Fiscal Competition for FDI with Knowledge Spillovers and Trade Costs

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Abstract

We develop a model of fiscal competition for foreign direct investment and show that the decision of multinational firms to locate in the proximity of indigenous firms – which can be thought of as agglomeration – may be the result of the provision of government incentives that aim to capitalise on the potential for knowledge spillovers to indigenous industry. Somewhat different but complementary to existing literature, we also show that fiscal competition may increase the welfare of both winning and losing countries in the auction for the multinational firm when it leads to the relocation of multinationals away from countries that do not have the potential to benefit from knowledge spillovers to countries that do. As trade costs fall and the potential for knowledge spillovers increases, both outcomes become more likely in equilibrium.

Keywords: FDI, fiscal competition, knowledge spillovers, trade costs, firm location
JEL codes: F23, H25, O33, R12

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1 Introduction

Knowledge spillovers from multinational enterprises (MNEs) to indigenous firms are often thought to be a primary benefit of foreign direct investment (FDI). Consistent with this belief, several empirical studies confirm that, given certain conditions, the presence of foreign firms causes productivity improvements in local firms (see, for example, Barrios and Strobl (2002) for Spain; Wei and Liu (2006) for China; Haskel *et al.* (2007) for the UK; and Keller and Yeaple (2009) for the US). To capitalise on such benefits, governments are often willing to offer fiscal inducements (e.g. favourable tax rates or, at times, even subsidies) to beat the competition of other potential host countries. For example, in 2017, the Slovakian government granted Jaguar Land Rover €125 million of investment aid to beat Mexico in a bid to host the company's new car manufacturing plant. The "transfer of technology to local firms" was among the primary reasons justifying the Slovakian government's subsidy (European Commission, 2017).

Like Slovakia, many governments use investment incentives to capitalise on benefits from inward FDI. In fact, a survey carried out with investment promotion agencies in over 45 countries from all regions of the world showed that nearly all countries offer some form of investment incentives (UNCTAD, 2000). Of course, it is possible that governments offer incentives for reasons other than knowledge spillovers (probably most importantly, the creation of "good" jobs). However, it is not difficult to think of cases where the governments of regions with near full-employment offer subsidies to attract MNEs. For example, in their study of General Motors' decision to locate its Saturn plant in Tennessee, Bartik *et al.* (1987) argue that the social efficiency benefits caused by additional labour demand were zero because the county of location did not have particularly high unemployment, such that jobs went to unemployed migrants or displaced workers from other jobs. In such cases, and barring political motives, the rationale for observed investment incentives may well be knowledge spillovers.

Nonetheless, theoretical analysis of fiscal competition for foreign direct investment (FDI) has generally overlooked governments' incentives to capitalise on the potential for knowledge spillovers, and instead emphasized the roles of market size and

structure (see, for example, Haufler and Wooton, 1999; Barros and Cabral, 2000; Bjorvatn and Eckel, 2006). For example, Bjorvatn and Eckel (2006), henceforth BE, study tax/subsidy competition between the governments of two potential host countries of different size in the presence of an immobile indigenous firm in the larger country. By assuming that the profits of the indigenous firm enter its country's welfare function, they show that the government of the country with the indigenous firm is less willing to bid for FDI due to the "market crowding effect" (i.e. the preference of imperfectly competitive firms for locations with relatively few competitors when trade is costly). This result, however, is at odds with empirical cases where governments frequently appear to be keen to attract inward FDI for its perceived *benefits* to indigenous industry.

In an attempt to capture these effects, we build on BE (2006) by incorporating into their model the potential for one-way knowledge spillovers from the MNE to the indigenous firm *if* the two firms are located in the same country. These may occur through several channels (such as "demonstration effects" and reverse-engineering by the indigenous firm; or if workers trained by an MNE move jobs and apply their newly-gained knowledge in an indigenous firm): and our modelling framework is consistent with all of these spillover mechanisms.[1] Assuming (for simplicity) that countries are symmetric in size, we show that in the absence of fiscal competition the MNE chooses to locate in the country without the indigenous firm. This outcome mirrors the symmetric-country-case in BE (2006), which is driven by the market crowding effect, but it is reinforced by the MNE's desire to limit knowledge spillovers to its rival. However, in contrast to the outcome in BE (2006), we show that the MNE's equilibrium location decision *may* change when governments compete in taxes/subsidies because, relative to BE, the potential for knowledge spillovers in our model increases the valuation of the FDI project of the country *with* the indigenous firm and decreases that of the country *without* the indigenous firm. Thus, in the presence of localised knowledge spillovers from inward FDI, the provision of investment incentives in the form of favourable taxes or subsidies may be considered to be an important determinant of agglomeration,

[1]See Saggi (2006) for a detailed discussion of channels through which knowledge spillovers may occur; and Cheung and Lin (2004) and Hale and Long (2006) for supporting empirical evidence.

i.e. the co-location of the MNE and the indigenous firm. We show that as trade costs fall and the potential for knowledge spillovers increases, this agglomeration outcome becomes more likely in equilibrium.

Baldwin and Krugman (2004) also study tax competition for mobile capital in the presence of agglomeration benefits. However, their source of agglomeration benefits, the market linkages of new economic geography, differs from ours, localised knowledge spillovers. In Baldwin and Krugman, agglomeration creates benefits for all mobile capital, which the "core" country is able to capture in tax. In essence, the Baldwin/Krugman model appears equivalent to one of two-way knowledge spillovers, such that the incoming MNE can be taxed. In contrast, the knowledge spillover is one-way (from the MNE to the indigenous firm) in our model, such that a subsidy is needed to attract the MNE. On the basis of this comparison, one may conjecture that the direction of knowledge spillovers is important for whether the MNE is subsidised or taxed in equilibrium.

Our study is also related to Fumagalli (2003) whose setup involves two countries of equal size, each of which contains an indigenous firm. The two indigenous firms have different levels of technology (reflected in different marginal costs), and thus the potential for knowledge spillovers differs between the two host countries. Similar to the model presented in this paper, inward FDI generates a positive externality in the form of knowledge spillovers to the indigenous firm located in the same country but, unlike us, Fumagalli does not allow for a trade cost between the two host countries. Her setup yields a result that is similar to one derived from our model: in contrast to laissez-faire, fiscal competition makes it possible that the MNE will locate in the country where knowledge spillovers are maximised. However, we show that this possibility recedes as trade costs rise because, in our model, agglomeration becomes less attractive as national product markets become more protected.[2] Thus, our setup makes it possible to explore the tension created by the opposing effects that knowledge spillovers and trade costs have on country valuations and the consequent location decision of the MNE.

