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Competing for a Duopoly: International Trade and Tax Competition

by

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Abstract

Oligopoly is empirically prevalent in the industries where MNEs operate and national governments compete with fiscal inducements for their FDI projects. Despite this, existing formal treatments of fiscal competition generally focus on the polar cases of perfect competition and monopoly. We consider the competition between two potential host governments to attract the investment of both firms in a duopolistic industry. Competition by identical countries for a monopoly firm's investment is known to result in a "race to the bottom" where all rents are captured by the firm through subsidies. We demonstrate that with two firms, both are taxed in equilibrium, despite the explicit non-cooperation between governments. When countries differ in size, a single firm will be attracted to the larger market. We explore the conditions under which both firms in the duopoly co-locate and when each nation attracts a firm in equilibrium. Our results are consistent with the observed stability of effective corporate tax rates in the face of ongoing globalisation, and our analysis readily generalizes to many specifications with oligopoly in the product markets.

JEL classification: F12; F23; H25; H73.

Keywords: tax competition; foreign direct investment; oligopoly; market size asymmetries.

Outline

Non-Technical Summary

This paper examines the fiscal competition between rival governments to attract the foreign direct investment of two firms from the same industry. Despite the empirical prevalence of oligopoly in the industries where MNEs operate and national governments are observed to compete for their FDI projects, existing formal treatments of tax/subsidy competition generally ignore strategic inter-firm rivalry and focus on the polar cases of monopolistic and (perfectly) competitive market structures. Two variables play prominent roles in our analysis. First, we allow for market size differences between the two bidding countries. Second, the existence of trade costs between the two countries means that both consumers and firms care about production locations: consumers care because locally produced goods are sold at lower prices than imports, and superior "market access'" pulls the investing firms towards the larger country.

We isolate all of the game's (pure-strategy) bidding equilibria. Qualitatively, we found two types of equilibrium to exist, and a bidding equilibrium (if it exists) is always unique. For "small" size differences between the two countries, we showed that production is internationally dispersed in equilibrium and all the firms' profits are captured by taxes ("full profit extraction"). This result on the distribution of benefits from FDI between firm and host is striking: it contrasts with the "race to the top" in *subsidy* payments that characterizes the competition between two identical countries for a monopoly firm's plant. When the size asymmetry between the bidding countries is "large," the firms co-locate in the larger country in equilibrium. Despite the smaller country's willingness to subsidize any investment within its borders, the larger country's "market access" advantage allows its government to tax the firms whilst retaining their plants in equilibrium. (However, in this case, the tax does not fully extract the firms' economic profits.)

Our results are consistent with empirical evidence that shows a remarkable stability of "effective" corporate tax rates over time in the face of ongoing "globalisation." Moreover, it seems clear that the logic of our arguments, and by extension our qualitative results, should readily generalize to many other specifications with oligopoly in the product markets.

1 Introduction

> "Tax competition among advanced states works to drain public finances and make a welfare state unaffordable." Gray (1998, p. 88)

This view of the effects of tax competition, offered by the eminent British political philosopher John Gray, echoes widely-held popular concern that competition between potential host countries for the foreign direct investment (FDI) of large, footloose multinational enterprises (MNEs) will result in a "race to the bottom" over time in corporate tax rates and an inflation in subsidy payments.[1] Gray's view receives support from two sources. First, there exists case-study evidence from a small number of industries, notably automobiles and electronics, that severe incentive-inflation exists.[2] However, such case studies provide an unrepresentative picture of the fiscal stance across all industries. For example, using information on the whole structure of national tax systems to derive "effective" tax rates, Devereux *et al.* (2002) show that over the 1980s and 1990s marginal corporate tax rates across 18 countries (the EU and G7) remained stable, while average rates fell slightly. We believe that the unrepresentativeness of the incentive-inflation case studies is not entirely due to an unimportance of MNEs in the aggregate economy.[3] Rather, it seems that tax competition for FDI does *not*

[1] During the late 1990s, these popular concerns were reflected at the policy level in the launching of initiatives by both the European Union and the OECD to combat "harmful" tax competition (see European Commission, 1997; OECD, 1998; in both cases, "harm" was equated with abnormally low corporate tax rates). In addition to collapsing corporate tax rates, there are also frequently voiced concerns that the "race to the bottom" will manifest itself in a multilateral deregulation of environmental protections and government-imposed floors on working conditions. However, our focus is tax competition. Markusen *et al.* (1996) formally analyse the "race to the bottom" in environmental policies.

[2] For example, in 1994 the US state of Alabama offered Mercedes an incentive package worth approximately $230 millions for a new plant to employ 1,500 workers (Head, 1998). In the UK, Siemens was offered £50 millions in 1996 to locate a 1000-worker semiconductor plant in Tyneside, northeast England. The factory closed 18 months later, and Siemens had to repay £18 millions in grants. See also Kozul-Wright and Rowthorn (1998, p. 86).

[3] UNCTAD (2000) reports that, by 1999, the ratio of world FDI stock to world GDP had reached 16%. The foreign-affiliate share of world production was 15% in manufacturing and other tradables (Lipsey *et al.*, 1998). Moreover, these figures probably understate the importance of MNEs as a source of corporate tax revenue, both because they omit the activities of MNEs in their home countries and because MNEs tend to be more profitable than other types of firm.

invariably result in a "race to the bottom."[4]

Given the theoretical focus of our paper, the second source of support for Gray's view is more significant. A general result from existing formal analyses of tax competition, such as the canonical model of Zodrow and Mieszkowski (1986), is that "independent governments engage in wasteful competition for scarce [mobile] capital through reductions in tax rates and public expenditure levels" (Wilson, 1999, p. 269). In common with much of the formal literature, Zodrow and Mieszkowski's "basic tax competition model" assumes perfectly competitive factor and product markets.[5] This stands in sharp contrast to the prevalence of oligopoly in industries where both MNEs operate and national governments are observed to compete for their FDI projects. Therefore the first of our two principal aims, in our examination of the competition between two potential host governments for the investments of two firms, is to investigate the robustness of the conclusions of the "basic tax competition model" to changes in market structure in favour of realism.

Secondly, we want to investigate the impact of asymmetries in market size between the bidding countries on their equilibrium tax rates and success in attracting FDI. Although previous analyses of tax competition have incorporated country-size differences,[6] none have

[4] Furthermore, the bulk of the fall in the effective average corporate tax rate (EACTR) reported by Devereux *et al.* (2002) occurred in the mid- to late-1980s. When, during the 1990s, world FDI flows grew very rapidly (e.g., relative to GDP), EACTRs remained stable, a fact which sits uncomfortably with the "race to the bottom" hypothesis.

[5] In his survey of theoretical contributions, Wilson (1999) christens the Zodrow and Mieszkowski framework with this name. In Zodrow and Mieszkowski, a number of identical (small) countries levy specific taxes on the capital employed within their borders to finance the provision of a public good. Capital is perfectly mobile internationally, so its post-tax rate of return must be equated across countries. The key insight is that a rise in a given country's tax rate creates a *positive externality*: capital is driven abroad, resulting in benefits for other countries from higher tax revenues and wages. Under non-cooperative behaviour, national governments fail to account for these external benefits and, consequently, tax rates and public good provision are set at inefficiently low levels.

[6] For example, Bucovetsky (1991), Wilson (1991) and Kanbur and Keen (1993) under perfect competition; and Haufler and Wooton (1999) with a monopoly firm. A general result is that the large country chooses the higher tax rate in equilibrium. However, equilibrium location patterns depend crucially on the assumed market structure (i.e., under perfect competition the small country hosts a disproportionate share of firms in equilibrium, while under monopoly the large country "wins" the firm), which creates an interest in the examination of location patterns under oligopolistic competition.

done so under oligopoly.[7] We fill this gap. There exists empirical evidence that corporation tax rates vary positively with country size,[8] and we aim to shed some light on the causes of this empirical correlation. Moreover, a belief in a positive tax/size relationship is presumably the premise behind calls for corporate tax co-ordination in the EU (see European Commission, 1997). Due to its size advantage, a "Fortress Europe" should be able to set higher corporate taxes in a world of capital mobility than any of its member countries could levy individually.

We build a two-country, two-firm model of MNE investment where the MNEs produce homogeneous goods. The countries' governments compete in taxes to attract the firms' plants. The governments attempt to maximise national social welfare, which comprises consumer surplus less total bid payments (or plus total tax revenues). The only asymmetry in the model is that countries may differ in size, with one country having more consumers than the other. The key element that makes our analysis interesting is the presence of trade costs. These mean that both firms and countries care about location. Countries prefer local production to imports because the price to their consumers is lower with local production, as the trade cost is eliminated from the firm's marginal cost. Indeed, raising consumer surplus is the *only* incentive for countries to bid for the FDI.[9] We assume that the firms are owned outside the region and that trade costs are real, therefore profits and transport cost payments do not enter the national welfare of either country. Firms also care about location but their

[7] Indeed, Janeba (1998) is, to our knowledge, the only existing model of tax competition under oligopoly. However, his set-up is very different to ours. In particular, all firms are assumed to sell into a single "third market," so the impact of market-size differences cannot be assessed.

[8] In their study of OECD countries' corporation tax-setting behaviour between 1982 and 1999, Devereux *et al.* (2004) find that country size, measured by GDP, has a positive effect on the statutory rate of corporation tax. Baldwin and Krugman (2004) compare average corporate tax rates (i.e., total corporate tax revenue divided by GDP) in the large "core" European countries (Germany, Benelux, France and Italy) to those levied by the smaller countries on the "periphery" (Greece, Portugal, Spain and Ireland) since the mid-1960s. They show that average corporate tax rates were systematically higher—often twice as high—in the "core."

