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Existing analyses of fiscal competition for foreign direct investment (FDI) often assume a one-shot interaction between governments and the firm within a static environment where the firm makes a permanent location choice. We examine a two-period regional model where economic geography evolves, giving the firm an incentive to relocate between periods. Government competition for FDI leads the firm to make efficient location choices, with relocation “more likely” in the presence of international tax competition, because the winning country’s bid absorbs some of the firm’s relocation costs. With more time periods, tax competition induces firm relocation sooner than in its absence.

JEL Classification: F23, H25, R38

Keywords: FDI, dynamic fiscal competition, geographical change, efficiency

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Does tax competition make mobile firms more footloose?

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1. Introduction

National governments often give significant tax and other incentives to foreign-owned firms in order to induce them to establish local production facilities. Despite this, the lifespan of these subsidised plants can be short. The firms concerned may move to sites in new countries that now offer better opportunities for profit. For example, in 2008, the German public was outraged and demanded the repayment of public subsidies when Nokia announced the relocation of its handset production from North-Rhine Westphalia to Romania, a little over a year after the end of a sizeable subsidy agreement between the firm and the German local government.[1] These moves may be triggered by changes in the underlying "geographical advantage" of one country relative to another. But it is frequently asserted that subsidies offered by a plant's destination country play a central role in firm relocations and there is some case-study evidence to support this view. For example, in December 2010, the *Financial Times* (FT) reported on its wide-ranging investigation into whether plants had been induced to relocate within the EU by subsidies offered by those plants' new host countries. The FT introduced its article thus: "Millions of euros in EU subsidies have been allocated to companies relocating factories from western to eastern Europe despite specific rules designed to prevent taxpayer subsidies from going to corporations moving plants in search of cheaper labour."[2]

This paper investigates the effect on observed firm mobility of governments making competing offers to attract and retain foreign direct investment (FDI) as the pattern of geographical advantage evolves over time. In particular, we wish to determine whether such

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[1] In January 2008, Nokia announced the closure of its plant in Bochum, with the loss of 2300 jobs, and the relocation of production to a subsidised site near the city of Cluj in Romania. Ironically, Nokia subsequently announced in September 2011 that the Romanian factory was itself to be shut down and production shifted to China.
See http://news.bbc.co.uk/1/hi/business/7232367.stm and http://www.bbc.co.uk/news/world-europe-16290078. A further, much-cited example of a short-lived, subsidised plant is the Siemens microchip factory in the north-east of England, which operated for only 18 months in the late 1990s; see http://news.bbc.co.uk/1/hi/business/332560.stm.

[2] See http://www.ft.com/cms/s/0/74ab02a6-fd85-11df-a049-00144feab49a.html?siteedition=uk#axzz48oi3kEfr.

fiscal inducements can make potentially-mobile firms more “footloose” than they would have been in the absence of such offers. Beyond this, we wish to determine whether any changes in industrial mobility associated with international tax/subsidy competition for FDI are beneficial to society.

At the outset of our research, we anticipated that financial inducements offered for FDI would reduce the likelihood of firm relocation in response to asymmetric growth in national market sizes. Our intuition suggested that, if the governments could anticipate future geographical developments and build them into their initial fiscal offers, there would be a more muted reaction to the unfolding of geography over time than would arise in the absence of international bidding for FDI. We shall demonstrate that this intuition is incorrect and attempt to provide an intuitively appealing explanation of the correct outcome.

We consider the FDI decisions of a multinational enterprise (MNE) in a multi-period model of production, trade and consumption in a region with an evolving pattern of geographical advantage arising from, for example, different national rates of growth in population and market size, changing production costs or improvements in local infrastructure. With the existence of sunk set-up costs for the firm’s operations, such as building the plant or searching for the optimal location within a country, relocating production is more costly than staying in the initial location. This might create inertia on the part of the firm, such that it chooses to remain in one place despite the existing host country having become the less-profitable location. Alternatively, if a nation is anticipated to develop a strong geographical advantage in the future, there is the potential that it will attract the firm immediately, despite being the less-profitable location when the FDI takes place.

We examine how government policies may encourage or hinder relocation of FDI in such a changing economic environment.[3] Our model has two active governments, each making offers of lump-sum taxes/subsidies in an attempt to attract the FDI of the MNE, which is owned in the rest of the world. Initially, we consider two time periods, in each of which the two governments can make offers to the firm. The firm can stay in its original location or choose to relocate at the beginning of the second period. Later in the paper, we extend our time horizon with asymmetric country growth over many periods. In this setting we ask whether government competition induces the firm to relocate sooner (or delay its decision) compared to the timing of its choice in the absence of the competition between countries.

The starting point of our analysis is the model of Haufler and Wooton (1999), who examine the fiscal competition for FDI between two asymmetric countries. Their analysis is "static", in the sense that it focuses on cases where the underlying geography is fixed and the firm/government interaction is one-shot. Thus, their model explains the firm's initial choice of plant location, but has nothing to say about possible plant relocation over time. The contribution of our paper is in extending the time horizon of the Haufler/Wooton framework to allow for repeated interaction between governments and the firm. As such, this paper adds to a relatively small literature on fiscal competition over time.

As our benchmark, we derive the equilibrium location decisions of the firm over time when the governments do not bid to attract its FDI and, consequently, geographical advantage is the sole determinant of location. We call this case "*laissez-faire*". We show that, depending on the initial pattern of geographical advantage and the growth disparity between the two nations, the firm might choose one country or the other as its permanent location or it may decide to relocate after the first period.

[3] Note that we assume that the underlying (technological) ability of the firm to move (e.g., to co-ordinate production and sales across national borders) is constant.