[2]Note that, in contrast to us, Fumagalli's framework is unsuited to examining the agglomeration/non-agglomeration distinction because *both* host countries contain an indigenous firm in her model.

Furthermore, our simultaneous consideration of knowledge spillovers and trade costs, which distinguishes our analysis from both Bjorvatn and Eckel (2006) and Fumagalli (2003), calls for a reassessment of the welfare impacts of fiscal competition. The established result that tax/subsidy competition in the form of an auction for a single firm maximises overall world welfare continues to hold. But, in addition, we derive two new welfare findings. Focusing first on welfare at the regional level (here defined as the welfare sum of the two countries), BE show that fiscal competition increases regional welfare only when trade costs are high. In contrast, we show that by introducing knowledge spillovers into the model, it is possible that fiscal competition improves regional welfare even at relatively low trade costs. Second, turning to the welfare of individual countries, Fumagalli shows that if *both* countries have the potential to benefit from knowledge spillovers from the MNE to indigenous industry, one country (the winner of the FDI under laissez-faire) is necessarily worse off under fiscal competition. In contrast, we show that in a model where only one country has the potential to benefit from knowledge spillovers (e.g. due to differing specialisations of indigenous industries or because "absorptive capacity" is significantly lower in a developing country), both countries may be better off under fiscal competition.

Summing up, we contribute to the existing literature on fiscal competition for FDI by showing how trade costs and knowledge-spillover benefits interact with fiscal policy to determine multinationals' location decisions and the associated welfare outcomes. The remainder of this paper is organised as follows: section 2 describes the model under "laissez-faire" and "fiscal competition"; section 3 discusses welfare issues; and section 4 concludes by discussing a number of policy-relevant results.

2 A Model of Fiscal Competition for FDI

Consider a model with a region consisting of two countries, A and B, which are symmetric in size.[3] Country A hosts the only indigenous and immobile firm in

[3]We abstract from market size issues because these have already been extensively explored in both theoretical and empirical literature (see, for example, Haufler and Wooton, 1999; Bjor-

the region and there also exists an MNE that wishes to invest in one of the two countries to serve regional demand. The indigenous firm in country A is entirely owned within that country, whereas the MNE is entirely owned outside the host region. Each firm can export within the region at a per unit trade cost t in either direction. However, the trade costs associated with serving the region through exports from outside the region are assumed to be prohibitively high so that access to regional consumers requires FDI. Setting up in one of the two countries involves a fixed investment cost, F, which is assumed to be the same in both countries. F is sufficiently high to ensure that the MNE does not split its production between the two countries by establishing a plant in each.

The MNE produces a good identical to that of the indigenous firm but the two firms' marginal costs of production are assumed to be different. The indigenous firm is less efficient than the MNE such that its marginal cost $c \in [0, 1]$ is greater than that of the MNE which is equal to zero.[4] However, if the MNE locates in country A, the indigenous firm benefits from a localised one-way knowledge spillover by gaining partial or even total access to the MNE's technology so that its marginal cost is reduced by ϕc to $(1 - \phi) c$, where $\phi \in [0, 1]$.[5] When $\phi = 1$ the knowledge spillover is the strongest possible and the indigenous firm becomes as efficient as the MNE.

After the MNE chooses in which country to invest, the firms play separate Cournot games in each product market. Both firms are assumed to sell in both markets, such that Cournot equilibria are always interior.[6] The inverse demand function

vatn and Eckel, 2006). Moreover, the assumption of equal sizes gives us a clean laissez-faire benchmark: see Proposition 1.

[4]Setting the MNE's marginal cost equal to zero simplifies the notation significantly as it enables us to express the post-knowledge spillover marginal cost of the indigenous firm independently of the MNE's marginal costs.

[5]This has two implications that are generally supported by empirical evidence. First, knowledge spillovers are *one-way* because MNEs are significantly more productive than exporting and non-exporting firms (see, for example, Helpman *et al.*, 2004). Second, and also supported by empirical evidence, is the assumption that proximity is an important determinant for knowledge spillovers (see, for example, Jaffe *et al.,* 1993; Girma and Wakelin, 2007).

[6]If the MNE invests in A, the two firms' marginal costs are $(0, (1 - \phi) c)$ on market A and $(t, (1 - \phi) c + t)$ on market B. Alternatively, if the MNE invests in B, the two firms' marginal costs are (t, c) on market A and $(0, c + t)$ on market B. We can move from the final marginal-cost pair to any of the other three by increasing the MNE's marginal cost and cutting the indigenous

for the good in each country is given by $P_i = 1 - Q_i$, where Q_i and P_i are the quantity demanded and price in country i. The MNE's problem is to decide in which country to locate to serve regional demand.

2.1 Laissez-Faire Scenario

Initially, we assume a laissez-faire scenario where there is no fiscal competition such that government intervention cannot influence the MNE's investment location. In this case, the MNE chooses its location solely on the basis of pre-tax profits, and the game involves two stages:

- in stage 1, the MNE decides where to locate; and
- in stage 2, the MNE and the indigenous firm compete *à la* Cournot to serve regional demand.

The MNE maximises its profits, and the game is solved by backward induction to isolate its subgame perfect Nash equilibrium (we focus on pure strategies throughout).

The derivation of the equilibrium outcome(s) is presented in Table 1. Let Γ, which we term country B's "geographic advantage", measure the additional pre-tax profits that the MNE earns if it locates in country B rather than country A:

$$\begin{aligned}\Gamma &= \underbrace{\left[\frac{1}{9}\left(1+c-2t\right)^2+\frac{1}{9}\left(1+c+t\right)^2\right]}_{\text{MNE's profits if it locates in B}} \\ &\quad - \underbrace{\left[\frac{1}{9}\left(1+(1-\phi)c\right)^2+\frac{1}{9}\left(1+(1-\phi)c-t\right)^2\right]}_{\text{MNE's profits if it locates in A}} \qquad (1) \\ &= \frac{2}{9}\left(2t^2+\phi c^2\left(2-\phi\right)+\phi c\left(2-t\right)\right)\end{aligned}$$

firm's. Therefore, if the fourth Cournot equilibrium (on market B when the MNE chooses B) is interior, then the other three will be too; and the condition for this is $c + t < 0.5$, which we assume to hold throughout.