[9] There are no aggregate employment effects of FDI. Hence production costs include no rent because workers are paid their opportunity cost (that is, the wage offered elsewhere in the economy). Haaparanta (1996) examines bidding for a monopoly firm when inward FDI relieves involuntary unemployment.

motivation arises from the desire to gain access to a large local market.

Our game comprises three stages. In stage one, the governments post lump-sum bids to attract the FDI (taxes are equivalent to negative bids). These bids are location-specific fixed costs, in that they are only paid if the MNE invests in a country. In the second stage, the firms choose their investment locations. Finally, in stage three, Cournot competition establishes equilibrium on the countries' product markets. We solve the game backwards to isolate its subgame perfect Nash equilibria in pure strategies and are able to isolate all of the game's bidding equilibria.[10] We show that the qualitative nature of the equilibrium depends on whether the country-size asymmetry is "small" or "large."

If the asymmetry is "small", the countries are the same size or close to it. In this situation, the equilibrium is characterised by one firm locating in each country and all the firms' profits being taxed away by the hosts. We call this *full profit extraction* (FPE). Compared to results in the existing formal literature on non-cooperative tax-setting, the FPE bidding equilibrium with similar-sized countries is striking. The perfectly-competitive "basic tax competition model" predicts suboptimally low corporate taxes in equilibrium, whereas our FPE equilibrium maximizes tax revenue from the industry (subject to the constraint that both firms enter). Moreover, our results contrast strongly with the monopoly model of Haufler and Wooton (1999), which we briefly review in section 3 and which predicts the "race to the bottom" in taxes (more accurately, a "race to the top" in *subsidy* payments) when countries are identical, so that the winner gains no benefit from hosting the FDI.[11]

Our second set of equilibrium predictions relate to a "large" country-size asymmetry. The first consequence of increasing the relative size difference is that the FPE bidding equilibrium

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[10] Whenever an equilibrium exists, it is unique.

[11] In the Haufler/ Wooton model, identical countries are Bertrand competitors for the monopolist. Other analyses of bidding for a monopolist that produce positive subsidies in equilibrium are Black and Hoyt (1989), King *et al.* (1993), Haaparanta (1996), and Menezes (2003).

breaks down. With a large country-size asymmetry, we show that, in equilibrium, both firms locate in the larger country and are taxed. Qualitatively, this bidding equilibrium is the same as that Haufler and Wooton's outcome for a single firm when there is a big difference in the sizes of the two countries.[12] Subject to keeping the small country indifferent between hosting one firm and none, the large country maximizes its tax level. Despite the small country's equilibrium subsidy, the large country can impose a tax *and* attract both firms because it offers the firms a larger local market.

A general conclusion of our analysis is that tax competition under duopoly does not create a "race to the bottom" in corporation tax rates. In both equilibria of our model, the firms are taxed. This is consistent with empirical evidence that shows a remarkable stability of "effective" corporate tax rates over time (Devereux *et al.*, 2002).[13] Moreover, we feel that our results will readily generalize to many specifications with oligopoly in the product markets.

The remainder of the paper is organized as follows. In the following section we develop the model used in the analysis. Section 3 examines the outcomes of the tax competition between countries, and distinguishes between the cases of small and large country-size asymmetries. Finally, section 4 concludes and discusses potential generalizations of our results.

2 The Model

We build a two-country model of MNE investment. There are potentially two firms in the industry, producing homogeneous goods in either of the two countries. The countries'

[12] Ottaviano and van Ypersele (2005, Proposition 4(ii)) also present a qualitatively identical equilibrium in a model of tax competition between countries of different sizes under large-group monopolistic competition.

[13] Moreover, our model is consistent with increased capital mobility ("globalization") causing the modest fall in effective average corporate tax rates documented by Devereux *et al.* (2002). In the case of a large country-size asymmetry, the larger country sets its tax below the level that would fully extract profits under geographically dispersed production. Assume a "pre-globalization" phase where the firms are pre-assigned to different countries; here, the countries would obviously levy FPE taxes. Then, a move to "globalization" (firm mobility between countries) would drive down the large country's taxes.

governments compete in subsidies/taxes to attract the firms' plants.

2.1 Households

We model the demand side of the model to be identical to that of Hauflet and Wooton (1999, hereafter H&W). Let there be a region composed of two countries, labelled A and B. We assume that country B is composed of a single household while country A has $n \geq 1$ identical households. Good X, whose production is central to our analysis, is an homogeneous good that is manufactured under conditions of imperfect competition, details of which are discussed below. Following H&W, the demand curves for this good are:

$$X_A = \frac{n\left(\alpha - p_A\right)}{\beta},\ X_B = \frac{\alpha - p_B}{\beta}, \tag{1}$$

where p_i is the market price of good X in country $i \in \{A, B\}$.[14]

Consumer surplus will depend upon the market price:

$$S_A\left(p\right) = \frac{n}{2\beta}\left(\alpha - p_A\right)^2,\ S_B\left(p\right) = \frac{1}{2\beta}\left(\alpha - p_B\right)^2. \tag{2}$$

2.2 Firms

We assume that the regional market for good X is served by one or two foreign-owned firms, each of which chooses to establish its production facilities in either country A or B (or, indeed, decides not to invest at all). We assume that each firm is able to operate *at most* one plant from which it can sell in both countries, although a specific trade cost applies to internationally traded goods.

Production is characterized by a fixed cost F and constant marginal cost w, which are assumed to be the same in both countries. The national markets are segmented and there is a trade cost of τ per unit of the good exported in either direction. This trade cost is a

[14] Implicit in our analysis is the existence of another sector Y, producing a numeraire good under conditions of perfect competition and constant returns to scale. Details can be found in H&W.

real (e.g., transport) cost, borne by firms and having no welfare role. The marginal cost of serving a market will depend on the location of the firm and the consumers. For the *local* market $MC_L \equiv w$ while for the *foreign* market the trade cost must be taken into account and therefore $MC_F \equiv w + \tau$. As the good is homogeneous, in equilibrium all units of the good sold in a particular country will have the identical consumer price regardless of whether the good is domestically produced or imported.[15]

Firms will make their location decisions based upon a comparison of the profits from setting up in each country, taking into account any taxes levied on (or subsidies granted to) them by the host government.

2.3 Governments

The governments are motivated by national social welfare, which comprises consumer surplus less total bid payments. The governments must balance their budgets and their only function is to redistribute income in a lump-sum manner between their citizens and the foreign MNEs.[16] We assume that the benefit arising from having a firm invest in a country lies in the lower price that consumers pay for locally produced goods, as opposed to imports of the same product. We ignore the labour-market implications of the investment.

The governments of the countries will be prepared to offer inducements to firms to locate within their borders. Let the bids made by country i be B_i where $B_i \gtrless 0$; a positive value being a lump-sum subsidy while a negative value represents a tax on the firm. Each government's objective function is therefore aggregate consumer surplus minus total bid payments (justified because utility is quasi-linear and the coefficient on the numeraire good

[15] The model has, in this regard, strong similarities with that of the "reciprocal dumping" model of Brander and Krugman (1983).

[16] Moreover, we assume that governments know the firms' costs. Olsen and Osmundsen (2003) relax this assumption in the context of competition for a monopolistic firm. On the role of asymmetric information in taxing transnationals, see Gresik (2001, section 7).

is 1).

3 The tax competition game

The tax competition game has three stages.

Stage 1. Governments of countries A and B simultaneously and irreversibly announce their bids, B_A and B_B.

Stage 2. The two firms simultaneously and irreversibly pick locations, choosing between $\{\varnothing, A, B\}$, where $\varnothing$ is a "stays out" option of not entering the market.

Stage 3. Firms compete à la Cournot to serve both countries.

Choices made in each stage are common knowledge in subsequent stages. We solve the game backwards to find a sub-game perfect Nash equilibrium (SPNE) in pure strategies.

3.1 Stage 3: Cournot competition

We determine the outcomes for firms and consumers resulting from the location choices made in Stage 2.

3.1.1 Firms' profits

In the following analysis, we assume that profits (exclusive of bid receipts/tax payments) are strictly positive for all pairs of location choices. This is a 'no lame ducks' assumption (NLD) by which we mean that subsidies are not required to make production profitable in absolute terms, but merely alter the *relative* profitability of alternative locations. We calculate the variable profits earned by either firm in market B for location choices of local production L or foreign production F, given its rival's choice either of where to locate or not to enter. Variable profits in market A are simply n times those in market B on the assumption of a symmetric trade cost between markets.