We then introduce "fiscal competition", where each country bids in each period to attract/retain the FDI in order to maximise its domestic welfare, on the plausible assumption that local production is preferred to imports. We show that the firm's location choices under such repeated fiscal competition are efficient and that, compared to *laissez-faire*, the firm is more likely to relocate production between periods. This greater propensity to relocate under fiscal competition is due to the fact that, with endogenously determined fiscal inducements, the host governments absorb some of the firm's relocation costs in their tax/subsidy offers.

In our model, geographical change is necessary to explain plant relocations over time. In contrast, adopting fixed geography, King *et al.* (1992, 1993) account for the relocation of a single firm's plant in a closely-related two-period model of international competition on the basis of *ex ante* uncertainty and *ex post* disappointment. In their approach, the firm does not know the countries' characteristics with certainty before choosing its initial location, and it might move away after investing if conditions turn out to be sufficiently worse than expected.

Unlike us, King *et al.* downplay relocation issues and concentrate on the time profile of taxes paid in a given location. (Furthermore, they do not analyse the comparison between *laissez-faire* and fiscal competition.) The sunk nature of FDI limits mobility between periods and allows the first-period host nation to extract rents from the firm in the second period. Anticipating these future tax payments, the firm receives a subsidy in the first period.

In contrast, we focus on how the sunk cost of FDI allows the firm to use its choice of initial location strategically to reduce its future tax burden. A given second-period host will set a lower tax if it gains the FDI through relocation between periods than if it also won the FDI initially; and the deterministic, as opposed to probabilistic, treatment of geography in our model facilitates a transparent analysis of the incentives that relocation opportunities create for the firm. Moreover, given the amount of effort that firms and their agents typically put into researching alternative locations, the pre-investment ignorance assumed by King *et al.* may

seem implausible. In contrast to theirs, our model can explain plant relocations in the absence of uncertainty or surprises and we view this as a distinctive contribution.

A second closely-related contribution is Konrad and Kovenock (2009), who study fiscal competition over time in the context of fixed geography. In their model, firms arrive and invest sequentially in a flow, each living for two periods, and cannot relocate, whereas our single firm can move as conditions change. If there is no means of discriminating between firms in tax-setting, a country thus faces a trade-off between imposing a high tax on existing, immobile capital and setting a low tax in order to attract new FDI. Our paper builds on the insight that the sunk nature of FDI implies higher taxes on established than on new investment by allowing our firm to respond to that insight strategically through the possibility of relocation.

Two other papers that are relevant but less closely related to ours are Haaland, Wooton and Faggio (2003) and Besley and Seabright (1999). As in our paper, both models have a time dimension and allow governments to offer FDI subsidies; but, in contrast to our framework, neither allows for firm relocation in the light of changing economic geography. In Haaland *et al.* a single MNE chooses the irreversible location for its plant, which is of uncertain lifespan, in the light of both set-up and closure costs. Besley and Seabright analyse a policy competition model with two host countries and two investing firms. The two firms arrive, receive bids, and make their irreversible location decisions in sequence, and it is shown that this sequential-auction structure can result in inefficient outcomes. For our present purposes, however, a key observation is that neither paper allows for future relocation away from a firm's initially chosen site – a mechanism that is central to our model.

The remainder of the paper is organised as follows. The next section describes our model. Sections 3 and 4 solve the model under *laissez-faire* and fiscal competition, respectively. Section 5 compares those two cases and discusses our main result, and section 6

considers two extensions: commitment in tax-setting and an infinite time horizon. Finally, section 7 concludes.

2. The Model

Our model comprises a region composed of two countries, a single firm, and two periods. The countries, denoted *A* and *B*, constitute a regional market for the firm's product and compete against each other to attract inward FDI from the firm. The region is surrounded by prohibitive trade barriers, such that the firm must produce in either *A* or *B* in order to serve consumers in both countries. The fixed costs of production ensure that the firm will operate only one plant at any point in time, with exports within the region being subject to a (non-prohibitive) trade cost. The national governments seek to maximise the welfare of their residents. We assume that the firm's owners reside outside the region and, therefore, their welfare is not taken into account by either country.

2.1 The time dimension

Our initial analysis assumes two periods, labelled 1 and 2, but we shall eventually extend this to many periods. The countries make competing bids to attract the firm's investment in both periods and the firm may relocate its production between the periods. Our key modelling innovation is that the geography of the region changes over time. Specifically, we assume that the population of country *B* changes from one period to the next, while that of country *A* remains the same. We normalise the population of *A* to one and let m_t denote the size of country *B* in period *t*. We define $\mu_t \equiv m_t - 1$ to be *B*'s "size advantage" in period *t*, acknowledging that μ_t may be positive or negative.[4] The size of *B* might change for a variety of demographic,

[4] At this stage, we do not intend our use of "advantage" in the definition of μ_t to carry any welfare connotations; it is a purely descriptive label.

economic or border-related reasons such as population growth, emigration, immigration, real income growth, territorial expansion, etc.[5]

We assume that inward FDI creates a welfare gain for the host country, relative to the benefits of importing the good from the other country in the region. Let S_L and S_F denote the *per-capita* levels of welfare in a country under "local" production (that is, hosting the FDI) and "foreign" production (that is, importing the product), respectively. Thus, the *per-capita* welfare gain from local production is $V \equiv S_L - S_F$, where we assume that $V > 0$. The fact that local production offers an aggregate welfare gain to the host country (equal to V for A in each period and $m_t V$ for B in period t) is the central motivation for the countries' willingness to bid for inward FDI. We define $\mu_t V$ as B's "welfare advantage" in period t; that is, the additional benefit that country B derives from inward FDI.[6]

The firm earns *per-capita* variable profits of π_L on local sales and π_F on foreign (export) sales, where $\omega \equiv \pi_L - \pi_F > 0$ due to the intra-regional trade cost. Thus, ω measures the profit premium from local sales.[7] Therefore, the firm's total variable profits in period t are $\pi_L + m_t \pi_F$ if production is located in A, and $\pi_F + m_t \pi_L$ if production is located in B. We define $\mu_t \omega$ to be B's "geographical advantage" in period t, that is, the variable-profit premium that B offers the firm relative to what the firm would get from locating in A.

