B and receive a subsidy, as opposed to facing a tax if they were targeted by country A.

When each country has a geographic advantage in one of the industries, as is the case in the second quadrant of Figure 2, the firms share a preference with respect to the targeting outcome. Suppose that the equilibrium is (1, 2), such that each country targets the firm in the industry in which it has a

[13] In this case, our targeting game is a game of chicken with targeting firm 2 representing the "not swerve" strategy.

[14] Formally, this requires $W > V_A + V_B$.

geographic advantage. In such a case, both countries charge a tax on the firms in equilibrium. These taxes mean that, despite having located in the more profitable country, each firm ends up with after-tax profits equivalent to it having located in the country with the geographic disadvantage. In contrast, when the targeting choice in equilibrium is (2, 1), each country gets the industry in which it has a geographic disadvantage and has to pay it a subsidy to attract the firm. From the perspective of the producers, the firms prefer this equilibrium outcome as they end up with after-tax profits equivalent to the pre-tax profits they would have earned from following geographic advantage.

In summary, given that taxes in equilibrium extract the rents of locating in countries with geographic advantage, firms will generally prefer to be compensated for making investment decisions contrary to the pattern of geographic advantage. This reflects a fundamental conclusion of this particular game of international competition for FDI, in that firms can never do better in the certainty equilibrium than earning the pre-tax profits from following geographic advantage.

In the next section, we investigate the implications of introducing a degree of uncertainty about the pattern of geographic advantage.

4. Bidding under uncertainty

We now assume that Γ_2 is a random variable, whose exact value is known only to firm 2. The other players (in particular, the governments of countries *A* and *B*) know only that Γ_2 is uniformly distributed on $[-\Delta, \Delta]$. The precise realisation of Γ_2 is only revealed to the governments *after* all of their decisions have been made, if it is revealed at all. We assume that $\Delta < W$, which ensures that the uncertainty over Γ_2 is not "too large." Specifically, it implies that if the Γ_2 realisation is known with certainty, then a country that is the sole nation to target firm 2 will always succeed in winning it. The expected payoffs to being the sole bidder for firm 2 are the same for both countries, given that they are assumed to get the same benefit *W* from the FDI and that the distribution of the geographic advantage is assumed to be symmetrical about zero.

We maintain our earlier assumption that the geographic advantage for firm 1 is known and has a value in the positive interval $\Gamma_1 \in [0, V_B]$. Consequently, if country *A* solely targets firm 1 it will make $V_A + \Gamma_1$ from the FDI, whereas country *B* will make $V_B - \Gamma_1$ if it were to be the sole bidder for firm 1.

The outcome of both countries bidding for firm 1 has been discussed in section 2.3 above. On the basis of these assumptions, the remaining task is to establish how the countries' uncertainty over the geographic advantage of firm 2 affects their bidding strategies and their expected payoffs for each pair of targeting choices.

4.1 Country A targets firm 1 and country B targets firm 2

We initially calculate the expected benefit based upon country B bidding for firm 2. Country B will attract the investment if and only if its subsidy offer S_B overcomes the realisation of country A's geographic advantage Γ_2. Country B will set S_B so as to maximise $E(\Omega_B)$, the expected gain from attracting firm 2's FDI:

$$E\left(\Omega_B\right)=\Pr\left\{S_B>\Gamma_2\right\}\left(W-S_B\right),\ \text{where}\ \Pr\left\{S_B>\Gamma_2\right\}=\begin{cases}0 & \text{if } S_B<-\Delta,\\ \left(S_B+\Delta\right)/2\Delta & \text{if } S_B\in\left(-\Delta,\Delta\right),\\ 1 & \text{if } S_B>\Delta.\end{cases} \qquad (6)$$

Country B will be unable to attract firm 2 if its subsidy is below the lower bound of A's geographic advantage, while it is guaranteed to attract firm 2 if it offers a subsidy above the upper limit of A's geographic advantage. Thus, country B never needs to make a subsidy offer in excess of Δ.