Should one firm stay out of the market (choose $\varnothing$), the remaining firm will be a monopolist and its operating profits per household will be:

$$\begin{aligned} \pi_{L\varnothing} &\equiv \frac{1}{4\beta}(\alpha - w)^2, && \text{if firm produces locally and rival does not enter;} \\ \pi_{F\varnothing} &\equiv \frac{1}{4\beta}(\alpha - w - \tau)^2, && \text{if firm produces abroad and rival does not enter.} \end{aligned} \tag{3}$$

Alternatively, the rival will enter the market and the firm's operating profits will depend upon both firms' locations:

$$\begin{aligned} \pi_{LF} &\equiv \frac{1}{9\beta}(\alpha - w + \tau)^2, && \text{if firm produces locally and rival produces abroad;} \\ \pi_{LL} &\equiv \frac{1}{9\beta}(\alpha - w)^2, && \text{if both firms produce locally;} \\ \pi_{FF} &\equiv \frac{1}{9\beta}(\alpha - w - \tau)^2, && \text{if both firms produce abroad;} \\ \pi_{FL} &\equiv \frac{1}{9\beta}(\alpha - w - 2\tau)^2, && \text{if firm produces abroad and rival produces locally.} \end{aligned} \tag{4}$$

These yields the following rankings:

$$\begin{gathered} \pi_{L\varnothing} > \pi_{F\varnothing}, \\ \pi_{LF} > \pi_{LL} > \pi_{FF} > \pi_{FL}, \text{ and} \\ \pi_{LF} + \pi_{FL} > \pi_{LL} + \pi_{FF}. \end{gathered} \tag{5}$$

It is convenient to introduce the following notation for the aggregate profits of a firm, composed of its operating profits in each location less the fixed costs of production:

$$\begin{gathered} \mathit{\Pi}_{A\varnothing} \equiv n\pi_{L\varnothing} + \pi_{F\varnothing} - F,\ \mathit{\Pi}_{B\varnothing} \equiv \pi_{L\varnothing} + n\pi_{F\varnothing} - F, \\ \mathit{\Pi}_{AA} \equiv n\pi_{LL} + \pi_{FF} - F,\ \mathit{\Pi}_{BA} \equiv \pi_{LF} + n\pi_{FL} - F, \\ \mathit{\Pi}_{AB} \equiv n\pi_{LF} + \pi_{FL} - F, \text{ and } \mathit{\Pi}_{BB} \equiv \pi_{LL} + n\pi_{FF} - F, \end{gathered} \tag{6}$$

where Π_{ij} are the profits of a firm based in country i while its rival is set up in country j.

The bottom result in (5) will be especially important in our analysis. It can be interpreted in two ways. In narrow terms, it states that if the host countries are of identical size and their posted bids are equal, the firms would rather locate in different countries than co-locate.

More broadly, it implies that

$$\Pi_{AB} + \Pi_{BA} > \Pi_{AA} + \Pi_{BB}, \tag{7}$$

where the sum on the left-hand side of the inequality represents total industry variable profits when production is geographically dispersed and that on the right-hand side is "average" industry variable profits when production is geographically concentrated (with equal weight placed on location choices of AA and BB). Industry profits are higher with dispersed production because this reduces "competition."[17]

We assume that

$$0 \leq \tau < \overline{\tau} \equiv \frac{1}{2}(\alpha - w) \tag{8}$$

to ensure that all possible Cournot equilibria are interior (the necessary and sufficient condition is $\pi_{FL} > 0$). We shall refer to $\overline{\tau}$ as the "prohibitive tariff" as it is just sufficient to block any international trade between A and B.

3.1.2 Consumer surplus and market prices

When the market outcome is a monopoly, the single firm sets a market prices equal to $(\alpha + MC_j)/2$, where $j \in \{L, F\}$. Consequently we can calculate the consumer surplus in country B as:

$$\begin{aligned} S_{L\varnothing} &= \frac{1}{8\beta}(\alpha - w)^2, \quad \text{if the monopolist produces locally;} \\ S_{F\varnothing} &= \frac{1}{8\beta}(\alpha - w - \tau)^2, \quad \text{if the monopolist produces abroad.} \end{aligned} \tag{9}$$

Clearly,

$$S_{L\varnothing} > S_{F\varnothing}.$$

Once again, consumer surplus in country A is simply n times that in country B.

[17] Consider, for example, the case of a very high trade cost. If firms locate in different countries, each will enjoy close-to-monopoly profits in its local market and make few, if any, exports. If the firms co-locate, they face an identical rival in their local market, yet continue to have few sales in their export market.

In the case of a duopoly, the Cournot duopoly price is $\left(\alpha + \sum MC_j\right)/3$ and the resulting consumer surplus levels corresponding to firm locations are:

$$\begin{aligned} S_{LL} &= \frac{2}{9\beta}\left(\alpha - w\right)^2, \quad \text{if both firms produce locally;} \\ S_{LF} = S_{FL} &= \frac{1}{18\beta}\left(2\alpha - 2w - \tau\right)^2, \quad \text{if one firm is local, other produces abroad;} \\ S_{FF} &= \frac{2}{9\beta}\left(\alpha - w - \tau\right)^2, \quad \text{if both produce abroad.} \end{aligned} \tag{10}$$

Clearly,

$$S_{LL} > S_{LF} \equiv S_{FL} > S_{FF}.$$

That is, the more firms in local production, the better.

3.2 Stage 2: Firms' location decisions

We begin by analyzing a firm's best response (BR) to its rival's choice, given the bids B_i being offered by the potential host countries. Using these decision rules we can plot the best responses to $\varnothing$, A and B in (B_A, B_B)-space and determine the locations chosen by firms in equilibrium.

3.2.1 The location of a single firm

We start by considering the outcome when a single firm is deciding on its location knowing that its rival will not enter the market (that is, the other firm chooses $\varnothing$). This is the case of the monopolistic firm that was analyzed by H&W. We can determine the frontiers along which the firm is indifferent between the locations.

In response to $\varnothing$ ("stays out"):

$$\begin{aligned} &A \succ \varnothing \quad \text{if and only if} \quad B_A > -\mathit{\Pi}_{A\varnothing}; \\ &B \succ \varnothing \quad \text{if and only if} \quad B_B > -\mathit{\Pi}_{B\varnothing}; \\ &A \succ B \quad \text{if and only if} \quad B_A > B_B - \mathit{\Gamma}, \text{where } \mathit{\Gamma} \equiv \mathit{\Pi}_{A\varnothing} - \mathit{\Pi}_{B\varnothing}. \end{aligned} \tag{11}$$

The results are illustrated in Figure 1, which shows $BR_{\varnothing}$, the firm's best responses to $\varnothing$ where the NLD assumption means that $\Pi_{B\varnothing} > 0$ (in the absence of any government bid payments the firm would still be prepared to invest in country B, the smaller and hence less attractive location).

Of course, the position of each frontier in Figure 1 depends on the model's structural parameters. If $n = 1$, the two potential hosts are the same size and $BR_{\varnothing}$ passes through the origin and is symmetric about the diagonal. In that case the firm has no preference for choosing one location over the other. Increasing n shifts all three inter-regional boundaries, away from the origin and in favour of country A. This is intuitive, in that choosing to invest in country A becomes even more attractive as n rises. In particular, the intersection of $BR_{\varnothing}$ and the B_A axis shifts down. The absolute value of the intercept is $\mathit{\Gamma}$, which we shall refer to as Country A's "geographic advantage." This is the additional tax burden (or lower subsidy) that could be imposed by country A that would leave the firm indifferent between locating in the two countries. Substituting (3) into (11) yields an explicit expression for Country A's "geographic advantage":[18]

$$\mathit{\Gamma} = \frac{\tau}{4\beta}(n-1)\left[2(\alpha - w) - \tau\right]. \tag{12}$$

This advantage becomes more pronounced the larger are the international trade costs, as $\frac{d\mathit{\Gamma}}{d\tau} > 0$.

We use the inequalities in (11) to analyze the outcome of the game below.

[18] This is identical to equation (9) in Haufler and Wooton (1999).

3.2.2 The location choices of two firms

We now consider the best locations for a firm given the choice made by its rival when the latter enters the market. From (5) and (6), we can find the inter-regional frontiers.

In response to A**:**

$$\begin{aligned} &A \succ \varnothing \quad \text{if and only if} \quad B_A > -\mathit{\Pi}_{AA}; \\ &B \succ \varnothing \quad \text{if and only if} \quad B_B > -\mathit{\Pi}_{BA}; \\ &A \succ B \quad \text{if and only if} \quad B_A > B_B - \mathit{\Delta}, \text{where } \mathit{\Delta} \equiv \mathit{\Pi}_{AA} - \mathit{\Pi}_{BA}. \end{aligned} \tag{13}$$

In response to B**:**

$$\begin{aligned} &A \succ \varnothing \quad \text{if and only if} \quad B_A > -\mathit{\Pi}_{AB}; \\ &B \succ \varnothing \quad \text{if and only if} \quad B_B > -\mathit{\Pi}_{BB}; \\ &A \succ B \quad \text{if and only if} \quad B_A > B_B - \mathit{\Theta}, \text{where } \mathit{\Theta} \equiv \mathit{\Pi}_{AB} - \mathit{\Pi}_{BB}. \end{aligned} \tag{14}$$

Panels (13) and (14) determine BR_A and BR_B, the best responses to A and B respectively. Under the NLD assumption, plots of BR_A and BR_B in (B_B, B_A)-space are qualitatively identical to $BR_\varnothing$ (as illustrated in Figure 1). In particular, in order to keep the firm out ($BR_A = \varnothing$ and $BR_B = \varnothing$) would require both host countries taxing its investment (that is, $B_A, B_B < 0$). Increasing n shifts the plots of BR_A and BR_B towards the south-west: the region where the best response is to invest in A grows and that where it is to stay out shrinks.[19]

In Figure 2, BR_A and BR_B are plotted together in the case where n is "small"; where the exact meaning and significance of this restriction will be explained below. There are four aspects of Figure 2 that are worthy of discussion.

i. The first point to note about Figure 2 is that the B_A-intercept of the BR_A plot lies above that of BR_B. This occurs because the geographic attractiveness of A, measured

[19] The region where the best response is B is squeezed from above by A but gains ground from $\varnothing$ to the left.