Building a plant in either country entails a sunk, capital cost of F for the firm. We assume for simplicity that, once a plant has been established, its capital does not depreciate over time.[8] We further assume that there is a per-period, fixed cost C of operating a plant and

[5] There are several real-world examples of discrete changes in market size, such as the unification of Germany and the eastern enlargement of the EU.

[6] There are many reasons for governments to prefer local production over importing goods. Haufler and Wooton (1999) explicitly model this as the consumer surplus gain from the lower market price of local goods compared to that of an imported good. The benefits may, however, arise from a wage premium for domestic workers from inward FDI, or production externalities, etc. All we need for our analysis is that governments value FDI over imports.

[7] Our assumptions that V and ω are both positive require that variable production costs are sufficiently similar in A and B.

[8] We briefly consider the effects of allowing for depreciation, which are intuitive, in section 3.2 below.

that this cost is sufficiently large that the firm will only ever operate one plant, even if it has built more than one.[9]

Finally, $\delta \in [0,1]$ is the discount factor, common to both host countries and the firm. If $\delta = 1$ then equal weights are placed on the payoffs in the two periods, whereas $\delta = 0$ means complete myopia.

2.2 Solution strategy

The periods are separated by changes in *B*'s size advantage. In each period the firm chooses the location of its plant and its production level. In the case of *laissez-faire* (denoted LF), where the governments make no direct attempts to influence the firm's choice of location, the prime influence on the firm will be the geographical advantage enjoyed by *B* and how this evolves from one period to the next. Under fiscal competition (denoted FC), the countries compete for the FDI in two auctions that are conducted sequentially. Table 1 summarises the sequence of moves in the two cases.

TABLE 1 ABOUT HERE

We assume that both countries and the firm aim to maximise the present discounted value (PDV) of their payoffs (social welfare and post-tax profits, respectively). For the potential hosts, social welfare is captured by *V* at the *per-capita* level less any net transfers to the firm. We assume that the host countries announce their offers simultaneously in each period and that these offers are irreversible within a period but can, of course, be changed between periods.[10]

Our game is one of complete information, and we assume that the change in the economic geography between periods 1 and 2 is anticipated, though we do consider the

[9] This cost *C* plays a background role in our model, in that it exists only to generate sufficiently large increasing returns to scale in production, and it plays no role otherwise.

[10] In section 6.1, we consider what happens if the host countries and the firm can make binding commitments at the start of period 1.

consequences of relaxing this assumption when discussing our results. Our solution concept is the subgame-perfect Nash equilibrium in pure strategies and we compare the firm's equilibrium location choices under FC and LF.

3. *Laissez-faire* (LF)

Under LF, the governments refrain from setting taxes or subsidies in either period, and the firm decides its location solely on the basis of profits. The location pattern in this case is the benchmark for our later analysis of fiscal competition.

The firm's equilibrium locations under LF depend upon *B*'s market-size advantage in each period. These locations are depicted in Figure 1 which plots the equilibrium outcomes in (μ_1, μ_2) space. The area labelled *AB* corresponds to the firm adopting the location profile *AB*, defined as choosing to produce in *A* in period 1 and in *B* in period 2. The other zones in the diagram can be interpreted similarly. The boundaries between the location profiles are shown as dashed lines.

FIGURE 1 ABOUT HERE

3.1 Derivation of the firm's equilibrium locations

To interpret Figure 1, we begin by thinking about the firm's location choice in period 2, which depends on *B*'s geographical advantage in that period, $\mu_2\omega$. If the firm produced in *A* in period 1, it will prefer *B* to *A* in period 2 if and only if *B*'s period-2 geographical advantage is sufficiently large to compensate the firm for its relocation costs of building a new plant: $\mu_2\omega > F$. However, if the firm was already in *B* in period 1, relocation to *A* would only be profitable if *B*'s geographical advantage declined such that $\mu_2\omega < -F$. These two inequalities determine the positions of the two horizontal inter-regional boundaries in Figure 1. We note that the firm is "more likely" to choose *B* in period 2 if it previously chose *B* in period 1 (i.e. $\mu_2\omega > -F$ is less demanding than $\mu_2\omega > F$) because continuing to produce in *B* requires no

further sunk-cost outlay (whereas moving to *B* from *A* does). Indeed, the firm might optimally remain in *B* in period 2 even if *B* loses its geographical advantage (that is, $\omega\mu_2 < 0$). Moreover, it is clear that *B* will always, regardless of the firm's location in period 1, be chosen in period 2 if its geographical advantage is sufficiently large (specifically, if $\mu_2 > F/\omega$).[11]

On the basis of the above discussion, in order to determine the firm's location profile over time, there are three cases to consider.

Case 1. $\mu_2\omega > F$. Here, the firm always chooses *B* in period 2, and thus its overall location profile is either *AB* or *BB*. *BB* is chosen if and only if $\mu_1\omega > -\delta F$; that is, as long as *B* does not have a first-period geographical disadvantage that is sufficiently large to justify initial production in *A* with subsequent relocation costs.

