

Subsidy competition and the Mode of FDI: Acquisition vs Greenfield

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Abstract

We model subsidy competition for a foreign MNC's investment in a two-country PTA. Taking into account acquisitions as an alternative investment mode weakens the case for subsidising greenfield investment, even for a single government. Considering competition between member states, it widens the scope of harmful subsidy competition. While our predictions are sensitive to the acquisition price, we predict that in many cases a ban on subsidies may increase welfare. In addition, we show how trade integration and increased competition for targets raise the prospects for social waste. Finally, if FDI entails significant positive spillovers to the host country, fiercer competition for investment and greater welfare losses should be expected.

1 Introduction

This paper attempts to fill a gap in the literature dealing with subsidy competition for FDI. Our objective is to give a formal treatment of FDI that has firms consider cross-border acquisitions as a realistic alternative to greenfield investment. In that unified framework, we try to assess the welfare consequences of incentive-based competition between governments.

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The widespread use of investment incentives to influence MNC location is a well documented fact. In a survey covering 83 countries, UNCTAD (1996) reports that 55 countries commonly use fiscal and indirect (infrastructure) incentives, while almost all resort to subsidies lowering the cost of capital for foreign investors. Unfortunately, limited disclosure of the details of incentive provision, as well as the diversity of incentive packages, make it difficult to construct a single summary statistic worldwide. However, considerable case-study evidence of subsidy wars may be found within regional blocs. Most of this evidence focuses on 'landmark investments', i.e. large-scale investment projects with significant local employment potential.

Oman (2000) and Charlton (2003) report many subsidy wars in emerging and rich countries alike. In Europe, following the completion of the Single Market, a number of bidding contests have occurred, particularly fierce in the automobile and semi-conductor industries¹. In 2001, BMW selected Leipzig for an \$860 million project, after having reviewed 250 potential locations and short-listed 4 locations in the Czech Republic, France and Germany. A generous package composed of fiscal and infrastructure incentives helped seal the deal. In 2000, Nissan withdrew its threat to relocate its Sunderland, UK plant after receiving a \$58 million grant. In 1999, Isuzu invested \$240 million to build an engine factory in the Polish special economic zone of Katowice, rather than the British Midlands, due to generous fiscal incentives from the Polish government. In 1998, Toyota received a \$57 million package to locate its European production facility in Valenciennes, France. In 1995, Mercedes-Benz and Swatch decided to build the Smart production plant in Hambach, France, ahead of many other European rival locations. The incentive package offered compensated for almost a third of the \$370 million investment. In 1991, Portugal had offered a \$680 million grant to Ford and Volkswagen. The semi-conductor sector also experienced similarly strong incentive-based competition. In 2004, AMD was offered \$550 million to locate a microchip production facility in Dresden, Germany. A contemporaneous R&D investment project by Siemens and Motorola in the same city received a \$156 million grant. This investment project followed an initial ambitious \$1.65 billion investment project by Siemens, which was subsidised by as much as \$275,000 per employee. In 1996, the British government induced Hyundai to

¹In the EU, competition for FDI is restricted to backward regions exempted from the overall ban by the Treaty of Rome, and/or specific sectors (steel, fibres, automobile). Subsidy expenditure is also subject to scrutiny from the competition authority, but regional funds may compensate for part of the set-up costs.

locate a plant in Scotland, offering \$190,000 per job.

Subsidy competition has not been confined to Europe. Another example of the coincidence of regional integration, changes in location patterns and intense subsidy competition is given by Mercosur. Before integration, MNCs created subsidiaries in Brazil and Argentina in order to 'escape' from trade protection. More often than not, those subsidiaries had similar operations, used similar technologies, and sold similar products (Gatto et al., 1984) on each national market. Regional integration, taking the form of a Customs Union in 1995, encouraged MNCs to use one of the member countries as an export platform to serve the region (Kosacoff, 2000). The dramatic fall in tariffs coincided with a rise in the provision of investment incentives from all member governments, most notably in Argentina and Brazil.² Indeed, the implementation of some sort of coordination on subsidies belongs to the current agenda of talks on Mercosur's future.³