From (6), the optimal FDI subsidy can be derived. If $W>3\Delta$, country B's valuation of the FDI is sufficiently high that it would be prepared to offer a subsidy equal to Δ. This would guarantee that it would win firm 1 and bring benefits equal to $(W-\Delta)$. Should country B's valuation of firm 2 be more modest, then it shall offer a lower bid of $S_B^*=(W-\Delta)/2$ and will win the FDI with probability $(W+\Delta)/4\Delta$ with country A attracting the FDI with probability $(3\Delta-W)/4\Delta$. while the countries' equilibrium expected payoffs will reflect the certainty of country A attracting firm 1, together with the expected gains from the countries' success (or otherwise) of attracting firm 2.

$$\begin{aligned}E(\Omega_A)&=\left(V_A+\Gamma_1\right)+\frac{\left(3\Delta-W\right)W}{4\Delta},\\ E(\Omega_B)&=\frac{\left(W+\Delta\right)^2}{8\Delta}.\end{aligned} \qquad (7)$$

For the remainder of the analysis, we shall assume that $W<3\Delta$, which ensures that the equilibrium probabilities of winning firm 2 are in the interval (0, 1).

4.2 Country A targets firm 2 and country B targets firm 1

This is analogous to the previous case, so it can be dealt with briefly. Country *B* wins firm 1 and makes $V_B - \Gamma_1$ from industry 1. Country *A* sets S_A to maximise:

$$E(\Omega_A) = \Pr\{S_A > -\Gamma_2\}(W - S_A), \text{ where } \Pr\{S_A > -\Gamma_2\} = \begin{cases} 0 & \text{if } S_A < -\Delta, \\ \dfrac{S_A + \Delta}{2\Delta} & \text{if } S_A \in (-\Delta, \Delta), \\ 1 & \text{if } S_A > \Delta. \end{cases} \tag{8}$$

For valuations where $W < 3\Delta$, country *A* will offer an optimal subsidy $S_A^* = (W - \Delta)/2$ that has a probability of success equal to $(W + \Delta)/4\Delta$. The resulting expected payoffs reflect country *B*'s success in attracting firm 1 and the expected location of firm 2 in equilibrium:

$$\begin{aligned} E(\Omega_A) &= \frac{(W + \Delta)^2}{8\Delta}, \\ E(\Omega_B) &= (V_B - \Gamma_1) + \frac{(3\Delta - W)W}{4\Delta}. \end{aligned} \tag{9}$$

4.3 Both countries target firm 1

As neither country bids for firm 2, the probability that either country wins the FDI is ½. Therefore, the countries' expected payoffs are:

$$\begin{aligned} E(\Omega_A) &= \max\{\Theta, 0\} + W/2, \\ E(\Omega_B) &= \max\{-\Theta, 0\} + W/2. \end{aligned} \tag{10}$$

We can now show that subsidy competition for firm 1 never arises in equilibrium. The reason is that the loser of such a subsidy competition would do better by deviating to target firm 2. Suppose, for example, that country *A* would lose the subsidy competition for firm 1. This means that the first element of $E(\Omega_A)$ in (10) is zero. Comparing (9) and (10), we can easily calculate that country *A* is better to avoid the FDI competition and to target firm 2 directly. It is similarly straightforward to show that country *B* will prefer to avoid the subsidy competition for firm 1 if it were guaranteed to lose. Thus, (1, 1) can never be a targeting equilibrium.

4.4 Both countries target firm 2

This case is qualitatively similar to the cases discussed above. The key difference is that, in setting its

bid for firm 2, a government now needs to consider both the pattern of geographic advantage and the other government's bid. Under (2, 2), firm 1 follows geographic advantage and locates in country *A*. Country *B* wins firm 2 if $S_B > S_A + \Gamma_2$ and it therefore sets S_B to maximise

$$E(\Omega_B) = \Pr\{S_B > S_A + \Gamma_2\}(W - S_B),$$
$$\text{where } \Pr\{S_B > S_A + \Gamma_2\} = \begin{cases} 0 & \text{if } S_B < S_A - \Delta, \\ \dfrac{S_B - S_A + \Delta}{2\Delta} & \text{if } S_B \in (S_A - \Delta, S_A + \Delta), \\ 1 & \text{if } S_B > S_A + \Delta. \end{cases} \tag{11}$$

We maintain our parameter restriction that $W < 3\Delta$ which ensures that the equilibrium probabilities of winning firm 2 are in the interval (0, 1) and both countries offer equilibrium subsidies that are strictly less than their valuations. Then country *B*'s reaction function is $S_B(S_A) = (S_A + W - \Delta)/2\Delta$ and, by symmetry, that of country *A* is $S_A(S_B) = (S_B + W - \Delta)/2\Delta$.[15] The equilibrium subsidies offered by the countries are $S_A^* = S_B^* = W - \Delta$, where the probability that each country attracts the FDI is one half. As the bids are identical, they do not distort the firm's location choice, which is therefore driven entirely by geographic advantage. The benefit to the lucky country that hosts the FDI is $\Delta/2$.