Case 2. $\mu_2\omega < -F$. This is the converse of Case 1 (above), where *B*'s period-2 geographical advantage is sufficiently negative (i.e., a geographical disadvantage) that *A* always hosts the production in period 2. Overall, *BA* is chosen over *AA* if and only if $\mu_1\omega > \delta F$; that is, if *B*'s first-period geographical advantage is sufficient to offset the relocation cost.

Case 3. $F > \mu_2\omega > -F$. This is the intermediate case where, in period 2, *B*'s geographical advantage is such that the firm optimally chooses to remain wherever it produced in period 1. Here, *BB* dominates *AA* if and only if $\mu_1 > -\delta\mu_2$; which arises when *B*'s initial size advantage is sufficient to offset its future, discounted size disadvantage. This inequality then defines the negatively sloped boundary between *AA* and *BB* in Figure 1.

3.2 Discussion

The pattern in Figure 1 makes intuitive sense. If *B* is at a size disadvantage in both periods (the lower-left quadrant), then the firm chooses *AA*. Conversely, if country *B* is larger than *A* in both

[11] Similarly, *A* is always chosen in period 2 if $\mu_2 < -F/\omega$.

periods (the upper-right quadrant), then the firm chooses *BB*. A rise in *B*'s size advantage over *A* in period *t* makes *B* more likely to be chosen as the location of production in that period. If *B*'s size is constant over time (so that $\mu_2 = \mu_1$), then the firm remains in its initial location for both periods, choosing whichever country is larger. Thus, relocation, which occurs in the location profiles *AB* and *BA*, requires some change in the relative market-size of country *B* over time.[12]

Finally, we note two extensions of our analysis, which are both straightforward within the context of Figure 1.[13]

First, we can consider the impact of a shock in the form of an unanticipated change in geographical advantage. Suppose that the firm expects period-1's existing geographical advantage to persist into the future. In such a situation, any actual geographical change between periods 1 and 2 will be unanticipated and the borders of both of the relocation zones, *AB* and *BA*, will shift sideways to meet the vertical axis. Thus, if the firm assumes $\mu_2 = \mu_1$ in deciding its period-1 location, it will choose *B* initially if and only if $\mu_1 > 0$. Thus, the *AB*/*BB*, *AA*/*BB* and *AA*/*BA* inter-regional boundaries all become the vertical line $\mu_1 = 0$.[14] Consequently, relocation by the firm between periods 1 and 2 will occur for a wider range of changes in geographical advantage if this geographical change is unanticipated. This makes intuitive sense. Suppose, for example, that $\mu_2 >> 0 > \mu_1$. A firm that believes that *A*'s initial geographical advantage will persist will choose to locate in *A*, expecting to remain there. In response to *B*'s large geographical advantage in period 2, the firm may choose to relocate. Had the firm been able to anticipate that *B* would become the much more attractive host, the firm might have chosen to save on the costs of relocation by investing initially and permanently in *B*. The

[12] If the intra-regional trade cost falls, which reduces ω, then relocation over time becomes less likely, which is intuitive: both *AB* and *BA* shrink.

[13] The following observations hold good in the FC case, which we consider in the next section.

[14] However, the vertical positions of the flat *AB*/*AA* and *BA*/*BB* inter-regional boundaries do not change because when period 2 arrives, the new geography is revealed and the firm's period-2 decision problem is then identical to that under anticipated geographical change.

preceding discussion of unanticipated geographical change reveals that the assumption has implications identical to those of assuming complete myopia (that is, $\delta = 0$).

Second, suppose that the plant cost F is *fixed* rather than *sunk*, such that F must be paid in both periods even if production remains in the same location. In this situation, the firm optimally chooses B in period t if and only if $\mu_t > 0$. One can see this by setting $F = 0$.[15] Each of the four regions in Figure 1 would then coincide exactly with one of the quadrants. Thus the absence of a sunk cost creates separability between the periods, such that the firm's location in a given period depends *only* on B's contemporaneous size advantage. In contrast, the presence of a sunk plant cost implies that possessing a size advantage in a given period is neither necessary nor sufficient for winning the firm's plant *in that period*.

4. Fiscal Competition (FC)

Under FC, the potential hosts compete by making offers in both periods to win or retain the firm's production. The firm's equilibrium locations under FC are depicted in Figure 2 with the boundaries shown as solid lines, where the LF boundaries continue to be represented by dashed lines. We consider FC in each period starting with period 2.

FIGURE 2 ABOUT HERE

4.1 FC in period 2

If A has attracted the FDI in period 1, then B wins the period-2 competition if and only if $\mu_2(V + \omega) > F$. This inequality ensures that the firm's post-tax profits in period 2 are higher in B when both countries offer their maximum bids (i.e. subsidies equal to their valuations).[16] It can be decomposed into three terms. B's welfare advantage over A in period 2 is $\mu_2 V$; $\mu_2\omega$ is B's geographical advantage in period 2; and F reflects the fact that production in B in period 2

[15] Of course, one can think of this fixed-cost case as representing complete capital depreciation between periods.
[16] Thus, $m_2V + m_2\pi_L + \pi_F - F > V + \pi_L + m_2\pi_F$ simplifies to $\mu_2(V + \omega) > F$.

requires new investment, whereas continuing to produce in A does not. In this situation, B's winning tax offer in period 2 is given by $\tau_B^C = \mu_2\omega - (F + V)$, where the superscript C stands for "capture". In other words, τ_B^C is B's equilibrium tax that induces relocation from A in period 2. Essentially, B can extract its geographical advantage from the firm through the tax, but must offset this against F and V, the cost of relocating the FDI to B and the value of A's subsidy offer, respectively.