by a firm's total variable profits when located in A minus those when located in B, *rises* if the rival firm switches from A to B.[20] Compared to the case of all production being concentrated in one country, a geographic dispersion of production, when combined with strictly positive trade costs, reduces the degree of "competition" in the industry and raises industry profits (see (5). Therefore, when the rival firm chooses B, the motive to disperse production and thereby reduce "competition" works in favour of A. However, when the rival itself chooses A, this dispersion motive favours B.

ii. The B_A-intercept of BR_A is nearer to the origin than that of BR_B.[21] This feature arises from our assumption that country A is, in general, larger than B. If $n = 1$, both countries are the same size and the smallest bid either country must post to attract both firms if its rival posts a zero bid is the same (and strictly positive) for A and B. For country A, this critical bid is equal to Δ, the B_A-intercept of BR_A; for B, it is Θ, the B_B-intercept of BR_B. Increases in n raise the *relative* geographic advantage of A and therefore affect the countries' critical bids asymmetrically. To attract both firms, country B must bid more if n rises; however, country A can bid less (and, for sufficiently large n, impose a tax).

iii. The horizontal part of BR_B is below that of BR_A. This arises because $\Pi_{AB} > \Pi_{AA}$: a firm located in A earns larger profits if its rival chooses B (dispersed production) than A (concentrated production).

iv. The vertical part of BR_B lies rightwards of the corresponding part of BR_A if and only if $\Pi_{BA} > \Pi_{BB}$. This holds at $n = 1$, reflecting the firms' preference for a geographical

[20] That is, $\Theta > \Delta$. For (B_A, B_B) between the upward-sloping parts of BR_A and BR_B we have $BR_A = B$ but $BR_B = A$. Thus a switch by its rival from A to B prompts a firm itself to switch in the opposite direction.

[21] When $n = 1$ (identical country sizes) BR_A and BR_B cut the B_A-axis at equal distances from the origin but on opposite sides. Increases in n shift both B_A-intercepts downwards.

dispersion of production. However, as n rises, the profits on sales in the A market of a firm producing in B rise faster if the rival firm is also located in B than if it is in A, so eventually $\Pi_{BB} > \Pi_{BA}$. This is because a firm based in B has a stronger "competitive position" on the A market when its rival is not local to A and therefore must also incur trade costs to serve A.

We define $\overline{n}$ to be the relative size of A at which the vertical parts of the best response schedules overlap ($\Pi_{BA} = \Pi_{BB}$). Using (4) and (6), we get:

$$\overline{n} \equiv \frac{\pi_{LF} - \pi_{LL}}{\pi_{FF} - \pi_{FL}} = \frac{2(\alpha - w) + \tau}{2(\alpha - w) - 3\tau}. \tag{15}$$

At $\tau = 0$, $\overline{n} = 1$. $\overline{n}$ is increasing in τ and realises a maximum value of 5 when (8) holds, in which circumstance the trade barrier is prohibitive. We shall define the "small" n case to be when $n < \overline{n}$, as illustrated in Figure 2, while the "large" n case corresponds to $n > \overline{n}$ and is shown in Figure 3.

Figure 3 replicates the first three properties of Figure 2, catalogued above. The crucial difference between the diagrams for large and small n concerns the "full profit extraction" (FPE) point E, shown in both diagrams. Point $E = (-\Pi_{BA}, -\Pi_{AB})$ is such that, if each of the two firms were to locate in a different country, *all* of the profits of each firm would be captured by the taxes set by its respective host nation. Country A's tax would be larger than that of country B, reflecting the geographic advantage enjoyed by the host with the larger domestic market. In the small n case, E lies at the intersection of BR_A and BR_B. However, when $n > \overline{n}$, E is an interior point as it does not lie on BR_B because, for large n, the vertical part of BR_B lies to the left of that of BR_A.[22]

Figures 2 and 3 both also illustrate a number of features regarding the location of $BR_{\varnothing}$.

[22] As explained below, the significance of interior E is that it cannot then be a bidding equilibrium in the first stage of the game,as only boundary points are eligible.

i. The horizontal part of $BR_\varnothing$ lies below the corresponding parts of the other two best response plots.

ii. The vertical part of $BR_\varnothing$ lies to the left of the corresponding parts of the other two best response plots.

Together, these mean that $BR_A = BR_B = \varnothing$ is *necessary* (but not sufficient) for $BR_\varnothing = \varnothing$.[23] Put differently, the presence of an incumbent firm reduces a second firm's incentive to enter the industry.

iii. The intercept of the BR_A plot on the B_A axis lies above that of the $BR_\varnothing$ plot.[24]

iv. The $BR_\varnothing$ plot lies above point E.[25]

If the bids of the national governments were set to fully extract the firms' profits (that is, $B_A = -\Pi_{AB}$ and $B_B = -\Pi_{BA}$ at E), then the equilibrium locations are:

$$(A, B) \text{ for small } n,\ [BR_A = B,\ BR_B = A,\ BR_\varnothing = B]\,;$$

$$(B, B) \text{ in dominant strategies for large } n,\ [BR_A = BR_B = BR_\varnothing = B]\,.$$

Thus, if the country size differential is not too great, the firms will choose to locate in different countries; otherwise they will both locate in B.[26]

We now turn to examining the potential equilibrium outcomes of the complete game.

[23] Moreover, given the NLD assumption, for a firm to have $\varnothing$ as its best response to *any* choice by its rival requires $B_A, B_B < 0$.

[24] This requires $\pi_{L\varnothing} - \pi_{F\varnothing} > \pi_{LL} - \pi_{FL}$, which holds for all $n \geq 1$ as long as $\tau \leq \overline{\tau}$. Intuitively, the gain from being local is greater if there is not already another local firm.

[25] The B_A-intercept of $BR_\varnothing$ is above that of BR_B for all n iff $\tau > \frac{2}{9}(\alpha - w)$. Otherwise, the B_A-intercept of BR_B is higher than that of $BR_\varnothing$ (as plotted in Figure 3) for sufficiently large n. However, as shown in section 3.3.3, this distinction is not significant for our analysis.

[26] The intuition for this co-location in B is as follows. At point E, the firms by definition make zero post-tax profits if they choose location pattern AB. However, for large n, *both* firms gain if the A-firm jumps into B: the jumper enjoys a fall in her tax burden ($\mathit{\Pi}_{AB} \gg \mathit{\Pi}_{BA}$); *and* the incumbent in B enjoys a rise in operating profits ($\mathit{\Pi}_{BB} > \mathit{\Pi}_{BA}$, the implicit definition of large n) because it gains more through reduced competition on the (larger) foreign market than it loses at home.

3.3 Stage 1: Bidding equilibria

In determining their best responses, we assume that countries never play weakly dominated strategies. This refinement of Nash equilibrium eliminates a number of implausible Nash equilibria and ensures that no country will ever offer a bid that exceeds its valuation of attracting the investment.[27]

3.3.1 Competition for the single firm

Turning to the H&W case of competition for the investment of a single firm, the countries' valuations of persuading the firm to locate within their borders are:

$$\begin{aligned} V_A &= n\left(S_{L\varnothing} - S_{F\varnothing}\right); \\ V_B &= S_{L\varnothing} - S_{F\varnothing}. \end{aligned} \tag{16}$$

Substituting (9) into (16) yields:

$$\begin{aligned} V_A &= \frac{n\tau}{8\beta}\left[2\left(\alpha - w\right) - \tau\right] > 0; \\ V_B &= \frac{\tau}{8\beta}\left[2\left(\alpha - w\right) - \tau\right] > 0. \end{aligned} \tag{17}$$

Thus both governments would be prepared to offer subsidies in order to attract the firm.

We use Figure 4 to determine the equilibrium bids and location of the firm. $R_A\left(B_B\right)$ and $R_B\left(B_A\right)$ are the reaction functions of countries A and B, respectively. Each country offers the maximum tax (minimum subsidy) that leaves the firm just willing to invest within the country's borders, given the other country's bid. Thus, for any offer made by country A, country B tries to make investment within its boundaries relatively more attractive to the firm by offering a tax/subsidy just to the right of the $BR_{\varnothing}$ plot. However, the bid cannot exceed the valuation V_B and so the reaction function turns vertical at that value. R_A is constructed in exactly the same way, though the kink occurs at the higher V_A. The reaction

[27] We will also find it convenient to assume that there exists a well-defined minimum interval between bids, ε; i.e. that the bid grid is "finite."

curves intersect at point M where country A captures the investment by marginally improving on $V_B - \Gamma$. While country A is prepared to pay more (that is, offer a larger subsidy than country B), it does not need to given its geographic advantage. Thus the winning subsidy B_A^* is less than that offered by country B.

The difference in country size rules out the familiar "race to the bottom" in taxes (subsidies) that would otherwise occur.[28] The bigger country does not have to match the offer of the smaller location and therefore the winning bid will not transfer all of the national benefits of the investment to the firm. Indeed, some of the profits from the firm may be captured by the host country. As H&W show, for sufficiently large n, $B_A^* < 0$. This is the case illustrated in Figure 4. Thus the larger country always wins and, if the size difference between the competing countries is sufficiently great, the winning bid will be a tax on the investment.

The next subsection investigates how this story changes when there are two firms looking to invest.

3.3.2 Competing for the duopoly: the small n case

The equilibrium locations for given B_A and B_B are illustrated in Figure 5. In order to limit the taxonomy, location decisions of the two firms have been grouped together.