Table 1: Equilibrium outcome(s) by MNE's location choice

	MNE locates in A	MNE locates in B
Output of MNE in market A	$\frac{1}{3}(1+(1-\phi)c)$	$\frac{1}{3}(1+c-2t)$
Output of MNE in market B	$\frac{1}{3}(1+(1-\phi)c-t)$	$\frac{1}{3}(1+c+t)$
Output of indigenous firm in market A	$\frac{1}{3}(1-2(1-\phi)c)$	$\frac{1}{3}(1-2c+t)$
Output of indigenous firm in market B	$\frac{1}{3}(1-(1-\phi)c-t)$	$\frac{1}{3}(1-2c-2t)$
Price in market A	$\frac{1}{3}(1+(1-\phi)c)$	$\frac{1}{3}(1+c+t)$
Price in market B	$\frac{1}{3}(1+(1-\phi)c+2t)$	$\frac{1}{3}(1+c+t)$
Consumer surplus in market A	$\frac{1}{18}(2-(1-\phi)c)^2$	$\frac{1}{18}(2-c-t)^2$
Consumer surplus in market B	$\frac{1}{18}(2-(1-\phi)c-2t)^2$	$\frac{1}{18}(2-c-t)^2$

Note: the profits earned by the MNE and the indigenous firm in each market are the squares of the respective firm's output in that market (as is standard in linear Cournot models).

Proposition 1: In the absence of fiscal competition, the MNE always locates in country B, at a distance from the indigenous firm.

Proof: From equation (1), it is clear that at $c=0$, $\Gamma=\frac{4}{9}t^2\geq 0$. Moreover, $\frac{d\Gamma}{dc}>0$ for all $c\geq 0$. □

This outcome is the result of two forces, which reinforce each other. The first is the MNE's incentive to avoid proximity to the indigenous firm in order to limit competition in the product market. This tendency to avoid proximity to competitors has been recognized for a long time in location theory and is generally referred to as the "market crowding effect" (see Fujita and Thisse, 2002; Baldwin *et al.*, 2003). The second is the MNE's incentive to locate its subsidiary in the country where rent erosion due to knowledge spillovers (to its competitor) is minimized; a strategy which has been recognised both theoretically (Fumagalli, 2003; Iammarino and McCann, 2013) and empirically (Shaver and Flyer, 2000; Alcácer and Chung, 2007). As Proposition 1 shows, agglomeration will not occur in our model for purely private reasons, and thus our laissez-faire benchmark is remarkably clean: the MNE always locates in B. This provides additional justification for our assumption of equal country sizes.

2.2 The Fiscal Competition Scenario

In the fiscal competition scenario, the governments of the two countries bid to host the MNE. The game involves three stages:

- in stage 1, the governments simultaneously and non-cooperatively announce their lump-sum tax/subsidy offers for the MNE's plant;
- in stage 2, the MNE decides where to locate and invests; and
- in stage 3, the MNE and the indigenous firm compete *à la* Cournot on both countries' product markets. A tax/subsidy transfer payment occurs between the MNE and the winning country's taxpayers.

The MNE maximises its after-tax profits and the host countries maximise their levels of social welfare; and, again, the game is solved by backward induction. However, unlike the game in the laissez-faire scenario, the outcome does not only depend on country B's geographic advantage, Γ, but also on the governments' valuations of the FDI project, which determine their willingness to bid.

In equilibrium, country A wins the auction for the MNE if its valuation of the FDI project, V_A, is so much higher than that of country B, V_B, that it more than makes up for country B's geographic advantage:

$$V_A > V_B + \Gamma \tag{2}$$

The bidding for the MNE's plant is a first-price auction (with complete information and private values) with an important twist. The fact that the countries offer the MNE different levels of pre-tax profits implies that, in general, the auction is not a tie (with the MNE being indifferent concerning the location of its plant) when the two countries post the same bid. Thus, for example, a country that enjoys a geographic advantage (here, country B) appreciates that it can win the FDI with a lower bid than its rival.[7]

[7] See Ferrett and Wooton (2010) for an extensive discussion of our auction set-up, including its microfoundations and equilibrium properties.

Using the expressions for consumer surplus presented in Table 1, we can write expressions for V_B and V_A used in expression (2). V_B is the additional consumer surplus that country B enjoys under local production via FDI compared to importing:

$$\begin{aligned} V_B &= \left[\frac{1}{18}\left(2-c-t\right)^2\right] - \left[\frac{1}{18}\left(2-\left(1-\phi\right)c-2t\right)^2\right] \\ &= \frac{1}{18}\left(t-\phi c\right)\left(3t-\phi c+2c-4\right) \end{aligned} \tag{3}$$

and V_A is A's consumer surplus gain from local production following inward FDI *plus* the change in the profits of its indigenous firm due to inward FDI:

$$\begin{aligned} V_A = &\underbrace{\left[\frac{1}{18}\left(2-\left(1-\phi\right)c\right)^2\right] - \left[\frac{1}{18}\left(2-c-t\right)^2\right]}_{\text{Gain in consumer surplus from inward FDI}} \\ &+ \underbrace{\begin{array}{c}\left[\frac{1}{9}\left(1-2\left(1-\phi\right)c\right)^2 + \frac{1}{9}\left(1-2\left(1-\phi\right)c-t\right)^2\right] \\ -\left[\frac{1}{9}\left(1-2c+t\right)^2 + \frac{1}{9}\left(1-2c-2t\right)^2\right]\end{array}}_{\text{Gain in indigenous firm's profits from inward FDI}} \end{aligned} \tag{4}$$

In our model, both governments are benevolent social-welfare-maximisers. Inward FDI alters the market price paid by a country's consumers (both because it eliminates the trade cost from the MNE's marginal cost and because it changes the realised knowledge spillover), and both countries take account of this welfare effect; in addition, country A also takes account of how inward FDI affects its indigenous firm's profits.[8]

Proposition 2 describes the MNE's equilibrium location under fiscal competition and follows from the preceding text:

[8]Besides consumer-welfare and spillover benefits, other possible motivations for bidding for FDI have been examined in the literature: e.g. wage premia for domestic workers in "good" MNE jobs, including the relief of involuntary unemployment (Haaparanta, 1996); and the net fiscal contribution from the mobile factors associated with inward FDI (Black and Hoyt, 1989).