4.5 Equilibria under uncertainty

Taking into account the nature of the uncertainty over firm 2's geographic advantage, the countries' expected payoffs are shown in Table 4, where we continue to assume that $\Gamma_1 \in (0, V_B)$ and Γ_2 is uniformly distributed over the interval $[-\Delta, \Delta]$.

[15] As we might expect, these reaction functions reveal that the countries' subsidies for firm 2 are strategic complements.

***A*'s payoff**		***B*'s payoff** Country *B* targets	
		Firm 1	Firm 2
Country *A* targets	Firm 1	$\max\{-\Theta, 0\} + W/2$ **(1, 1)** $\max\{\Theta, 0\} + W/2$	$(\Delta + W)^2/8\Delta$ **(1, 2)** $V_A + \Gamma_1 + (3\Delta - W)W/4\Delta$
	Firm 2	$V_B - \Gamma_1 + (3\Delta - W)W/4\Delta$ **(2, 1)** $(\Delta + W)^2/8\Delta$	$\Delta/2$ **(2, 2)** $V_A + \Delta/2$

Table 4. Payoffs under uncertainty

Our first observation is that, as expected, the two countries will never simultaneously compete for firm 1, such that (1, 1) cannot be a Nash equilibrium. It is always better for the country that knows it will lose the subsidy competition for firm 1 to target firm 2 instead. To see this, consider value of the terms in the (1, 1) cell of Table 4. For the country losing the battle for firm 1, it can choose to target firm 2 instead, if that will result in a higher expected benefit. This is always the case as $(\Delta + W)^2/8\Delta - W/2 = (\Delta - W)^2/8\Delta > 0$. Consequently, the losing country from the subsidy competition for firm 1 is always better off targeting firm 2 than ineffectually competing for firm 1's FDI.

We now study the conditions under which both countries may compete to attract firm 2, such that (2, 2) is a Nash equilibrium. It is useful to define another term.

$$\Psi(\Delta) \equiv \frac{(W - \Delta)(W - 2\Delta)}{4\Delta}.$$

$\Psi(\Delta)$ measures the increase in a country's expected payoff from industry 2 when the country joins the subsidy competition for firm 2.

From the payoffs in Table 4, it is clear that country *A*'s best response to country *B*'s decision to target firm 2 is to target the same firm if and only if $\Gamma_1 < \Psi(\Delta)$. If country *A*'s geographic advantage in sector 1 is very large, then country *A* will choose to avoid the competition for firm 2 and capture Γ_1 in tax instead. Similarly from Table 4, we can see that targeting firm 2 is country *B*'s best response to country *A* targeting firm 2 if and only if $\Gamma_1 > V_B - \Psi(\Delta)$. As before, this is an intuitive result. A very large Γ_1 would require country *B* to pay firm 1 a sizeable subsidy in order to attract firm 1's FDI.

Linking these two inequalities yields $\Psi(\Delta) > \Gamma_1 > V_B - \Psi(\Delta)$ as a necessary and sufficient

condition for (2, 2) to be a targeting equilibrium. We can plot these thresholds in Figure 2, which shows the level of geographic advantage in sector 1 and the range of geographic advantage in sector 2 that are consistent with both countries competing to attract firm 2, the industry with the geographic advantage that is known only to the firm. The lower limit of $\Delta = W/3$ is chosen to ensure that neither country bids Δ and guarantees that it attracts firm 2's FDI. In this range $\Psi(\Delta)$ is declining in Δ.[16] In general, a region where (2, 2) is the unique targeting equilibrium exists if $V_B < W/3$, which ensures that $\Psi > V_B - \Psi$ at $\Delta = W/3$. Intuitively, subsidy competition for firm 2 can only arise if the value that the countries place on firm 2's FDI is sufficiently large.