In the shaded triangle, $BR_A = \varnothing$, $BR_B = A$, and $BR_\varnothing = B$, so there is no pure strategy location equilibrium under simultaneous moves by firms.[29] Were sequential moves assumed, the equilibrium would be $(A, \varnothing)$, with the leader choosing A.[30]

We now consider the conditions for a bidding equilibrium to occur at FPE point E. At

[28] If $n = 1$ (i.e., the countries are identical to each other), $B_A^* = V_A = V_B = B_B^*$, as in a standard first-price auction. This means that the countries would be indifferent to hosting the monopoly, as the winning bid transfers all of the benefits of the the investment from the host nation to the firm in the form of a subsidy.

[29] A symmetric, mixed-strategy Nash equilibrium does, however, exist.

[30] Note also that all of the simultaneous-moves location equilibria would be preserved under sequential moves (with the leader choosing the more profitable location).

this point, each country gets the investment of one of the firms and has imposed a tax that equals the profits accruing to the firm. Thus the total benefit accruing to each country is the consumer surplus arising from having one local and one foreign firm servicing its market together with the entire profits of the local firm.

If country A were to reduce its offer and cut B_A (that is, increase its tax), it would move to inside the $(B, \varnothing)$ region and the previously local firm would be driven out of the industry. This is clearly not worthwhile for A because *both* its consumer surplus and tax revenues fall. Likewise, it is not worthwhile for country B to deviate from point E by cutting B_B.[31]

Now consider whether either country will improve its offer. It is only going to want to do this if it results in attracting the investment of the second firm, otherwise it would forego tax revenues with no change in consumer surplus. Were the improved offer to bring in the second firm, domestic consumer surplus would increase while the country's tax base would change and it would be able to tax both firms. Country A will want to move from FPE at point E to attracting both firms just inside the (A, A) region if and only if the increase in consumer surplus plus the combined profits of the two firms producing locally exceeds the profits of the single local firm at E. Otherwise, attracting the second firm would not improve on the FPE outcome for country A at E, even if it were to tax all of the profits of both local firms. Thus the necessary and sufficient condition to ensure that country A would *not* improve its bid is:

$$nS_{LF} + \Pi_{AB} > nS_{LL} + 2\Pi_{AA}. \tag{18}$$

[31] Note that country A is indifferent between all B_A in $(B, \varnothing)$ and B is indifferent between all B_B in $(A, \varnothing)$. The formal conditions for deviations from point E to higher taxes not to be worthwhile are: $nS_{LF} + \Pi_{AB} > nS_{F\varnothing}$ for country A and $S_{LF} + \Pi_{BA} > S_{F\varnothing}$ for B. The NLD assumption is *sufficient* for both of these to hold. If NLD failed, the countries would face a trade-off when contemplating "deviating downwards" from E between lower consumer surplus and reduced subsidy payments.

Similarly for country B the necessary and sufficient condition is:

$$S_{LF} + \mathit{\Pi}_{BA} > S_{LL} + 2\mathit{\Pi}_{BB}. \tag{19}$$

When will these conditions hold, such that point E is the equilibrium?

We start initially with the symmetric case of $n = 1$ and consider the incentives facing one of the countries, say country B. With symmetry, total profits are the same for each firm at point E, that is, $\mathit{\Pi}_{AB} = \mathit{\Pi}_{BA} > 0$ (given the NLD assumption). Country B will have to improve its offer by lowering its tax if it is to tempt the other firm to move its investment. Given (7) and the fact that symmetry also implies $\mathit{\Pi}_{AA} = \mathit{\Pi}_{BB}$, it must be the case that $\mathit{\Pi}_{BA} > \mathit{\Pi}_{BB}$. Thus the tax that country B charges any firm producing locally must fall from the FPE level to (just less than) $\mathit{\Pi}_{BB}$ if the foreign firm is going to be induced into jumping from A to B. If (19) holds, it is not in country B's interests to do this as the increase in consumer surplus and the expansion of the tax base would be insufficient to offset the decline in the profitability of each firm (i.e., the tax that B could levy on a *single* firm).

Substituting (6) for the profit terms in (19), setting $n = 1$ and re-arranging yields:

$$F > (S_{LL} - S_{LF}) + 2(\pi_{LL} + \pi_{FF}) - (\pi_{LF} + \pi_{FL}). \tag{20}$$

Using the expressions for consumer surplus (10) and firm profits in each location (4), we can rewrite (20) as:

$$F > \frac{1}{9\beta}[2(\alpha - w)^2 - \frac{7\tau^2}{2}]. \tag{21}$$

Thus fixed costs have to be sufficiently high in order to deter country A's attempt to attract both firms. Yet at the same time they cannot be too high to break the NLD assumption $\Pi_{AB} > 0$, that is, firms have be willing to enter and produce without the inducement of subsidies. From (6) and (4), NLD can be rewritten as:

$$F < \frac{1}{9\beta}[2(\alpha - w)^2 + 5\tau^2 - 2(\alpha - w)\tau]. \tag{22}$$

There is a potential conflict between (21) and (22). Putting them together provides a condition on the trade cost, τ:

$$\tau > \tau^* \equiv \frac{4}{17}(\alpha - w). \tag{23}$$

This minimum trade cost τ^* is less than $\overline{\tau}$, the prohibitive tariff derived in (8), so trade between the two countries is profitable. Consequently, if trade costs are sufficiently high, it will not pay for either country to lower its taxes so as to attract the second firm. Intuitively, the loss in industry profits from the co-location of the firms swamps the increase in consumer surplus for the host nation such that, even if the host were able to tax all of the profits of local firms, it would lose from the relocation of the second firm.

What about $n > 1$? As country A's market becomes relatively bigger, producing in its market becomes increasingly attractive to both firms, even when another firm is present. Will point E remain the equilibrium? We rewrite the two sufficient conditions (18) and (19), substituting the profit definitions (6):

$$F > n(S_{LL} - S_{LF} - \pi_{LF} + 2\pi_{LL}) + (2\pi_{FF} - \pi_{FL}), \tag{24}$$

$$F > (S_{LL} - S_{LF} - \pi_{LF} + 2\pi_{LL}) + n(2\pi_{FF} - \pi_{FL}). \tag{25}$$

At $n > 1$, condition (24) is tighter so (25) can be dropped. Substituting (10) into (24) gives a necessary-and-sufficient condition for neither country to improve its bid:

$$F > \frac{n}{9\beta}\left[(\alpha - w)^2 - \frac{3\tau^2}{2}\right] + \frac{1}{9\beta}\left[(\alpha - w)^2 - 2\tau^2\right]. \tag{26}$$

Our maintained NLD assumption requires that pre-tax profits at E be positive. The $n > 1$ version of (22) is:

$$F < \frac{1}{9\beta}(\alpha - w + \tau)^2 + \frac{n}{9\beta}(\alpha - w - 2\tau)^2. \tag{27}$$

Again, there is a potential conflict between these last two expressions, and we must establish whether there is a non-empty interval of F values that meets both. Inequalities (26) and

(27) are consistent if and only if:

$$n < n^* \equiv \frac{4(\alpha - w) + 6\tau}{8(\alpha - w) - 11\tau}, \tag{28}$$

where $n^* > 1$ if and only if $\tau > \tau^*$. Therefore, for trade costs τ, $\tau^* < \tau < \overline{\tau}$, and fixed costs F consistent with the two inequalities above, a bidding equilibrium exists at the full-profit-extraction point E for all $n \in [1, n^*]$.[32] Furthermore, this equilibrium is unique.[33]

The critical value n^* can be compared with $\overline{n}$, our "smallness" criterion (15). For all parameter values, $n^* < \overline{n}$. Thus there is always a range of values of n where the country size differential is still "small" but is great enough that the full-profit-extraction point E cannot be an equilibrium.[34]

Consider how the outcome of this game differs from that of competing for a monopoly. Initially, return to the symmetrical case of $n = 1$. In this situation, neither country has a geographical advantage. In competing for the monopoly, each nation will be prepared to bid up to its valuation of capturing the investment. The ensuing race to the bottom will transfer the increased consumer surplus V_i of "winning" country i to the firm in the form of a subsidy, such that the host nation ends up no better off than the loser. The situation is effectively reversed when a second firm also wishes to invest. In this case, each country is able to attract

[32] An illustrative numerical example of this result would be if we let $(\alpha - w) = 10$, $\beta = 1$, and $\tau = 4$ (which is non-prohibitive). Therefore, $n^* = 1.78$. From the restrictions on F, we get: (i) at $n = 1$, an FPE equilibrium exists for all $F \in [16, 22.22]$; and (ii) at $n = 1.5$, an FPE equilibrium exists for all $F \in [20.22, 22.44]$.

[33] To prove the uniqueness of the bidding equilibrium at E, consider first the part of Figure 5 where $B_A < -\Pi_{AA}$ and $B_B < -\Pi_{BB}$. Here, there are four location equilibria, $(\varnothing, \varnothing)$, $(A, \varnothing)$, $(B, \varnothing)$ and (A, B), and for all bid pairs the location equilibrium is unique. Country A could profitably deviate from any candidate equilibrium point in $(\varnothing, \varnothing)$ or $(B, \varnothing)$ by setting $B_A = -\Pi_{AB} + \varepsilon$; this would increase both A's consumer surplus and A's tax revenue. Likewise, country B could profitably deviate from any point in $(\varnothing, \varnothing)$ or $(A, \varnothing)$ (e.g., by setting $B_B = -\Pi_{BA} + \varepsilon$). Lastly, note that point E is the only possible bidding equilibrium in (A, B) because, at all other points, at least one country can profitably deviate by increasing its tax *without affecting the firms' locations.*

If, in Figure 5, $B_A > -\Pi_{AA}$ or $B_B > -\Pi_{BB}$, the problem of isolating bidding equilibria becomes identical to that tackled in section 3.3.3 below. In section 3.3.3 we show that no bidding equilibrium exists in this part of bid space for $n < n^*$.