If, however, B won the firm's plant in period 1, then it will retain the FDI by winning the period-2 competition if and only if $\mu_2(V + \omega) > -F$.[17] In this inequality, the negative F term reflects the fact that continuing to produce in B in period 2 requires no new investment whereas relocation does. Thus, because of its pre-existing plant, B might retain the FDI even if its combined welfare and geographical advantages are negative. B's winning tax offer in period 2 is given by $\tau_B^R = \mu_2\omega + F - V$, where the superscript R stands for "retain". Thus τ_B^R is B's equilibrium tax that retains the firm in period 2. It is increasing in F because B gains leverage in the period-2 competition from having a pre-existing plant (while A does not).

Note that $\tau_B^R - \tau_B^C = 2F > 0$. In equilibrium, country B imposes a higher tax in period 2 to retain the firm than to capture it. This is due to the existence of the sunk investment in plant in period 1. Indeed, if $F = 0$, such that there were no *sunk* cost associated with starting production in a given location, then $\tau_B^R = \tau_B^C$ and the outcome of the competition in period 2 would be independent of the location of production in period 1.

4.2 FC in period 1

As with LF, there are three cases to consider.

Case 1. $\mu_2(V + \omega) > F$. In this situation, B always wins the period-2 competition, regardless of the winner in period 1, and thus the firm's overall location profile is either AB or BB. Country B will win the period-1 competition if the PDV of the firm's post-tax profits

[17] By analogy with the previous footnote, $\mu_2(V + \omega) > -F$ is equivalent to $m_2V + m_2\pi_L + \pi_F > V + \pi_L + m_2\pi_F - F$.

is higher in B than in A in period 1, when both countries offer their maximum bids. The period-1 valuations of countries A and B are V and $m_1V + \delta(\tau_B{}^R - \tau_B{}^C)$, respectively, where the tax-difference term in B's valuation reflects the fact that, in period 2, B earns more tax revenue from the firm if it previously won the FDI in period 1. The firm is forward-looking (as are the countries) and realises that its period-2 tax will be higher by $(\tau_B{}^R - \tau_B{}^C)$ if it chooses B initially. Consequently, if we consider the firm's period-1 location decision when the countries post their valuations (as we do in order to derive the equilibrium), then the tax-difference term, $\delta(\tau_B{}^R - \tau_B{}^C)$, washes out; it is effectively rebated to the firm through B's maximum offer in period 1. Therefore, B wins the period-1 competition if and only if $\mu_1(V + \omega) > -\delta F$; that is, as long as country B's combined welfare and geographical disadvantages in period 1 are not so large as to justify the extra cost of relocation from A to B. Moreover, if this inequality holds, then (as we show in section 4.3 below) having the firm locate in B in both periods generates greater world welfare than if the firm were initially to choose A and then relocated to B.

Case 2. $\mu_2(V + \omega) < -F$. This is analogous to Case 1, except that A always wins the production in period 2. Reworking the previous analysis, we can show that B wins the period-1 competition if and only if $\mu_1(V + \omega) > \delta F$, which is also the condition for the PDV of world welfare to be greater in BA than in AA. In this case, B requires sufficient period-1 welfare and geographical advantages to offset the cost of relocation.

Case 3. $F > \mu_2(V + \omega) > -F$. This is the intermediate case where, in period 2, B's size is such that the period-1 winner (whether A or B) retains the firm. Thus, the firm's overall

location profile is either *AA* or *BB*. *B* wins the period-1 competition if and only if $\mu_1 > -\delta\mu_2$, as in Case 3 of LF.[18]

4.3 Discussion

The most striking feature of Figure 2 is that it is qualitatively identical to Figure 1, the LF case. (Recall that the dashed lines in Figure 2 are the inter-regional boundaries from Figure 1.) Therefore, our observations regarding the outcomes in LF (in sub-section 3.2) carry over to the FC case.[19] It is clear in Figure 2 that *AB* and *BA*, the areas where relocation occurs between periods 1 and 2, are both bigger under FC than in LF. Thus, relocation by the firm between the two periods is "more likely" under FC. This is our central result, which we discuss further in the next section.

If the plant cost *F* were a per-period fixed cost rather than a sunk cost, then our model would follow Haufler and Wooton (1999) in finding that, in any period, the larger country within a region always wins the FDI, under both LF and FC. In contrast, with repeated periods and a sunk plant investment that persists over time, we have shown that the smaller country might win the production for a period, under both LF and FC.

Furthermore, the equilibrium location profile over time under FC is efficient, in the sense that it coincides with the choices that would be made by a social planner who decides the firm's period-1 and period-2 locations to maximise the PDV of world welfare. This extends the well-known efficiency result from the one-shot FC game to the two-period case. To see this result, consider, for example, the upper-left quadrant in Figure 2. Unsurprisingly, world welfare is higher there under *AB* than *BA* because, in the former profile, the firm produces in the larger country in each period. Moreover, from a welfare perspective, *BB* dominates *AA* if and only if

[18] In period 1, country *B* appreciates that it will either win the firm in both periods or not at all, and thus its valuation is $m_1V + \delta(m_2V + \tau_B^R)$. As in Case 1, when we consider *B*'s maximum period-1 take-home offer to the firm, the period-2 tax term, $\delta\tau_B^R$, washes out of the PDV of post-tax profits in *B* in period 1.

[19] Note that if the geographical change is *unanticipated*, then relocation remains "more likely" under FC than under LF, but this arises solely because the conditions on μ_2 for relocation to occur are weaker under FC.