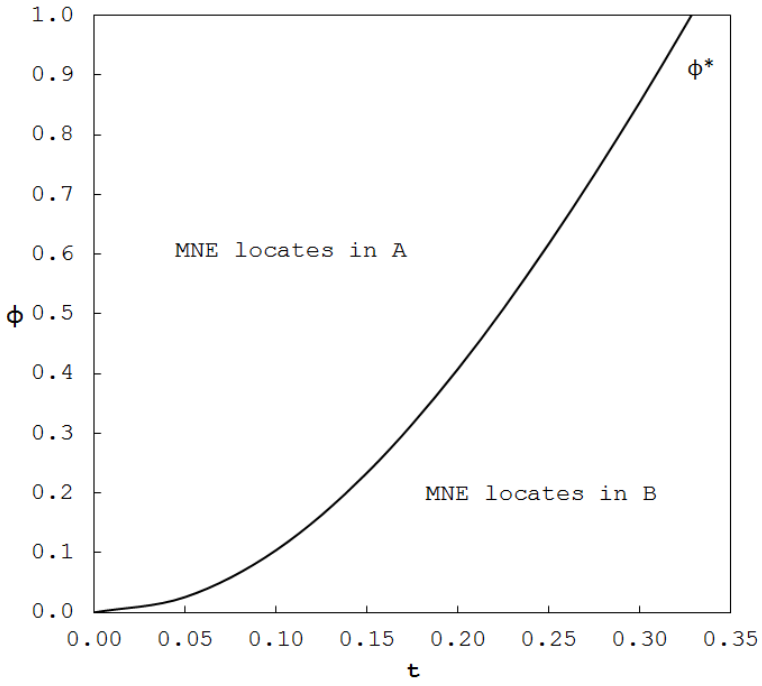

Figure 1: The MNE's Location Decision under Fiscal Competition ($c = 0.15$)

Proposition 2: Under fiscal competition for the MNE's plant, country A wins the FDI if and only if $V_A > V_B + \Gamma$ or, equivalently, $\phi > \phi^*$, where ϕ^* is the level of knowledge spillovers that, for given values of t and c, would make the MNE indifferent between the two countries if they were both to bid their valuations. (See appendix for explicit definition of ϕ^*).

While the above proposition gives the MNE's equilibrium location, it is important to recognise that both countries do *not* actually bid their valuations in equilibrium. In equilibrium, the losing country bids its valuation; and, taking account of the pattern of geographic advantage, the winning country just trumps that losing bid.[9]

Assuming, for example, that $c = 0.15$, the proposition is illustrated in Figure 1.[10] It shows that country A wins the auction when trade costs, t, are sufficiently

[9]Thus, for example, the winning country would be able to impose a *tax* in equilibrium if its geographic advantage were sufficiently strong.

[10]With $c = 0.15$, our condition for interior Cournot equilibria ($c + t < 0.5$) implies that $t < 0.35$.

low and knowledge spillovers, ϕ, are sufficiently large. Otherwise country B wins. Note that any point on the horizontal axis, where $\phi = 0$, represents an outcome identical to BE (2006), i.e. the MNE locates at a distance from the indigenous firm when the two countries are the same size. On the other hand, any point on the vertical axis, where $t = 0$, represents an outcome similar to Fumagalli (2003), i.e. the MNE locates in the country where knowledge spillovers would be greatest. This suggests that as t falls and ϕ increases, agglomeration (i.e. the co-location of the MNE and the indigenous firm) becomes more likely in equilibrium. To understand the drivers of this result in more detail, we next consider the impact of both *trade costs* and *knowledge spillovers* on the two sides of condition (2).

The trade cost effect

Consider the case where $\phi = 0.2$. From Figure 1 above, we know that at that level of knowledge spillovers, the MNE is indifferent between locating in either of the two countries in equilibrium if $t \approx 0.14$. This is also reflected in Figure 2, which for ease of exposition assumes ϕ to be constant. It shows that for $t < 0.14$, $V_A > V_B + \Gamma$ such that country A wins the auction for the MNE by paying a subsidy of (marginally above) $V_B + \Gamma$.[11] For $t > 0.14$, on the other hand, $V_B + \Gamma > V_A$ such that country B wins the auction for the MNE by paying a subsidy of (marginally above) $V_A - \Gamma$. Thus, country A wins the MNE for sufficiently low trade costs while country B wins the MNE for sufficiently high trade costs. The winning subsidy/tax offer in the equilibrium is depicted as a heavy bold line in Figure 2.[12] The winning country's surplus – representing the difference between its valuation and the equilibrium subsidy it pays – is represented by the shaded areas in figure 2. Note that as the auction for the FDI progressively moves away from being a tie (i.e. as t moves away from the vertical dashed line), so the winning

[11] Recall that, while the losing country bids its valuation in equilibrium, the winning country need not pay a subsidy equal to its valuation; it suffices to slightly improve on its rival's losing offer, adjusted for Γ. The equilibrium subsidy paid to the MNE is $V_B + \Gamma + \varepsilon$ if country A wins and $V_A - \Gamma + \varepsilon$ if country B wins, where ε is an infinitesimal amount.

[12] Note that, for sufficiently large t, B wins the FDI and *taxes* the MNE in equilibrium. (Although $V_A > 0$ so country A offers a positive subsidy in equilibrium, B's geographic advantage, Γ, is so large that $V_A - \Gamma < 0$.)

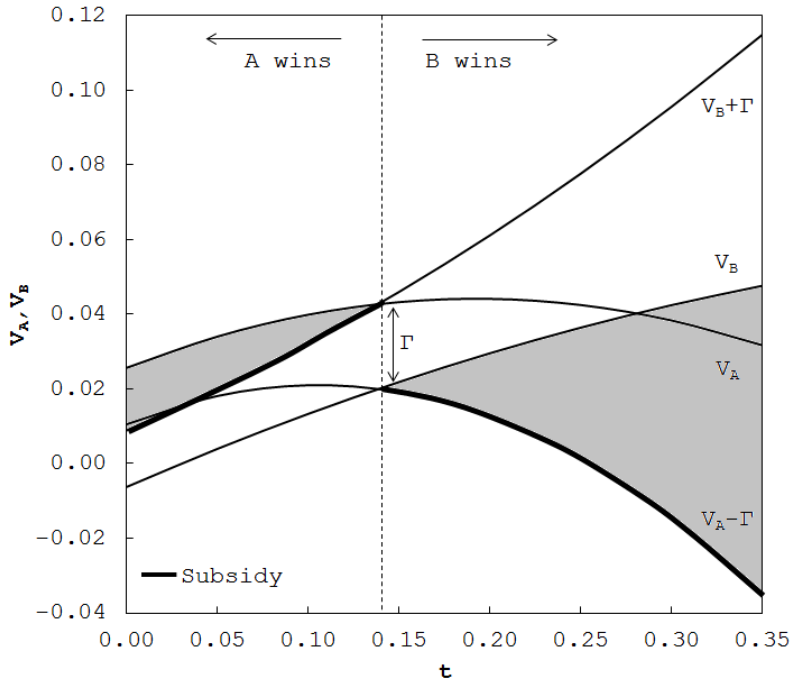

Figure 2: Trade Cost Effect ($c = 0.15$, $\phi = 0.2$)

country's equilibrium surplus progressively grows. This is consistent with our finding in the welfare analysis below that the host region is more likely to be better off under fiscal competition than under laissez-faire, the further removed is the auction for the FDI from being a tie.