[34] Of course, $n^* < \overline{n}$ is not surprising. When $n \approx \overline{n}$, the vertical parts of the BR_A and BR_B plots almost coincide, and country B can attract both firms with only a very small cut in its tax from its level at E.

investment by one of the firms while imposing an FPE tax of Π_{AB} =Π_{BA}. Thus, rather than the firm being given a subsidy that exhausts all of the aggregate benefits to the host country (increased consumer surplus and profits) from its investment under monopoly, the shift in bargaining power to the host governments under duopoly results in their capturing all of the gains. If $n > 1$, the geographic advantage enjoyed by country A allows it to reduce its subsidy to the monopolist and still attract the investment, but qualitatively the result is the same as under symmetry, in that the firm essentially has the upper hand in choosing where to invest. Under duopoly, as long as n is not "too large", FPE still occurs with the allocation of gains being biased in favour of the larger country. What happens when n does become "too large" is the focus of the next subsection.

3.3.3 Competing for the duopoly: the large n case

If n is large then locating in the larger market becomes more of an imperative for both firms despite the more intense competition that would result. We illustrate the equilibrium locations in Figure 6.[35]

We concentrate our search for bidding equilibria outside the region where $BR_A = \varnothing$ (that is, we exclude bid pairs with $B_A < -\Pi_{AA}$ and $B_B < -\Pi_{BA}$) because no bidding equilibria exist there.[36] We would expect country A to be host to at least one of the firms. The question is whether the size differential is now sufficiently large (compared to the small n

[35] These locations are independent of whether the upward-sloping component of $BR_\varnothing$ lies above or below that of BR_B.

[36] This can be straightforwardly shown. With "large" n, four location equilibria exist in the region of bid space where $BR_A = \varnothing$: $(\varnothing, \varnothing)$, $(A, \varnothing)$, $(B, \varnothing)$ and (B, B). The location equilibrium associated with a bid pair such that $BR_A = \varnothing$ is, in general, unique (whether this is always so depends on the position of the B_A-intercept of $BR_\varnothing$ relative to BR_B, although uniqueness is not important); and in the particular case where no pure-strategy location equilibrium under simultaneous moves by firms exists, we use the intuitively-appealing sequential-moves equilibrium. From the NLD assumption, note that $BR_A = \varnothing$ implies that $B_A, B_B < 0$. Therefore, no bidding equilibria are possible with locations $(\varnothing, \varnothing)$, $(B, \varnothing)$ or (B, B) because country A could profitably deviate, increasing both tax revenue and consumer surplus, to $B_A = -\Pi_{AA} + \varepsilon$ (i.e. just inside the (A, A) region). Likewise, no bidding equilibrium is possible with locations $(A, \varnothing)$ because country B could profitably deviate to $B_B = -\Pi_{BA} + \varepsilon$ (i.e. just inside the (A, B) or (B, B) regions).

case) to result in both firms being persuaded to invest in the larger country. We determine country A's best bidding responses; country B's can be derived by straightforward analogy. For $B_B > -\Pi_{BA}$, country A will be choosing between three location pairs, (A, A), (A, B) and (B, B).[37] Consider the lowest bids that country A would have to offer to achieve the investment that it wants. Of all the offers that would induce the firms to choose (A, A), country A strictly prefers setting $B_A = B_B - \varDelta + \varepsilon$. This is just above BR_A and maximizes the revenue from its two-firm tax base. Likewise, amongst the offers that would result in firms choosing (A, B), country A strictly prefers setting $B_A = B_B - \varTheta + \varepsilon$. In this case the offer is just above BR_B, maximizing the tax revenue from the one firm it attracts. Because it collects no tax revenue under (B, B), country A is indifferent between all B_A that attract no firms.

The value to country A of attracting one firm, given that the second firm chooses B, is

$$V_A^1 \equiv n\left(S_{LF} - S_{FF}\right), \tag{29}$$

which measures the increase in country A's consumer surplus if one of the two firms jumps from B to A. In other words, this is A's valuation of (A, B) over (B, B). The smallest "price" A would have to pay in order to tempt one of the firms away from B is $B_A = B_B - \varTheta + \varepsilon$. This price is strictly less than B_B because A's market enjoys the geographic advantage $\varTheta > 0$ of having the larger market. Therefore, A will optimally bid one firm away from B if and only if its valuation exceeds the price. This can be expressed in terms of $\overline{B_B}$, the maximum bid that country B could make that still makes it just worthwhile for A to attempt to grab one firm:

$$B_B < \overline{B_B} \equiv V_A^1 + \varTheta. \tag{30}$$

[37] Note, in particular, that if bid pairs where $BR_A = \varnothing$ are excluded, then both firms always enter the industry for all remaining bid pairs.

The value to country A of attracting both firms away from B, rather than just one, is A's valuation of (A, A) over (A, B):

$$V_A^2 \equiv n\left(S_{LL} - S_{LF}\right) - (\Theta - \Delta). \tag{31}$$

The first term of (31) is the increase in A's consumer surplus. The second term $(\Theta - \Delta) > 0$ is the extra bid payment A must make (or taxes that it must forego) in order to attract the firm under (A, B).[38] The price A must pay to attract the second firm away from B is $B_A = B_B - \Delta + \varepsilon$. Therefore, A will optimally bid the second firm away from B if and only if its valuation exceeds the price. Writing this in terms of $\underline{B_B}$, the maximum bid that B could make that still makes A to attempt to get the second firm, yields:

$$B_B < \underline{B_B} \equiv V_A^2 + \Delta. \tag{32}$$

The critical values V_A^1, V_A^2 and associated bids $\overline{B_B}$, $\underline{B_B}$ are shown in Figure 6, where R_A is country A's best response function. It is straightforward to show that $V_A^1 > V_A^2$ (that is, the marginal benefit of having the first local firm is greater than that arising from capturing the second) and $\overline{B_B} > \underline{B_B} > 0$. Therefore, on $B_B \in \left(-\Pi_{BA}, \underline{B_B}\right)$, A's best response is to bid just above BR_A, inducing (A, A); on $B_B \in \left(\underline{B_B}, \overline{B_B}\right)$, it is to bid just above BR_B, inducing (A, B); and on $B_B > \overline{B_B}$, A optimally bids V_A^1, inducing (B, B).[39]

Repeating the preceding analysis for country B produces R_B, B's best response function, which is qualitatively identical to R_A. By analogy with the four critical values derived above,

[38] The presence of the term in $(\Theta - \Delta)$ in V_A^2 follows from our assumption that the countries cannot, in setting their bids, discriminate between the firms. If A bids more to attract an additional firm, its bid payments to the firm already hosted must rise by the same amount (the countries are "oligopsonists" in the market for firms). In the present model, there is no obvious basis for discrimination. Discrimination might be thought likely if the firms arrived sequentially (so bids could be "dated"). However, in that case, the equilibrium would be identical in all respects to the one we derive under simultaneous firm arrival. In particular, both firms would face the same tax of just under $-\overline{B_A}$ from country A.

[39] Although country A's social welfare is the same for all B_A beneath BR_B, our assumption that countries never post weakly dominated bids rules out all $B_A > V_A^1$ in response to $B_B > \overline{B_B}$.

we get

$$V_B^1 \equiv (S_{LF} - S_{FF}), \tag{33}$$

$$\overline{B_A} \equiv V_B^1 - \Delta, \tag{34}$$

$$V_B^2 \equiv (S_{LL} - S_{LF}) - (\Theta - \Delta), \tag{35}$$

$$\underline{B_A} \equiv V_B^2 - \Theta. \tag{36}$$

In particular, note that $V_A^1 > V_B^1$ and $V_A^2 > V_B^2$, that is, the larger country has a higher valuation of both a first and a second firm. The *sole* reason for this is that (for a given number of firms already hosted) A gains more in aggregate consumer surplus by attracting an additional firm than does B. For a given bid posted by the other country, the prices to B of one or two firms are both higher than those faced by A (because country A has the advantage of being able to offer the firms a larger local market). However, the premium that must be paid to attract both firms rather than just one is the same for both countries and equal to $(\Theta - \Delta)$.

A bidding equilibrium exists at point D in Figure 6 if and only if $V_A^2 > \overline{B_A}$ (or, equivalently, $\underline{B_B} > V_B^1$). In this equilibrium, country A attracts both firms, country B offers a subsidy equal to V_B^1, and country A trumps this with a tax just less than $-\overline{B_A}$.[40] The existence condition $V_A^2 > \overline{B_A}$ holds if and only if:

$$n > n^{**} \equiv \frac{12(\alpha - w) + 5\tau}{12(\alpha - w) - 17\tau}. \tag{37}$$

It is straightforward to show that this existence condition holds for all "large" n; i.e., from (15), $\overline{n} > n^{**}$. Moreover, the equilibrium at point D is unique.[41]

[40] Note that $\overline{B_A} > -\Pi_{AA}$, so not all of the firms' profits are captured in tax in this equilibrium.

[41] Given that no bidding equilibrium can exist in Figure 6 where $BR_A = \varnothing$, the equilibrium at D is unique if and only if $V_A^1 > \underline{B_A}$ (or, equivalently, $\overline{B_B} > V_B^2$), which holds for all $\tau > 0, n \geq 1$.