Other examples of competition between member countries of a PTA include ASEAN, with the simultaneous creation of investment packages in many countries, but most notably Malaysia and Singapore, following the creation of AFTA and the ASEAN Investment Area (AIA) in 1992. This region already had a history of countries mimicking one another's incentive packages. As in the EU, landmark investments have led to fierce competition, as for instance Thailand outbid the Philippines in 1996 to land a \$500 million investment of General Motors. Generalised subsidy competition has also allowed existing foreign investors to obtain grants from governments out of the threat of relocation.

Finally, all these examples should not overshadow the intense subsidy competition taking place within countries, most notably in Brazil, the US, Canada, India and China (see Oman, 2000 for similar examples).

All the above examples suggest, as emphasised by Charlton (2003), that some features of incentive-based competition have universal prevalence. First, competition occurs mostly between neighbour countries with similar factor endowments, and between subdivisions of the same country. Second, com-

²With, respectively, 22% and 40% of FDI in the manufacturing sector being subject to incentives from the central State. Some sectors were more specifically targeted by authorities, especially the automobile ('Auto regime') and the computer industry, as suggested by the creation of state-funded programmes dedicated to these industries (Chudnovsky and López, 2001 and 2002).

³As reported by Página 12, Argentinean newspaper, on June 28th, 2005. See also Polínia Rios, 2003.

petition is endemic, suggesting a strategic interaction between 'bidding' governments. Third, competition seems to intensify as regional integration proceeds.

Indeed, increased subsidy competition has coincided with waves of FDI flows following the creation of trade blocs, most notably in the EU, in NAFTA, in Mercosur and in the ASEAN. Given the increasing prevalence of regional trade agreements around the world in recent years, it is essential to understand the impact of such agreements on the amount and type of investment, and on government policy relating to FDI.⁴ Indeed, there is considerable evidence that regional integration affects FDI flows, in particular by redefining the location of horizontal FDI (see Barba Navaretti and Venables, 2004 for a detailed and up-to-date survey and discussion). Ethier (1998) argues that attraction of FDI, rather than traditional gains from trade, has been a key motivation for membership in regional unions, consistent with the modest actual extent of trade concessions agreed upon.

As well as seeing an increase in total FDI, recent years have also seen a notable change in the nature of this investment, with mergers and acquisitions increasing in importance relative to greenfield investment. The figures in Table 1 illustrate that FDI inflows by mergers and acquisitions in industrial countries were almost five times as high as inflows by greenfield investment between 1995 and 1999, with merger and acquisition activity almost doubling as a percentage of GDP between the late 1980s and the late 1990s. Meanwhile in developing countries greenfield investment still accounted for a majority of FDI in the latter period, but was more than nine times as high as a share of GDP compared to the earlier period, whereas the increase in total FDI inflows into these countries was approximately threefold.

Within figures for developed countries, notable differences appear. Table 2 reports ratios of mergers and acquisitions to FDI inflows for the OECD as a whole, European OECD members in aggregate (together with some individual members) and the United States. This ratio increased greatly in Europe, rising from 56.2% in the period 1988-93 to 89.6% in the period 1994-99. This period corresponds to a period of deepening integration within the EU, with the completion of the Single Market under the '1992' programme.

⁴250 regional trade agreements had been notified to the GATT/WTO up to December 2002, of which 130 were notified after January 1995. Over 170 regional trade agreements are currently in force, with every WTO member except Japan, Korea and Hong Kong belonging to at least one.