The result that country A becomes more likely to win the auction for the FDI as t falls is driven by the way in which t effects V_A, V_B and Γ. We see from figure 2 that V_A varies less with t than does $V_B + \Gamma$, which is sharply increasing in t. Thus, $V_A > V_B + \Gamma$, the condition for country A to win, becomes more likely to hold as t falls. Intuitively, V_A varies relatively little with t because, as t falls, inward FDI benefits A's consumers less (through market-price reduction) *but* it also *harms* A's indigenous firm less (through the market-crowding effect) – and these two welfare effects push V_A in opposite directions, thus tending to counteract each other. In contrast, V_B is clearly increasing in t because country B's valuation only reflects the interests of its consumers, and the consumer-surplus gain from inward FDI varies positively with t. Moreover, $V_B + \Gamma$ is also increasing in t because, in

general, B's geographic advantage, Γ, tends to vary positively with t (i.e. falls in t tend to weaken the market-crowding effect of co-location in A).[13]

The knowledge spillover effect

For a given level of t, an increase in ϕ reduces the unit production cost of the indigenous firm *if* the MNE is located in the same country, A. This increases country A's valuation, V_A, and decreases that of country B, V_B. The latter effect is due to the benefit to consumers in country B from the knowledge spillovers to the indigenous firm in country A if the MNE locates in A. This is a benefit to B's consumers that occurs because B *fails* to win the FDI, and it arises because the indigenous firm is itself an exporter to country B. On the other hand, country A's valuation is increasing in ϕ because: (i) the benefit of inward FDI for its consumers is increasing in ϕ; and (ii) the profits of its indigenous firm are also increasing in ϕ.

We conclude that an increase in ϕ increases the likelihood of a win for country A in the FDI auction (the relevant condition is (2): $V_A > V_B + \Gamma$). This is true even though increasing ϕ has a positive impact on Γ, because this positive impact is always smaller than the negative impact that an increase in ϕ has on V_B.[14] Noting that an increase in the indigenous firm's initial unit cost, c, also increases the *size* of the potential spillover, ϕc, this leads us naturally to the third proposition:

Proposition 3: *In the fiscal competition scenario, a larger "technology gap" between the MNE and the indigenous firm (i.e. a higher c) expands the area in the parameter space where country A wins for all* $c \leq c^* = \frac{2}{11}\left(\frac{2-t}{2-\phi}\right)$.

Proof: for $c \leq c^*$, $\frac{d(V_A - V_B - \Gamma)}{dc} = \frac{2\phi}{9}\left(4 + 11c(\phi - 2) - 2t\right) \geq 0$, where $V_A - V_B - \Gamma$ is A's surplus if it wins the FDI. □

The proposition is illustrated in Figure 3. It shows that an increase in c within $[0, c^*]$ rotates the curve along which the fiscal competition for FDI is tied clockwise

[13] And even on the extremely small interval (near $t = 0$) where $d\Gamma/dt < 0$, the positive effect of t on V_B (i.e. $dV_B/dt > 0$) dominates.

[14] Thus, $\frac{dV_A}{d\phi} > 0$, $\frac{dV_B}{d\phi} < 0$, $\frac{d\Gamma}{d\phi} > 0$, and $\frac{d(V_B+\Gamma)}{d\phi} < 0$.

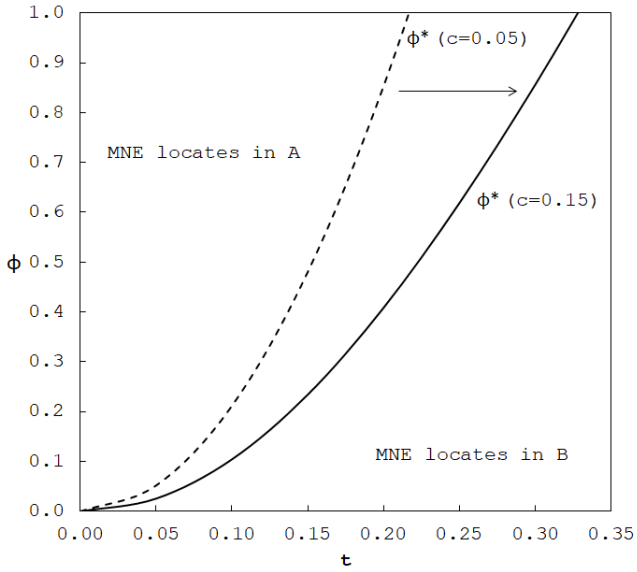

Figure 3: Firm Heterogeneity Effects

around the origin such that more combinations of t and ϕ lead the MNE to locate in country A in equilibrium. This happens because, for a given ϕ, an increase in c increases country A's valuation premium $(V_A - V_B)$ by more than it increases county B's geographic advantage, Γ, suggesting that a higher degree of firm heterogeneity makes the agglomeration outcome more likely under fiscal competition.[15]

In our model's equilibrium, technological spillovers are more likely to be observed flowing from subsidised inward investment (which requires country A to win the FDI), the larger is the unit cost (and hence size) gap between the MNE and the indigenous firm. This appears to be consistent with the empirical findings of Brülhart and Simpson (2016). They conclude that spillover benefits to indigenous industry are more likely to be associated with observed corporate subsidy payments in the case of very large FDI projects, as studied by Greenstone *et al.* (2010), than in the case of smaller ones.