In summary, when n is large enough, the equilibrium of the international competition is characterized by both firms being attracted to the larger country, where their investments are taxed despite the offer of a subsidy from the smaller country. We have now isolated all the game's pure-strategy bidding equilibria for $n \geq 1$. For $n \in [1, n^*]$, where n^* is defined in (28), an FPE bidding equilibrium with dispersed production exists (see section 3.3.2). For $n \geq n^{**}$, we have derived a "co-location" equilibrium in this section. For all non-prohibitive τ, i.e. $\tau < \overline{\tau}$ in (8), we can show that $n^{**} > n^*$, so in the interval $n \in (n^*, n^{**})$ no pure-strategy bidding equilibrium exists.

4 Conclusions and Extensions

This paper examines the fiscal competition between rival governments to attract the foreign direct investment of two firms from the same industry. Despite the empirical prevalence of oligopoly in the industries where MNEs operate and national governments are observed to compete for their FDI projects, existing formal treatments of tax/subsidy competition generally ignore strategic inter-firm rivalry and focus on the polar cases of monopolistic and (perfectly) competitive market strucures.[42] Two variables play prominent roles in our analysis. First, we allow for market size differences between the two bidding countries. Second, the existence of trade costs between the two countries means that both consumers and firms care about production locations: consumers care because locally produced goods are sold at lower prices than imports, and superior "market access" pulls the investing firms towards the larger country.

We have isolated all of the game's (pure-strategy) bidding equilibria. Qualitatively, we found two types of equilibrium to exist where the bidding equilibria (if they exist) are always

[42] To repeat, Janeba (1998) is the only exception to this rule that we know of, and his analysis is quite different from ours (see footnote 7).

unique. For “small” size differences between the two countries, we showed that production is internationally dispersed in equilibrium and all the firms’ profits are captured by taxes (“full profit extraction”). This result on the distribution of benefits from FDI between firm and host is striking: it contrasts with the “race to the top” in *subsidy* payments that characterizes the competition between two identical countries for a monopoly firm’s plant (Haufler and Wooton, 1999). Moreover, it is consistent with empirical evidence that shows a remarkable stability of “effective” corporate tax rates over time in the face of ongoing “globalisation.”

When the size asymmetry between the bidding countries is “large,” the firms co-locate in the larger country in equilibrium.[43] Despite the smaller country’s willingness to subsidize any investment within its borders, the larger country’s “market access” advantage allows its government to tax the firms whilst retaining their plants in equilibrium. (However, in this case, the tax does not fully extract the firms’ economic profits.)

It seems clear that the logic of our arguments, and by extension our qualitative results, should readily generalize to many other specifications with oligopoly in the product markets. With g countries of “similar” sizes and h firms ($h \geq g$ and h/g an integer), we expect to be able to construct a “full profit extraction” bidding equilibrium where each country hosts h/g firms. In this case, the tradeoffs facing each country would be the same as those in our “small” size-asymmetry case: if *local* markets are sufficiently important to firms as a source of profits (a restriction on the level of trade costs), then the reduction in taxes necessary to attract extra firms would be too great to be worthwhile.

The analysis of the “large” size-asymmetry case should be generalizable to more than two firms (but sticking with two host countries). We should always be able to find a sufficiently large size difference such that (*i*) the larger country attracts all the firms; (*ii*) the smaller

[43] We provide intuition for the transition between our two equilibria in footnote 26.

country bids its valuation for one firm; and (*iii*) the larger country's bid just trumps its rival's bid. We would expect the minimum size asymmetry necessary for the existence of such a bidding equilibrium to be increasing in the number of firms. Formalising some of these extensions is a task for future work.

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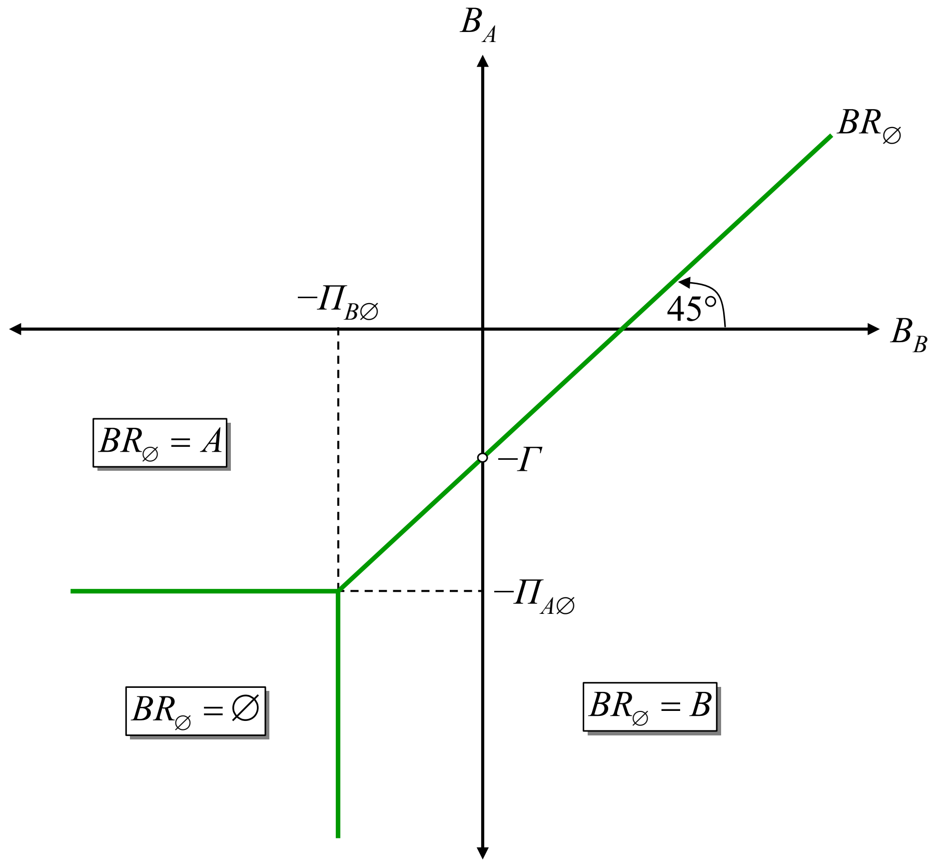