Table 1: Gross FDI inflows (% of GDP, weighted averages)

	Total	Greenfield	M & A
Industrial countries			
1987-89	1.07%	0.25%	0.82%
1990-94	0.82%	0.29%	0.53%
1995-99	1.88%	0.33%	1.55%
Developing countries			
1987-89	0.97%	0.87%	0.10%
1990-94	1.59%	1.28%	0.32%
1995-99	2.95%	2.01%	0.94%

Source: Calderón *et al.* (2002)

However the ratios for the United States, while higher than those for Europe, showed a very small increase over this period, from 93.9% to 97.0%.⁵

Table 2: Ratio of Inward Mergers and Acquisitions to FDI Inflows (percent)

	1988-93	1994	1995	1996	1997	1998	1999	1994-99
OECD total	68.8	73.3	76.7	82.7	85.4	97.9	106.1	92.9
Europe	56.2	67.7	65.0	75.0	88.0	83.2	116.6	89.6
UK	85.9	135.5	178.4	127.2	139.0	150.9	161.9	152.3
France	42.0	104.7	32.7	67.1	87.7	80.1	64.4	70.5
Germany	120.7	62.6	62.3	181.9	107.1	95.0	175.8	121.5
United States	93.9	105.9	93.9	83.4	81.6	118.3	91.8	97.0

Source: OECD (2001), p.47.

It is worth noting that all the 'landmark' investment projects referred to above were greenfield investments. While this might be partly due to employment effects and other spillovers associated with greenfield investment that are less likely to accrue with acquisitions, it also reflects a certain hostility shown by governments towards foreign firms bidding for domestic rivals. Policy makers often view acquisitions of domestic firms by foreign predators

⁵Due to differences in the way the series are calculated, the values for mergers and acquisitions are often more than 100% of the corresponding values for total FDI inflows. Details of how these series are calculated can be found in OECD (2001, p.19).

as undesirable, fearing anti-competitive effects of increasingly concentrated ownership by large multinational firms and wanting to keep profits within their country. Even where acquisition can involve the transfer of improved technology into a country and have beneficial effects for consumers in the region, subsidies are not offered.⁶ One possible reason for this is that policy makers do not recognise that acquisitions involve payments to the original owners of the firm, which should compensate them for any lost future profits.

The modelling of the acquisition price is therefore important when considering the welfare effects of acquisitions relative to greenfield FDI. In this paper we allow for a range of acquisition prices, from the acquired firm's profits before entry by the foreign firm to its potential profits were the firm to enter by greenfield FDI. This could be thought of as representing the bargaining power of the two firms (ranging from the domestic firm having the greatest to the least bargaining power). A take-it-or-leave-it offer from the target firm should be priced in this interval and decrease in the likelihood of a greenfield investment alternative by potential acquirers. In that setting, fiercer competition between potential buyers should put upward pressure on the acquisition price towards the pre-entry duopoly profits. We will find that such pressure should increase the welfare-decreasing potential of subsidy competition.

Summarising, there has been a simultaneous rise in incentives offered by governments for greenfield FDI and the proportion of FDI that has occurred through mergers and acquisitions. Given the coexistence of these alternative methods of producing abroad, we need to allow for both alternatives within a single model. This allows us to analyse the incentives for choosing one strategy over the other, whereas previous literature has tended to concentrate on one case or the other.⁷

The rest of this paper is set out as follows. Section 2 sets up the model and considers the benchmark case of no government intervention and the

⁶Kendall and Ryan (2005) consider the welfare and competition policy implications of international acquisitions. Acquisitions which involve the transfer of technology from a more efficient foreign predator to a domestic target are shown to be welfare-improving for the domestic country.

⁷Previous theoretical analyses of the impact of regional integration on FDI by Norman and Motta (1993), Motta and Norman (1996) and Neary (2002) have all assumed that FDI is greenfield.

case of intervention by a single government. Section 3 considers subsidy competition between the two governments in the region and characterises equilibria of this game. Section 4 undertakes comparative statics analysis to determine the effects of trade integration, increased competition for targets and the existence of vertical spillovers. Finally, Section 5 concludes.

2 The model

The world is assumed to consist of three countries, 1, 2 and 3. Countries 1 and 2 are potential partners in a preferential trade agreement (PTA) while 3 is a foreign country from outside the region. Each country contains a firm, indexed by country: firms 1 and 2 already sell in their own and each others' markets, while firm 3 has a choice of how to supply the markets in the two potential PTA partners. The foreign firm is assumed to have a lower marginal cost than the other two firms and can transfer this cost advantage to any plant it buys or establishes in another country.