$\mu_1 + \delta\mu_2 > 0$, which sets the PDV of *B*'s size advantage to be positive and generates the downward-sloping *AA*/*BB* border in the figure. Above this border, within the upper-left quadrant, the efficient outcome is thus either *AB* or *BB*. *BB* dominates *AB* if and only if $\mu_1(V + \omega) > -\delta F$, where the LHS gives *B*'s combined welfare and geographical advantages in period 1 while $-\delta F$ reflects the saving in discounted plant costs through avoiding relocation.

We can use our analysis to investigate the time profile of equilibrium taxes/subsidies paid. For simplicity, let us assume that *B* possesses a market-size advantage throughout, such that $\mu_1, \mu_2 > 0$. As a consequence, the equilibrium under FC is *BB* in Figure 2. *B*'s equilibrium tax in period 2 is given by $\tau_B^R = \mu_2\omega + F - V$, as shown above. *B*'s equilibrium tax in period 1 is found to be $\tau_{B1} = \mu_1\omega - \delta F - V$.[20] Taking the difference, we find the time profile of *B*'s equilibrium tax, $\Delta\tau_B \equiv \tau_B^R - \tau_{B1} = (\mu_2 - \mu_1)\omega + (1 + \delta)F$. The increase in tax between periods reflects both any rise in *B*'s geographical advantage as well as the opportunity of *B*, in period 2, to exploit the fact that the firm has already sunk investment in a local plant.[21]

5. Comparison between LF and FC

Our central result is that, compared to LF, there is greater observed plant mobility in equilibrium between periods 1 and 2 under FC. This may, perhaps, appear counter-intuitive. To explore this result and provide the missing intuition, we focus on the case where μ_2 is sufficiently large that the firm's period-2 location is always *B*.[22] In period 1, the firm can anticipate perfectly the FC taxes that it will pay in *B* in period 2, either τ_B^R or τ_B^C. Therefore, for given offers in period 1, the gain in its discounted profit from choosing *A* rather than *B* in

[20] This comes from solving $\pi_L + m_1\pi_F - \delta(F + \tau_B^C) + V = m_1\pi_L + \pi_F - \delta\tau_B^R - \tau_{B1}$, which holds in equilibrium in period 1.

[21] The tax increase in *B* over time is larger, the more the players value the future. Specifically, τ_{B1} falls as more weight is placed on the future and δ rises. In this case, the forward-looking firm is effectively trading its second-period tax payment, once its FDI is sunk, for a reduced initial tax burden.

[22] i.e. $\mu_2 > F/(V + \omega)$.

that period is $\delta(\tau_B^R - \tau_B^C) - \omega\mu_1 - \delta F$, where $\tau_B^R - \tau_B^C = 2F > 0$.[23] The firm will be aware that, by choosing *A* in period 1, it can reduce the tax that it will pay *B* in period 2 compared to what it would have to pay had it chosen *B* as its initial location. (Effectively, the firm can manipulate its tax burden in period 2 through its choice of location in period 1.) In essence, with endogenously determined fiscal inducements, the taxpayers in *B* absorb some of the firm's relocation cost through their government's tax/subsidy offers. In LF, the firm cannot avail itself of this opportunity (as no taxes or subsidies are offered) and, consequently, the firm is more willing to relocate under FC than it would be under LF.

An alternative interpretation of our result compares the private and social incentives to choose a location in period 1 that avoids subsequent relocation, bearing in mind that private incentives drive the firm under LF and that the equilibrium location pattern over time under FC is efficient. Assume again that the firm will end up in *B* in period 2. If $\mu_1 > 0$, the firm should initially locate in *B* and stay there, so the non-trivial case is where $\mu_1 < 0$. By choosing *B* over *A* in period 1, the firm suffers from *B*'s period-1 geographical disadvantage of $-\omega\mu_1$ but avoids the future cost δF of having to build a second plant in *B* in period 2. Therefore, under LF, choosing *B* over *A* in period 1 is *privately* profitable if and only if $\delta F > -\omega\mu_1$. On the other hand, choosing *B* over *A* in period 1 is *socially* beneficial if and only if $\delta F > -(V + \omega)\mu_1$. In contrast to the previous inequality, this includes $-V\mu_1$, *B*'s period-1 welfare disadvantage.

As $-(V + \omega)\mu_1 > -\omega\mu_1 > 0$, the social condition for the firm to stay in one location is more demanding than the private condition. Consequently, whenever it is socially beneficial to avoid relocation through the choice of *B* in period 1, it will also be the privately more-profitable choice under LF. However, it might be privately more profitable to avoid relocation when

[23] By moving from *B* to *A* in period 1, the firm foregoes *B*'s period-1 geographical advantage (hence $-\omega\mu_1$), and it will also have to build a second plant (in *B*) in period 2 (hence $-\delta F$). In the absence of taxes, the firm therefore prefers *A* to *B* in period 1 if $\mu_1 < -\delta F/\omega$, the vertical *AB/BB* boundary in Figure 1.

doing so is socially detrimental. This means that there can be "too little" relocation from an efficiency point of view under LF.[24]

6. Extensions to the analysis

We now consider the implications of two of our modelling assumptions: commitment (or the lack of it); and having only two periods.