Above the (2, 2) region in Figure 2, the targeting equilibrium is (1, 2).[17] In this region, country *A* chooses to exit the subsidy competition for firm 2 and instead captures Γ_1 in tax by targeting firm 1 alone. Below the (2, 2) region, the targeting equilibrium is (2, 1). In this case, firm *B* opts to exit the subsidy competition for firm 2.[18]

[16]Figure 2 was generated using the parameter values $V_B = 7$ and $W = 30$.

[17] In addition to $\Gamma_1 > \Psi(\Delta)$, we also require $\Gamma_1 > V_B - V_A - \Phi(\Delta)$ for (1, 2) to be the targeting equilibrium, where $\Phi(\Delta) = (\Delta - W)^2 / 8\Delta$. The latter condition ensures that *B*'s best response to 1 is 2. However, to simplify our presentation and to allow us to focus on essentials, we note that it is straightforward to show that $\Gamma_1 > V_B - V_A - \Phi(\Delta)$ whenever $\Gamma_1 > V_B - \Psi(\Delta)$, and thus (1, 2) is always an equilibrium above $\Gamma_1 = \Psi(\Delta)$ and $\Gamma_1 = V_B - \Psi(\Delta)$.

[18] The condition for *A* to choose 2 in response to 1 is $\Gamma_1 < V_B - V_A + \Phi(\Delta)$, which holds for all $\Gamma_1 < \Psi(\Delta)$.

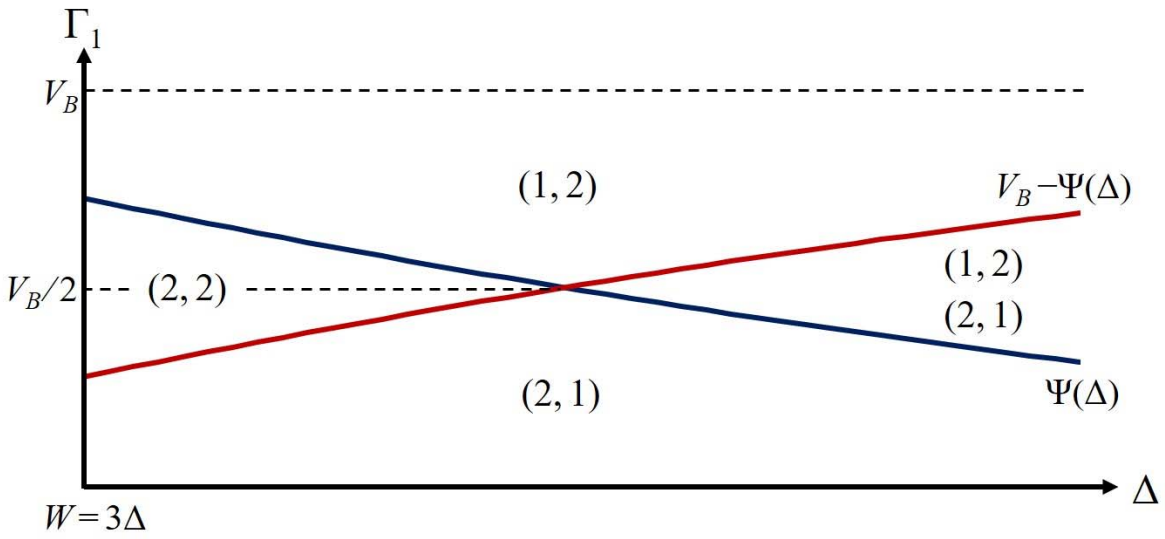

Figure 2. Equilibria under uncertainty

5. To reveal or not to reveal?

Suppose that, in the beginning, firm 2's geographic advantage is unknown by the potential host nations. Are there any circumstances under which the firm would benefit from credibly announcing the value of Γ_2? In this section, we compare the payoffs to firm 2 from the competition to attract its FDI under certainty and uncertainty. We can then determine whether it is worthwhile for the firm to reveal its geographic advantage prior to the governments making their choice as to which industry to target and the magnitude of the corresponding subsidies or taxes. We assume that the point of revelation is prior to stage one of the game, in advance of the governments' decisions as to which firms to target.[19]