We consider a three-stage game. In the first stage the two partner governments set policy levels, which are assumed to be lump-sum location taxes/subsidies on the foreign firm, should it choose to invest in either partner country.

In the second stage, the foreign firm chooses how to supply the partner countries. It faces two choices (assuming at least one to be profitable): greenfield FDI, setting up a new plant in either country 1 or 2; or acquiring the existing firm in either country 1 or 2. If it chooses greenfield FDI, it will face a fixed set-up cost and a transport cost for units shipped between countries 1 and 2. If it chooses acquisition, it will also pay this transport cost, plus an acquisition price that depends on the profits of the acquired firm in a way explained below.

In the third stage, all firms remaining in the market sell a homogeneous product under Cournot competition. Markets are segmented, meaning that we can ignore the market in country 3 when analysing the effects of regional integration on countries 1 and 2. We note that, because of their lump-sum nature, subsidies and fixed costs do not affect third-stage production decisions described in the previous section, but only the second-stage investment decisions.⁸

⁸This implicitly assumes that firm 3 will continue to supply its own market from its original plant in country 3 rather than shutting that plant down and importing from a

Country i 's demand curve is given by

$$p_i = a_i - \sum_j q_{ij} \quad (1)$$

where p_i is the price in country i ($i = 1, 2$) and q_{ij} is firm j ($j = 1, 2, 3$)'s output in country i . The a_i parameters can be interpreted in various ways. The most literal interpretation is in terms of country sizes, with country 1 larger (smaller) than country 2 for $a_1 > (<)a_2$. However these parameters could also be thought of as representing other factors, such as tastes, which result in differences in demand between countries.

Firm j selling in country i has a marginal cost of c_{ij} , which might consist of two components: a constant marginal cost of $c_j > 1$ for $j = 1, 2$ or 1 for $j = 3$ and a trade cost, due to one or all of transport costs, tariffs or non-tariff barriers, of τ if production takes place outside country i .

The foreign firm (firm 3) has to pay a fixed cost of F if it sets up a new plant in country 1 or 2, but may receive a location subsidy of S_i from government i to locate there.⁹ Firm 3 can alternatively acquire either firm 1 or 2 and produce in that firm's country, transferring its cost advantage and thus producing with a marginal cost of 0. The cost of acquiring a firm depends on its profitability, but we allow for a range of alternative prices. The highest acquisition price we allow for is equal to the profits made by the acquired firm before firm 3 enters the market, the lowest acquisition price is the profits that would be made by the acquired firm if firm 3 entered by greenfield FDI (the worst possible outcome for the target firm). The acquisition price is a weighted sum of these two prices, with a weighting of α given to the former and $(1 - \alpha)$ to the latter. This can be thought of as representing the outcome of a bargaining game between the predator and target, with a higher α representing higher bargaining power for the predator.

In the final output stage, Stage 3, firm j faces the following profit maximisation problem:

$$\max_{q_{ij}} \Pi_j = \sum_i \pi_{ij} = \sum_i (p_i - c_{ij})q_{ij} \quad (2)$$

This is solved to find Cournot outputs and prices under five different modes

plant in country 1 or 2.

⁹This subsidy is constrained to be positive, so a lump-sum tax is not possible in this model. We make this assumption as our focus is on competing for investment.