Figure 1. Monopolist's best response

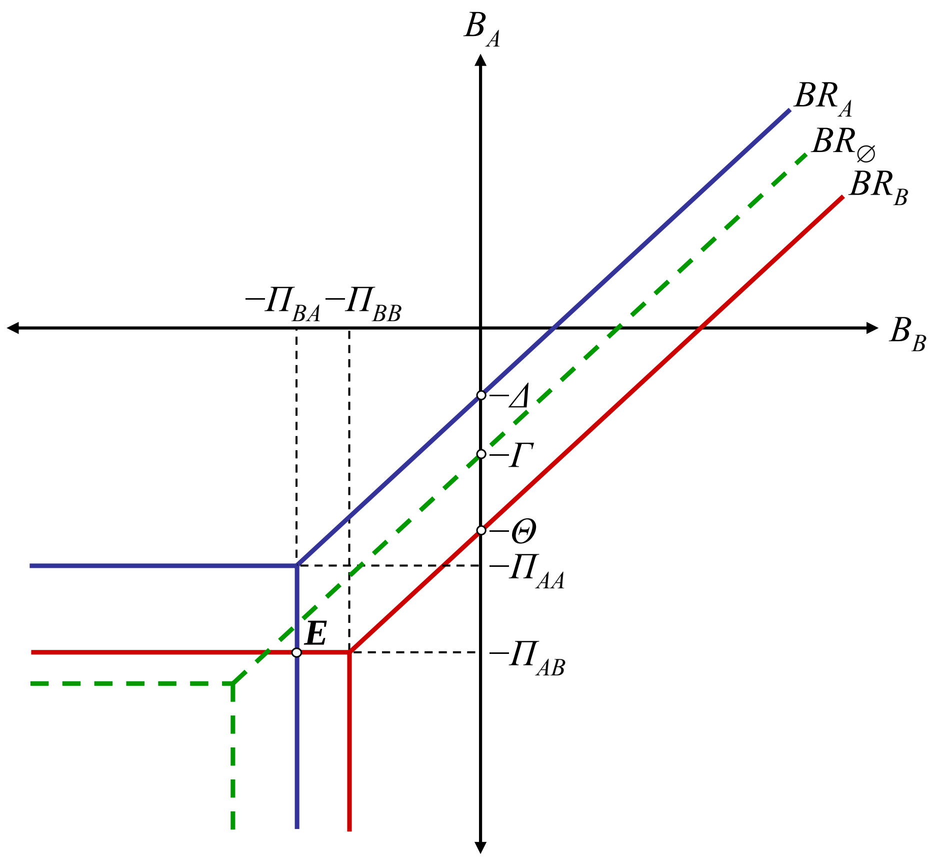

Figure 2. Best responses in the small *n* case

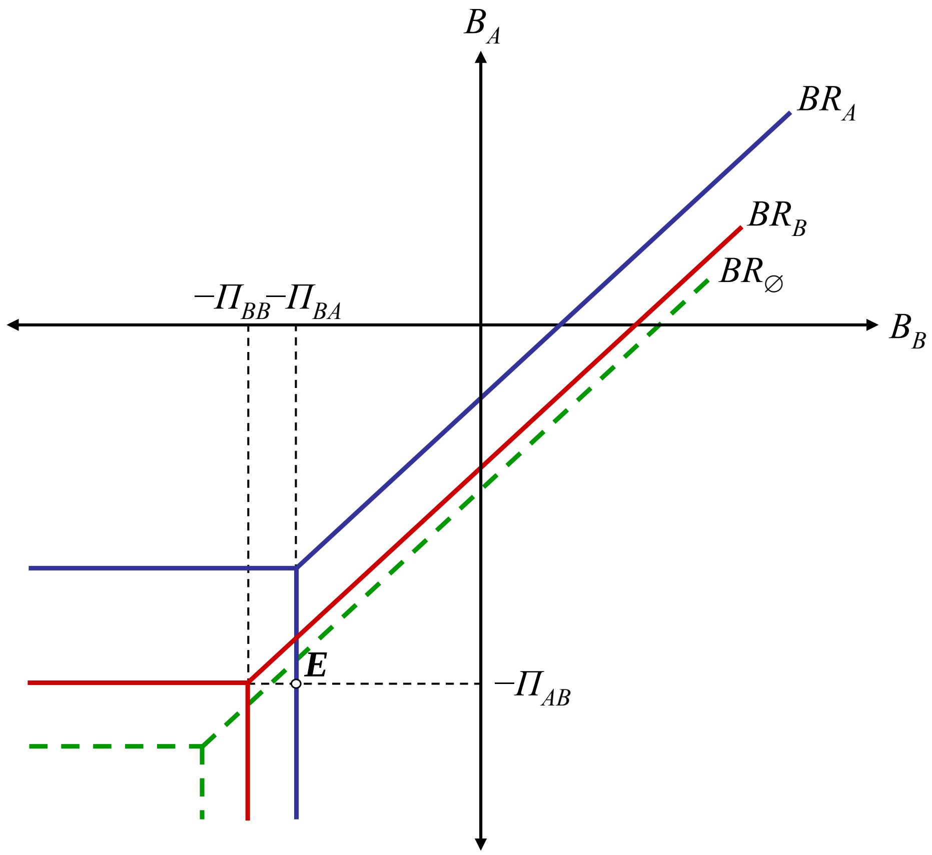

Figure 3. Best responses in the large *n* case

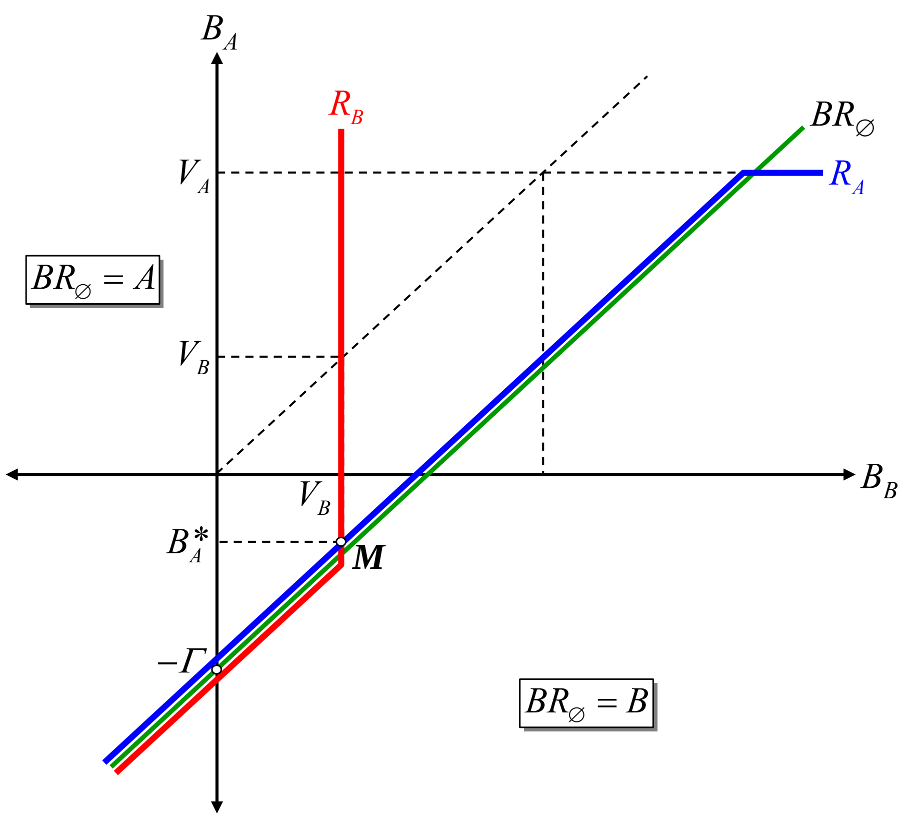

Figure 4. Bidding for a monopolist

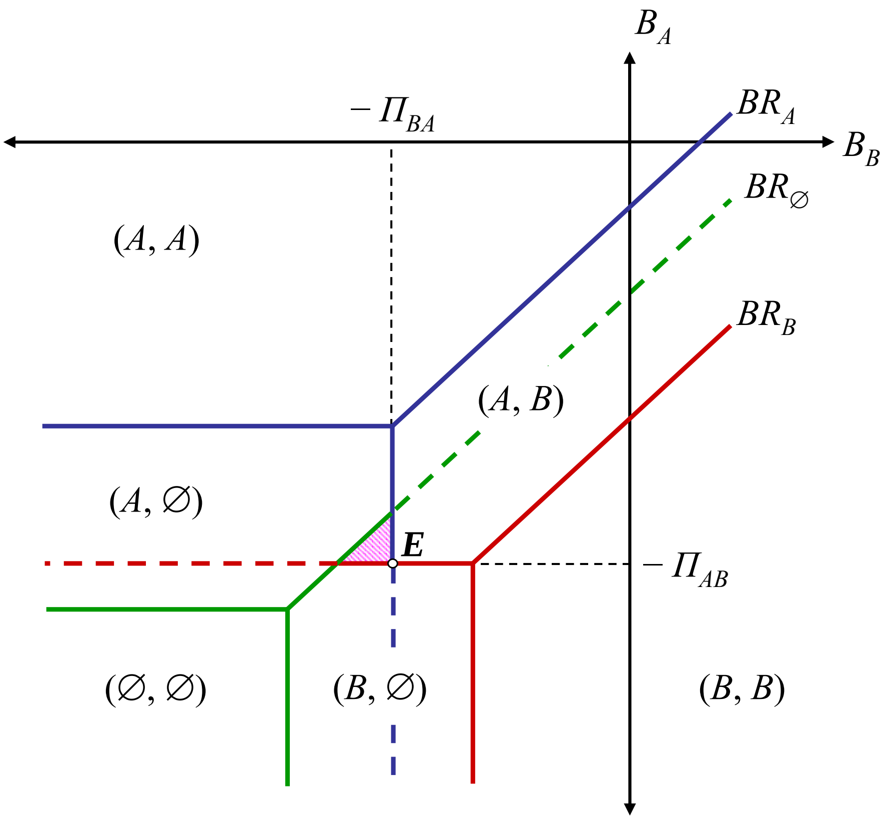

Figure 5. Bidding equilibrium in the small n case

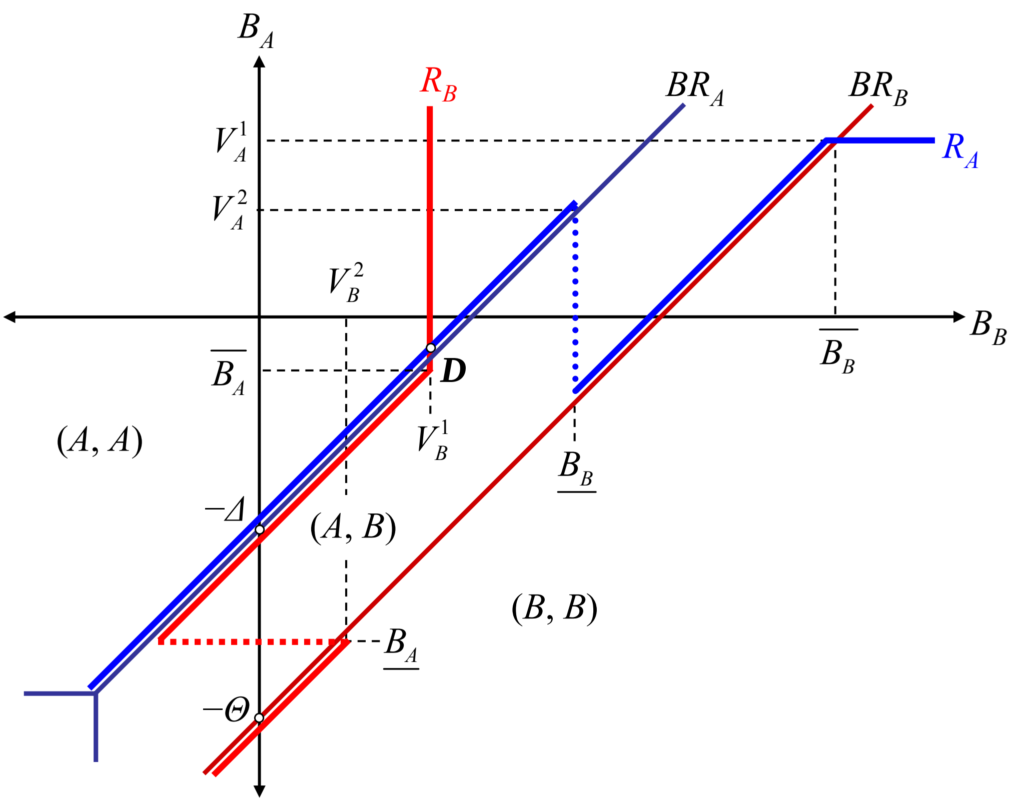

Figure 6. Bidding equilibrium in the large n case