6.1 Commitment

Consider what would happen if we assumed (credible) binding commitments in both tax/subsidy-setting and location choice.[25] Suppose that, at the beginning of period 1, the firm commits to remain in whichever country it initially chooses, and each country commits, in present-value terms, to a lifetime tax/subsidy total. This occurs even though it would be in the winning country's interests to change its offer once the firm has incurred its sunk investment cost.[26]

Essentially, the assumption of binding commitments returns our two-period analysis of competition to a simpler, one-shot case. The valuations of countries A and B are $(1 + \delta)V$ and $(m_1 + \delta m_2)V$, respectively. The PDV of the firm's pre-tax profits is $(1 + \delta)\pi_L + (m_1 + \delta m_2)\pi_F - F$ in A and $(1 + \delta)\pi_F + (m_1 + \delta m_2)\pi_L - F$ in B. Maintaining our assumption that $V + \omega > 0$, it follows that B wins the firm for both periods if and only if $\delta\mu_2 > -\mu_1$. Therefore, with binding commitments, the boundary between A's winning region and that of B is given by the downward-sloping inter-regional boundary between AA and BB in Figures 1 and 2.[27]

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[24] Note, however, that the private and social preferences between AA and BB, neither of which involve relocation over time, coincide: The AA/BB boundary is the same in Figures 1 and 2.

[25] Our definition of "commitment" follows King and Welling (1992, p. 65).

[26] A host country could commit to future subsidy payments through the *form* of the subsidy such as, for example, the initial provision of (relatively irreversible) public infrastructure or through through a binding financial agreement.

[27] Note that because the no-commitment equilibrium under FC is efficient, there will be scope for welfare-enhancing renegotiations whenever the binding-commitment and no-commitment equilibria diverge (i.e. whenever the latter involves relocation between periods).

6.2 More periods

How limiting is our assumption of having two periods? With only two periods, relocation either coincides with the change in economic geography or the firm does not move. If we had more periods, then a richer sequencing of moves would be possible.

Our analysis could be extended to a multi-period, infinite horizon model in which *B*'s geographical advantage builds over time. In such a setting under LF, the firm has to decide not just whether it should relocate production to *B*, presuming that it is initially operating in *A*, but also when this should occur. The firm has an incentive to delay its new FDI as late as possible, in order to put off the outlay of *F* for as long as possible, but this incentive is tempered by the attraction of moving to the larger market.

Suppose that we consider an environment where the firm has been based in *A* but this country's growth is outpaced by that of rival *B*. Thus at the starting point of our multi-period analysis, *B* now has the larger market ($\mu_0 \geq 0$) and this geographical advantage will continue to grow over time. At some point, the firm will choose to relocate its production to *B* and we wish to know whether this jump will take place earlier or later when governments compete to attract the firm under FC than the time chosen by the firm when privately maximising the present value of its profits under LF.

Under LF, the firm will seek to maximise Π_{LF}, the PDV of its stream of profits, by choosing the time s_{LF} at which it should relocate its production from *A* to *B*. This can be written as:

$$\Pi_{LF} = \max_{s_{LF}} \left\{ \frac{\pi_L + \pi_F}{1-\delta} + \left[\sum_{t=0}^{s_{LF}-1} \delta^t \mu_t \pi_F + \sum_{t=s_{LF}}^{\infty} \delta^t \mu_t \pi_L \right] - \delta^{s_{LF}} F \right\}.$$

The expression balances the benefits to the firm of moving to the larger country early in order to take advantage of the higher profits resulting from serving more consumers directly, as

opposed to through exports, against deferring the cost of investing in a new plant as long as possible.

The outcome under FC will be more complex. The equilibrium offers once the firm has relocated to *B* are straightforward to calculate but the national offers prior to the move are harder to work out, as they will depend upon expectations as to when the firm will move. Rather than make these calculations, we take advantage of the equivalence result that we obtained in the 2-period case that the efficient (welfare-maximising) location choice coincided with the FC outcome. We conjecture that the FC outcome will continue to be more efficient than that under LF when the analysis is extended to a longer time horizon. Thus, we can infer from the timing of the welfare-maximising relocation, whether FC accelerates relocation or retards it.

The optimal timing of relocation with respect to overall welfare is s_W, the value of s that maximises W_W, the PDV of the stream of benefits arising from the FDI. This can be written as:

$$W_W = \max_{s_W} \left\{ \frac{\pi_L + \pi_F + V}{1-\delta} + \left[\sum_{t=0}^{s_W - 1} \delta^t \mu_t \pi_F + \sum_{t=s_W}^{\infty} \delta^t \mu_t \left(\pi_L + V \right) \right] - \delta^{s_W} F \right\}.$$

Clearly, more weight is now placed upon the periods after the jump, such that $s_W < s_{LF}$. Thus relocation occurs earlier under FC than under LF. Moreover, even if tax competition repeated over infinitely many time periods does not generate a fully welfare-maximising outcome, our presumption that FC is more efficient than LF means that the firm will be induced to relocate its production earlier under FC than it would have chosen to do under LF.

7. Conclusions

It is well established that the tax burden on immobile inputs into production tends to be higher than that on footloose factors. This is reflected in, for example, new inward investment typically receiving more favourable tax treatment than sunk FDI. The MNE in King *et al.* (1992, 1993) responds to this by trading its anticipated future tax payments to its host government in exchange for initial subsidies from that government while its FDI is still mobile.

Our paper complements King *et al*. by focussing on how the MNE strategically responds to the differential tax treatment of new *versus* established investment, through its choice of whether and when to relocate between host countries.

Our modelling framework contains geographical change over multiple time periods and the possibility that host governments might repeatedly bid to attract/retain the MNE's FDI. Our central result is that plant relocation over time is more likely to occur when governments compete to attract FDI as the taxpayers in the host nation effectively bear some of the fixed cost of relocation.