of entry by firm 3. These are greenfield FDI and acquisitions in country 1 (denoted $G1$ and $A1$ respectively) or country 2 ($G2$ and $A2$). For greenfield FDI in country 1 the outputs are:

$$\begin{aligned} q_{11}^{G1} &= \frac{a_1 - 3c_1 + c_2 + 1 + \tau}{4} & q_{21}^{G1} &= \frac{a_2 - 3c_1 + c_2 + 1 - 2\tau}{4} \\ q_{12}^{G1} &= \frac{a_1 + c_1 - 3c_2 + 1 - 3\tau}{4} & q_{22}^{G1} &= \frac{a_2 + c_1 - 3c_2 + 1 + 2\tau}{4} \\ q_{13}^{G1} &= \frac{a_1 + c_1 + c_2 - 3 + \tau}{4} & q_{23}^{G1} &= \frac{a_2 + c_1 + c_2 - 3 - 2\tau}{4} \end{aligned} \quad (3)$$

while for acquisition in 1 they are:

$$\begin{aligned} q_{11}^{A1} &= 0 & q_{21}^{A1} &= 0 \\ q_{12}^{A1} &= \frac{a_1 - 2c_2 + 1 - 2\tau}{3} & q_{22}^{A1} &= \frac{a_2 - 2c_2 + 1 + \tau}{3} \\ q_{13}^{A1} &= \frac{a_1 + c_2 - 2 + \tau}{3} & q_{23}^{A1} &= \frac{a_2 + c_2 - 2 - 2\tau}{3} \end{aligned} \quad (4)$$

Outputs for greenfield investment and acquisitions in country 2 can be seen simply by relabelling firms 1 and 2 above.

Total outputs and prices in country 1 in the five cases are given by:

$$\begin{aligned} Q_1^{G1} &= \frac{3a_1 - c_1 - c_2 - 1 - \tau}{4} & P_1^{G1} &= \frac{a_1 + c_1 + c_2 + 1 + \tau}{4} \\ Q_1^{A1} &= \frac{2a_1 - c_2 - 1 - \tau}{3} & P_1^{A1} &= \frac{a_1 + c_2 + 1 + \tau}{3} \\ Q_1^{G2} &= \frac{3a_1 - c_1 - c_2 - 1 - 2\tau}{4} & P_1^{G2} &= \frac{a_1 + c_1 + c_2 + 1 + 2\tau}{4} \\ Q_1^{A2} &= \frac{2a_1 - c_1 - 1 - \tau}{3} & P_1^{A2} &= \frac{a_1 + c_1 + 1 + \tau}{3} \end{aligned}$$

with similar expressions for country 2.

For each firm selling in each market profits, net of any fixed costs, lump-sum subsidies or acquisition payments, are equal to $\pi_{ij}^k = (q_{ij}^k)^2$, for $k = \{G1, A1, G2, A2, \}$. The acquisition price for the firm in country 1 is given by

$$AqPrice_1 = \alpha [\pi_{11}^D + \pi_{21}^D] + (1 - \alpha) [\pi_{11}^{G1} + \pi_{21}^{G1}] \quad (5)$$

where $\pi_{11}^D = \left(\frac{a_1 - 2c_1 + c_2 + \tau}{3}\right)^2$ and $\pi_{21}^D = \left(\frac{a_2 - 2c_1 + c_2 - 2\tau}{3}\right)^2$ are firm 1's duopoly profits in countries 1 and 2 before entry by firm 3. A similar expression exists for the acquisition price of firm 2.

2.1 No government intervention

Before considering the effects of government policies, we first consider what would happen if both governments were passive. The condition below is for firm 1's profits from greenfield FDI to be greater than those from acquiring the domestic firm:

$$\pi_{11}^{G1} + \pi_{21}^{G1} - F > \pi_{11}^{A1} + \pi_{21}^{A1} - AqPrice_1 \quad (6)$$

From this condition we can show that, in the absence of government intervention, there is a positive threshold level of fixed costs below which the firm will always choose greenfield investment. Equivalently, for any level of fixed costs, full reimbursement of these costs by an active government would lead to the foreign firm choosing greenfield investment.