[15]Thus, for $c < c^*$, we have $\frac{d(V_A - V_B)}{dc} > \frac{d\Gamma}{dc} > 0$. Note that $c > c^*$ is also compatible with our maintained assumption $c + t < 0.5$, and in this case a larger technology gap makes it more likely that the MNE locates in country B under fiscal competition (because increasing c has a greater positive impact on B's geographic advantage than on A's valuation premium, i.e. $\frac{d\Gamma}{dc} > \frac{d(V_A - V_B)}{dc}$) .

Putting everything together, we note that in the laissez-faire scenario the MNE locates in country B for all values of c, t and ϕ. However, the opposing effects that knowledge spillovers and trade costs have on the countries' valuations of the FDI project may induce the MNE to co-locate alongside the indigenous firm in country A when governments compete in taxes/subsidies. Furthermore, we note that the agglomeration outcome is more likely the bigger the technological gap between the MNE and the indigenous firm.

3 Welfare Analysis of Fiscal Competition

When multinational firms' location decisions are influenced by fiscal competition, an important question is whether the use of publicly financed subsidies is efficiency enhancing. And even if fiscal competition *does* lead to a more efficient outcome, an important distributional issue remains: how are the net benefits from fiscal competition distributed, and might some players lose? We seek to answer these questions by comparing the equilibrium outcome under fiscal competition with that under laissez-faire.

World Welfare

Let world welfare be the sum of consumer surplus in countries A and B *plus* the profits earned by the indigenous firm and the MNE.

Proposition 4: Under fiscal competition, the MNE chooses the efficient location for its plant, where "efficient" means world-welfare-maximizing.

Proof: The condition for FDI in country A to be world-welfare-maximising is identical to that for the MNE to locate in A in fiscal-competition equilibrium, i.e. $V_A > V_B + \Gamma$. $\square$

Proposition 4 is not particularly remarkable because it is consistent with the well-established result that an auction for a single firm leads to the efficient location

(see, for example, Ferrett and Hoefele, 2015, Proposition 1; Bjorvatn and Eckel, 2006, Proposition 5). However, as is shown in the analysis below on individual countries' welfare levels and the MNE's profits, fiscal competition need not necessarily be Pareto-improving: while some players must gain (at least weakly), others might lose in strict terms.

Three observations on Proposition 4 are noteworthy. First, if the MNE continues to locate in country B under fiscal competition, then world welfare will be unchanged relative to laissez-faire. In this case, consumer surplus in both countries, as well as the profits of the indigenous firm, remain unchanged relative to laissez-faire. The only factor that changes is the introduction of a tax/subsidy transfer payment between the MNE and country B, which nets out of world welfare. Second, if fiscal competition *does* change the MNE's equilibrium location decision from B to A, then it *must* be world-welfare-improving. To see this, note that relocation by the MNE from B to A will increase world welfare if $V_A > V_B + \Gamma$, where the L.H.S. is the welfare gain to country A from inward FDI, and the R.H.S. is country B's loss of consumer surplus following outward FDI plus the MNE's loss of pre-tax profits. This is also the condition, (2) above, for relocation from B to A to *occur* in equilibrium under fiscal competition. Thus, we conclude that fiscal competition leads to relocation by the MNE if and only if such relocation is world-welfare-improving. Third, we note that fiscal competition does *not always* lead to MNE relocation and the agglomeration of production in country A (see Figures 1 and 2 above). For sufficiently large t, world welfare is – perhaps surprisingly – maximised when the MNE remains in country B under fiscal competition and the potential knowledge spillover in country A is foregone. Intuitively, FDI in B benefits both B's consumers (via price reduction) and the MNE itself (which enjoys a protected local market); and when t is large, this combined welfare gain outweighs the loss of the benefits of agglomeration in country A.

It is also interesting to note that the MNE's equilibrium location would be the same if, rather than competing, countries A and B coordinated their fiscal offers cooperatively. Policy coordination enables the host countries both to choose the MNE's location and to appropriate the entire social surplus generated within the industry. For example, the optimal fiscal offers to induce the MNE to locate

in country A are taxes of $\pi_A - \varepsilon$ and π_B on FDI in countries A and B respectively, where π_i denotes the MNE's total pre-tax profits if it locates in country i and where ε is arbitrarily small. Therefore, under policy coordination, the host countries will ensure that the MNE chooses the efficient (surplus-maximising) location; and they can then achieve any desired "equitable" distribution of the total social surplus via lump-sum intra-regional transfers. However, while fiscal competition and cooperative policy coordination are associated with the same FDI location and level of social surplus (or world welfare), they differ in terms of the distribution of surplus between the host region and the rest of the world. In particular, policy coordination benefits the host region at the expense of the MNE's owners elsewhere in the world, who are left (approximately) indifferent between undertaking FDI in the efficient location and not investing.

Country A's Welfare

Proposition 5: Relative to the laissez-faire scenario where the MNE locates in B, fiscal competition increases country A's welfare if it wins the MNE, $\phi > \phi^*$, but otherwise leaves country A's welfare unchanged.

This follows from the discussion above. By condition (2), we know that country A wins the auction for the MNE if and only if $V_A > V_B + \Gamma$. In this case, A pays a subsidy of (just above) $V_B + \Gamma$ and, relative to laissez-faire, thus enjoys a welfare gain of $V_A - (V_B + \Gamma)$.[16] If, on the other hand, country B wins the fiscal competition for the MNE, both consumer surplus in A and the profits earned by its indigenous firm remain unchanged from those under laissez-faire. Thus, when country B wins, fiscal competition does not affect country A's welfare.

Country B's Welfare

Proposition 6: Relative to laissez-faire, fiscal competition increases country B's welfare if: (i) $\Gamma > V_A$ or $\phi < \phi'$ (explicitly defined in the appendix), such that

[16] See the shaded area in the L.H.S. of Figure 2.