We also confirmed that a key feature of our model, geographical change over time, is *necessary* to explain plant relocation. This central result appears to be consistent with popular and media concerns (e.g. *Financial Times*, 2010) that the availability of public subsidies facilitates international plant relocation. However, from an efficiency point of view, our analysis should not be taken to imply that there is excessive plant mobility under fiscal competition, but rather that there is too little plant mobility under *laissez-faire*. Thus, once again, popular concerns about the outcomes of international subsidy competitions for large FDI projects are properly interpreted as concerns about distribution rather than efficiency.

Our result on the relative likelihood of relocation under fiscal competition contradicted our initial intuition which suggested that there would be *less* observed plant mobility over time under fiscal competition as compared to *laissez-faire*. Instead, with endogenously determined fiscal inducements, international relocation between periods is less costly for the MNE. As a result, international competition for FDI may make the MNE more willing to move over time. We extend our model to show that this fundamental intuition survives in the infinite-horizon case, where tax competition induces firm relocation sooner than in its absence.

There are several ways in which our analysis could be extended. For example, we could ask what might happen if the MNE could endogenously influence its relocation cost? By

adopting a plant technology that intensively uses local factor inputs (e.g. workers), the MNE could potentially reduce its production cost in a particular location. This might make subsequent relocation more costly, as compared to the case where the MNE chooses a more "generic" technology. Further research could determine how the MNE might choose to manage this trade-off between the cost of production and the cost of relocation. Alternatively, we might extend the model to include additional mobile firms, arriving either sequentially or simultaneously at the start of the first period. The efficiency properties of such a multi-firm extension to our fiscal competition model would be of particular interest.

8. References

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	Investment Environment	
	LF	**FC**
Period 1	Firm chooses its location, invests, produces and sells.	*A* and *B* announce offers to attract the FDI.
		Firm chooses its location, invests, produces and sells.
		Tax/subsidy paid to/by the winning country.
	Geographical advantage may change.	
Period 2	Firm chooses whether to relocate, produces and sells.	*A* and *B* announce *revised* offers to attract/retain the FDI.
		Firm chooses whether to relocate, produces and sells.
		Tax/subsidy paid to/by the winning country.

Table 1. Sequence of moves

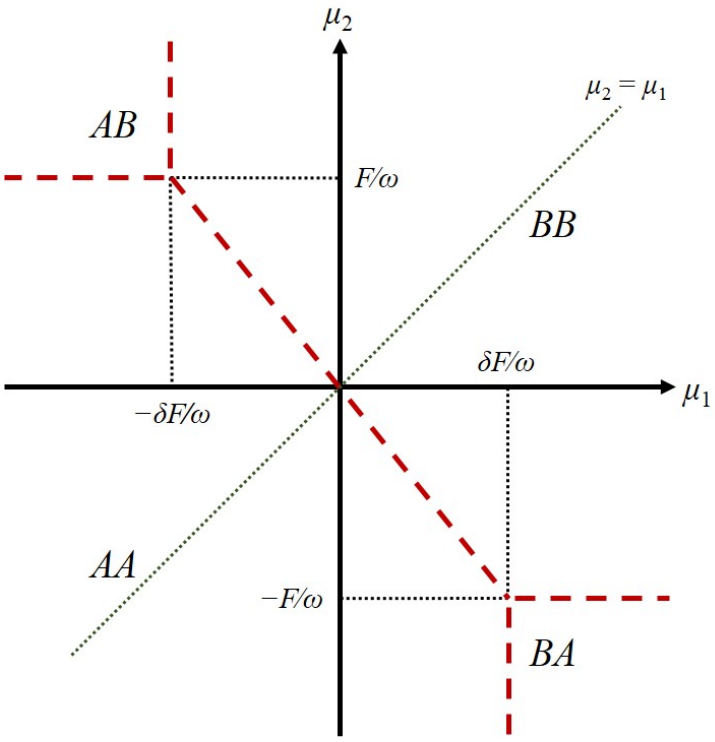

Figure 1. Equilibrium locations under LF

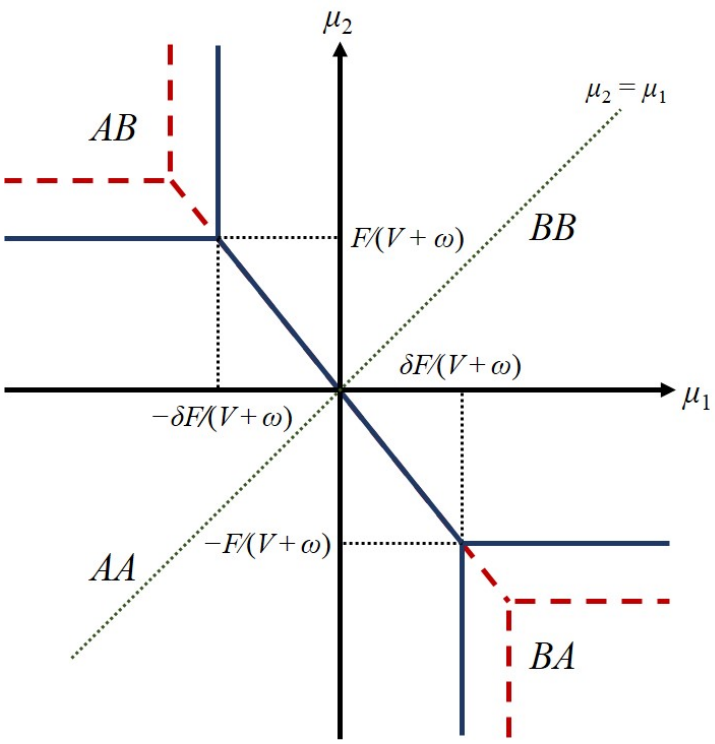

Figure 2.Equilibrium locations under FC