In the certainty case, we established above that the best a firm can do in the equilibrium is receive the equivalent of its pre-tax earnings from locating in the country with the geographic advantage for its industry. Indeed, the equilibrium bids are designed to make the firm just willing to locate in the country bidding for it. Consequently, a subsidy in equilibrium is just enough to offset the bidding country's geographic disadvantage. This will not be the case under uncertainty, as the countries do not know the precise level of subsidy sufficient to nudge the firm from one location to the other. If a country's offered subsidy is insufficient to compensate for its geographic disadvantage, the firm can always make its

[19] An alternative would be for firm 2 to announce the value of Γ_2 prior to stage 2, in an attempt to influence the size of the inducement(s) that it would receive from its committed suitor(s).

investment decision on geographic advantage alone. This provides a backstop for the game under uncertainty, such that the worst a firm could do is locate in the country in which it has geographic advantage, despite it not being offered a subsidy by that country in equilibrium.

We have determined that under uncertainty, the bids made to attract firm 2 are always positive subsidies. If a subsidy offer made by the country with the geographic disadvantage was insufficient to offset the difference in pre-tax profits, the firm will take advantage of its backstop. In all other situations, either where the subsidy offer more than offsets the geographic disadvantage or when the subsidy is offered by the government of the country with the geographic advantage, the firm captures post-tax earnings in excess of what they might have received under certainty. This demonstrates that the firm never has an incentive to reveal the true nature of its geographic advantage to its potential hosts.

6. Summary and conclusions

Our contribution is to incorporate governments' targeting choices into the analysis of fiscal competition for FDI under imperfect competition, and area of research that we believe to have been somewhat neglected in the literature. We argue that governments will choose which firms to target prior to their deciding upon the composition of incentive packages, including the tax/subsidy levels, that they will offer firms to invest. Under the assumption that governments are unable to target every potential inward investor with a tailored subsidy offer, we have shown that subsidy competition, where both countries target the same firm, never arises in equilibrium if all players know the pattern of geographic advantage. The intuition for this central result is clear. The country that would lose the subsidy competition can always do better by opting out of a head-to-head contest and switch to targeting the other firm. Consequently, the equilibrium is characterised by the two countries targeting and winning different firms, such that the firms never co-locate.

We moved beyond our baseline model to allow for uncertainty in the pattern of geographic advantage. We assumed that the bidding governments only had a probability distribution of the geographic advantage in one of the two sectors, while the firm knew the exact value. In this environment, where the MNEs are better informed than the governments about the relative profitability of rival plant locations, we showed that subsidy competition can arise in equilibrium. The intuitively

appealing condition for subsidy competition is that both governments must both value the FDI project of the firm concerned sufficiently that they are prepared to spend resources on bidding for the firm, despite running the risk that they may be unsuccessful.

We then explored some of the welfare properties of our model. In the certainty equilibrium, where the firms locate in different countries and are both subject to tax/subsidy transfers, we showed that neither firm can earn after-tax profits that exceed level of profits it would earn under *laissez-faire* (where geographic advantage alone determines plant locations). We made use of this result in our uncertainty game, where both governments offer strictly positive bids for FDI in the subsidy-competition equilibrium and the firm concerned thus earns higher profits than under *laissez-faire*. The MNE that is the subject of subsidy competition under uncertainty will therefore have no incentive to reveal the precise pattern of geographic advantage in its sector to either government (even if it could credibly do so), since such revelation would return the game to its baseline, certainty case.

In the certainty version of our model, there are circumstances where two targeting equilibria exist simultaneously. The governments will target different firms (as subsidy competition never arises in equilibrium), but the assignment of governments to firms appears indeterminate. Moreover, we have shown that it is not always possible to Pareto-rank the two equilibria from the perspective of the host countries. A potential avenue for future research would be to extend this study of countries' preferences. Might there be, for example, a conflict between the welfare of the host region (that of countries *A* and *B* combined) and efficiency (global welfare, which includes the firms' after-tax profits)? Under certainty over geographic advantage, it seems clear that global welfare would be maximised if both firms were subject to subsidy competition. We therefore speculate that the existence of targeting constraints might benefit the host region at the expense of the world as a whole. Essentially, the targeting constraints act as a commitment device, limiting the spread of subsidy competition. We leave these issues for future study.

7. References

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