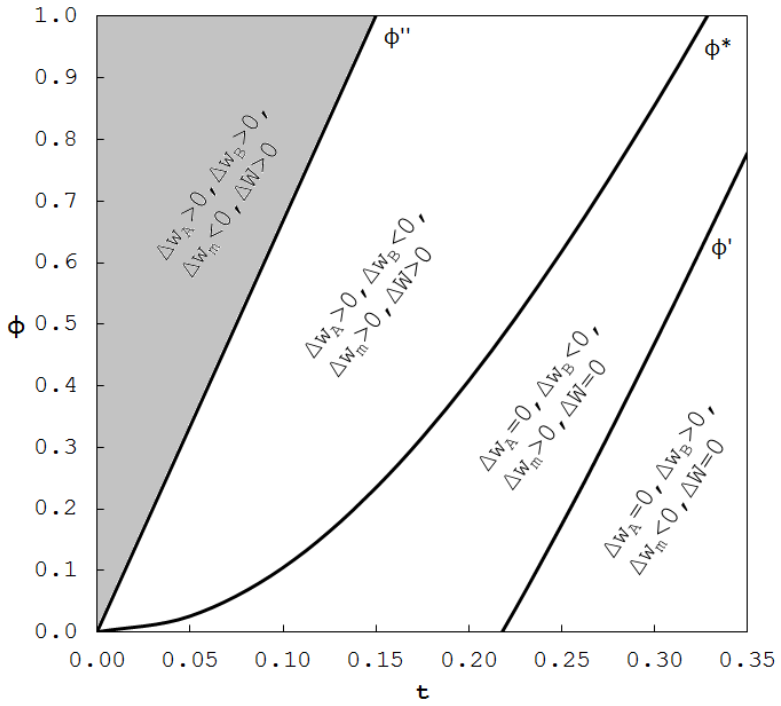

Figure 4: Welfare Impacts of Fiscal Competition ($c = 0.15$)

country B retains the MNE's plant and taxes it; and (ii) $\phi > \frac{t}{c} \equiv \phi''$ *such that the relocation of the MNE to country A in equilibrium reduces the price on country B's product market. Otherwise, country B's welfare falls.*

There are two distinct ways in which fiscal competition might benefit country B. Firstly, if fiscal competition leaves the MNE's location unchanged as B (i.e. $V_B + \Gamma > V_A$), then B's winning fiscal offer (in response to A's losing bid of V_A) is $V_A - \Gamma$. Thus, if B's geographic advantage is sufficiently strong (i.e. $\Gamma > V_A$), it is able to retain the MNE's investment and *tax* it. In this case, B's welfare rises by its level of tax revenue. Alternatively, if B retains the MNE's plant with a subsidy payment in equilibrium (i.e. $V_B > V_A - \Gamma > 0$), then B's welfare falls by the amount of the subsidy payment.

Secondly, even if B loses the FDI to A under fiscal competition, then it is still possible for country B to gain from fiscal competition. This gain to B occurs if the agglomeration of production in country A produces a spillover to A's indigenous firm that is sufficiently large to result in a *fall* in the equilibrium price on B's

product market. Noting that the relocation of the MNE from B to A increases its unit cost of serving market B by t but cuts that of A's indigenous firm by ϕc and that the Cournot equilibrium price depends on the sum of marginal costs, it follows that the MNE's exit reduces the market price in B if $\phi c > t$ or $\phi > \phi'' \equiv \frac{t}{c}$. The condition $\phi > \phi''$ is thus equivalent to $V_B < 0$ – i.e. inward investment into B *harms* its consumers by leading to an increase in its market price.

In the shaded area of Figure 4, $V_B < 0$ ($\phi > \phi''$) and, unsurprisingly therefore, country A wins the fiscal competition for FDI ($\phi > \phi^*$).[17] Thus, in that shaded area, *both* countries benefit from fiscal competition.[18] This contrasts with the finding of Fumagalli (2003) that fiscal competition always harms one of the competing countries (specifically, the host of the FDI under laissez-faire). The key, relevant distinction between our model and Fumagalli's is that *only one* of our competing countries, A, contains an indigenous firm. Thus, when country A wins the FDI, agglomeration replaces non-agglomeration in our model; whereas in Fumagalli, the MNE is *always* co-located alongside an indigenous firm (since both host countries contain one). Moreover, if the spillover benefits of agglomeration in A are sufficiently strong in our model, then the country, B, that loses the FDI in the move from laissez-faire to fiscal competition ends up better off (despite the fact that trade costs now apply to all of its consumption).

MNE's Welfare

Proposition 7: With fiscal competition, the MNE's after-tax profits ("welfare") increase for all $\phi \in \left[\phi', \phi''\right]$.

Intuitively, if the multinational locates in country B, its after-tax profits rise compared to laissez-faire if it gets subsidised ($V_A - \Gamma > 0$ or $\phi > \phi'$) but fall if it gets taxed ($V_A - \Gamma < 0$ or $\phi < \phi'$). On the other hand, if the multinational

[17] In Figures 4 and 5, Δw_A, Δw_B, Δw_m and ΔW represent, respectively, the changes in the welfare of country A, country B, the MNE's owners and the world as a whole.

[18] Moreover, because fiscal competition causes the MNE to change its equilibrium location, the world as a whole gains ($\Delta W > 0$). However, as we show below, the gains to the host region come partially at the expense of the MNE's owners ($\Delta w_m < 0$).

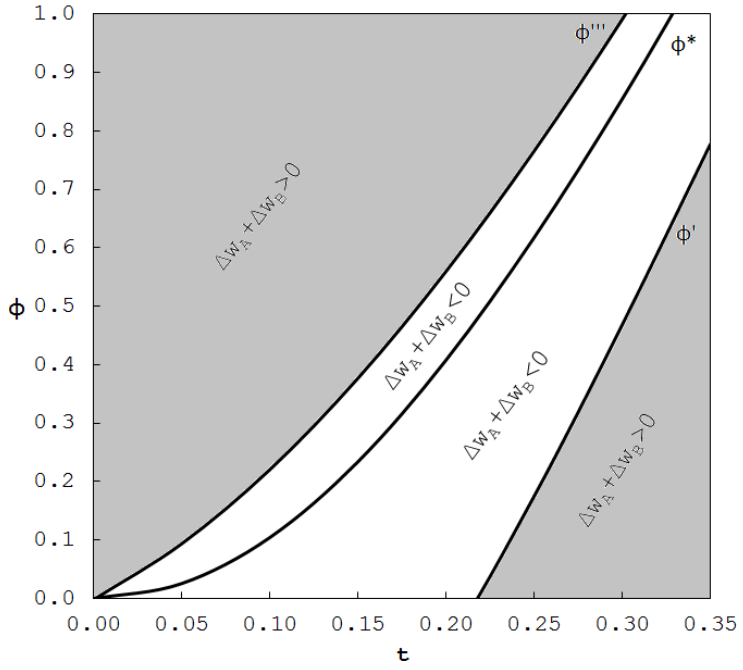

Figure 5: Regional Welfare Impact of Fiscal Competition ($c = 0.15$)

relocates to country A under fiscal competition, its after-tax profits rise only if country B's valuation (which itself determines the size of the subsidy paid by host country A, $V_B + \Gamma$) is positive: specifically, $V_B > 0$ or $\phi < \phi''$. However, if country B attaches a negative value to inward FDI (i.e. $V_B < 0$ or $\phi > \phi''$), then country A wins the auction for FDI with a subsidy that is lower than the relocation-induced fall in the MNE's pre-tax profits (Γ), leaving the MNE's owners worse off under fiscal competition. Recalling that the fiscal competition is tied at $\phi = \phi^*$, it is noteworthy from Figure 4 that the MNE is more likely to gain from fiscal competition, the closer is the auction to being a tie.

Regional Welfare

Let regional welfare be equal to the sum of the welfare of the two countries.

Proposition 8: Relative to the laissez-faire scenario, fiscal competition decreases regional welfare for all $\phi \in \left[\phi', \phi'''\right]$, where ϕ''' is that level of ϕ which makes fiscal

competition regional-welfare-neutral when country A wins the auction for FDI. Otherwise, regional welfare rises.

The proposition is illustrated in figure 5. It shows that fiscal competition increases regional welfare in two (shaded) areas: first, when $\phi < \phi^{'}$, or $V_A - \Gamma < 0$, as this enables the government of country B to retain the MNE with a tax; and second, when $\phi > \phi^{'''}$ or $V_A > 2V_B + \Gamma$, as this implies that country A's surplus from winning the fiscal competition exceeds the loss B suffers when the MNE exits.[19] There exists an intermediate area in the (ϕ, t) parameter space where fiscal competition is regional-welfare-decreasing because subsidy competition between the two governments is close to being a tie, i.e. around $\phi = \phi^*$; in this case, the fiscal competition might be thought of as being "intense" or "closely fought". These results contrast with the findings of BE (2006) who show that fiscal competition increases regional welfare only for high levels of t, which implies that the decline in trade costs observed over the past two decades makes it less likely that fiscal competition will improve regional welfare.[20]

4 Concluding Remarks

This paper analyses the location outcomes and welfare effects of fiscal competition for FDI in the presence of localised knowledge spillovers. We show that in the absence of government intervention, the multinational firm's optimal strategy is to locate at a distance from the indigenous firm in order to limit the market crowding effect and to minimize the knowledge spillover to its competitor. However, governments may cause a switch in the multinational's location decision by offering financial incentives – in the form of subsidies or beneficial tax rates – to the MNE. This is largely the result of the way in which the potential for knowledge spillovers pushes the two countries' valuations of the FDI project in opposite

[19] A's surplus is $V_A - V_B - \Gamma$ and B's loss is V_B. Note that $V_A - V_B - \Gamma > V_B$ rearranges to $V_A - \Gamma > 2V_B$.

[20] WTO (2008) reports an overall downward trend in trade costs in the last half century, including traditional trade costs (such as tariff an non-tariff barriers) as well as transport and communication costs.

directions: with spillovers, the valuation of the country with the indigenous firm is increased, while that of the other country falls. This outcome suggests that *agglomeration* may, in part, be the result of the provision of government incentives, particularly if competing countries' other characteristics are similar. Thus, besides simplicity, an important justification for our assumption that country sizes are equal is that it creates a framework where agglomeration will *not* occur for purely private reasons under laissez-faire. In turn, this enables us to bring out clearly the potential role of fiscal activism in facilitating industrial agglomeration.

In line with existing literature, our study also shows that fiscal competition is world-welfare-maximising because it directs investment to where it is valued most. However, we add to existing literature on the welfare impacts of fiscal competition in two ways. First, in contrast to BE (2006), who show that fiscal competition increases regional welfare only when trade costs are relatively high, we show that regional welfare also rises under fiscal competition at low levels of trade costs if knowledge spillovers are sufficiently strong – since, in that case, consumers in both countries benefit from spillovers to the indigenous firm. Second, in contrast to Fumagalli (2003), whose model shows that fiscal competition necessarily harms the country that would host the FDI under laissez-faire, we show that this is not the case when one potential host country cannot benefit from knowledge spillovers while the other one can (possibly due to differing industrial specialisations). Taken together, these observations suggest that for sufficiently low trade costs and high spillovers, fiscal competition may not only increase regional welfare but also improve that of all the individual competing countries.

Finally, we make two points on the practical applicability of these results. First, we note that the novel results obtained from this study are more relevant to situations where governments compete to host *highly* productive firms (which MNEs often are). This is because, for a given spillover rate (our parameter ϕ), a larger technology gap between the MNE and the indigenous firm increases the willingness of the country containing the established firm to bid for the FDI, while it reduces the other country's willingness to bid. Second, we note that the decline in trade costs observed over the past two decades (WTO, 2008) and the likely increase in firms' absorptive capacities (associated with higher levels

of educational attainment, training and worker mobility) make an *agglomeration* outcome that improves the welfare of *all* countries in the host region seem more likely.

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Appendix

Explicit definitions for ϕ^*, $\phi^{'}$ and $\phi^{'''}$ follow.

Explicit definition for ϕ^*. Let ϕ^* be that level of knowledge spillovers that makes the MNE indifferent in equilibrium between locating in country A or B when there is fiscal competition for FDI; i.e. $V_A = V_B + \Gamma$. This is given by:

$$\phi^* = \tfrac{1}{22c^2}\left(22c^2 - 8c + 4ct + \sqrt{308c^2t^2 + (8c - 22c^2 - 4ct)^2}\right).$$

Explicit definition for $\phi^{'}$. Let $\phi^{'}$ be that level of knowledge spillovers that makes fiscal competition welfare-neutral (because fiscally neutral) from country B's perspective when the MNE locates in country B; i.e. $V_A - \Gamma = 0$. This is given by:

$$\phi^{'} = \tfrac{1}{21c^2}\left(21c^2 - 6c + 2ct + \sqrt{c^2\left(9\left(2 - 7c\right)^2 + 18t \cdot (7c - 6) + 361t^2\right)}\right).$$

Explicit definition for $\phi^{'''}$. Let $\phi^{'''}$ be that level of knowledge spillovers that makes fiscal competition regional-welfare-neutral when the MNE locates in country A. This requires $V_A > 2V_B + \Gamma$ and is given by:

$$\phi^{'''} = \tfrac{1}{23c^2}\left(23c^2 - 10c + 6ct + \sqrt{c^2\left((10 - 23c)^2 + 2t \cdot (115c - 4) + 289t^2\right)}\right).$$