Lemma 1 *In the absence of government intervention, there is always some positive level of fixed costs \tilde{F} below which the foreign firm will prefer greenfield investment to acquiring a domestic firm.*

Proof. We set $\alpha = 0$: this is the case where the acquisition price is lowest and hence the foreign firm's incentives will be most biased towards acquisition. From condition (6) we find that greenfield FDI will be preferred when:

$$\begin{aligned} & a_1^2 + a_2^2 + 14(a_1 + a_2) + 74c_1^2 - 44c_1 + 26 \\ & - 34(a_1 + a_2)c_1 + 18(a_1 + a_2)c_2 - 36c_1c_2 \\ & + (2a_1 - 4a_2 + 34c_1 - 18c_2 + 5\tau + 50)\tau - 72F > 0 \end{aligned} \quad (7)$$

For $F = 0$ this condition is always satisfied for combinations of other parameters that lead to positive outputs. Hence we can identify a positive value \tilde{F} below which the foreign firm will choose greenfield investment. Any increase of α above 0 will raise the acquisition price and give a greater incentive for greenfield investment, so \tilde{F} will increase. ■

2.2 Welfare functions

We now introduce an active government in country 1.¹⁰ We assume that the government does not set an output tax, but only a lump-sum subsidy.

¹⁰To avoid repetition, we do not define welfare functions for country 2 here, simply noting that they take the obvious forms.

Additionally, this subsidy is only ever given for greenfield investment; no acquisition will ever be subsidised, even if this would increase the country's welfare.

In order to consider the incentive the government might have to provide a subsidy, we first need to define the welfare function that the government aims to maximise. The components of welfare differ according to the type of investment by the foreign firm. In the case of greenfield FDI, welfare is the sum of consumer surplus in country 1, profits earned by firm 1 in both countries 1 and 2, minus any subsidy paid to the foreign firm¹¹.

$$W_1^{G1} = CS_1^{G1} + \pi_{11}^{G1} + \pi_{21}^{G1} - S_1 \quad (8)$$

The welfare function where country 1's firm is acquired differs in a number of ways. As mentioned above, no subsidy is given for acquisition. Also, the profit terms for the domestic firm are no longer present as it has been acquired by the foreign firm, so all profits leave the country. However, an extra term appears in the welfare function as the price paid for the domestic firm is now part of welfare, together with consumer surplus:

$$W_1^{A1} = CS_1^{A1} + AqPrice_1 \quad (9)$$

where $CS_1^{A1} = (Q_1^{A1})^2/2$ and $AqPrice_1$ is as given by equation (5).

Finally, welfare functions need to be defined for the cases where firm 3 does not invest in country 1. These functions, for the case where the firm does not invest in the region at all or produces in country 2 either through greenfield investment or acquiring firm 2, all take the same form. In all three cases, welfare takes a similar form to the case with greenfield FDI in country 1, but without the subsidy terms. For greenfield FDI in country 2,

$$W_1^{G2} = CS_1^{G2} + \pi_{11}^{G2} + \pi_{21}^{G2} \quad (10)$$

where $CS_1^{G2} = (Q_1^{G2})^2/2$. Replacing $G2$ throughout with $A2$ gives the last welfare function.

2.3 One Active Government

We now consider the case where only the government in country 1 is active. Further, we assume that any investment made by the foreign firm will be

¹¹We allow for positive spillovers in subsection 4.3.

in this country. Hence we consider the incentive for government 1 to use a subsidy to change the form of investment and identify cases where the government will offer a sufficiently high subsidy for firm 3 to change its mode of entry from $A1$ to $G1$.

Proposition 1 *In the case where only one government is active and when the foreign firm would otherwise enter by acquisition, the government will be willing to subsidise greenfield investment for sufficiently low acquisition prices. The subsidy required to change the form of investment is equal to $F - \tilde{F}$.*

Proof. First, we note that we only need consider cases where the firm would prefer acquisition in the absence of intervention, that is where fixed costs F exceed \tilde{F} as defined in Lemma 1. The necessary subsidy to induce the firm to change the nature of its investment is $\tilde{S} = F - \tilde{F}$. To identify when government 1 will be prepared to offer this subsidy we need to compare W_1^{G1} when $S_1 = 0$ and W_1^{A1} . The maximum subsidy the government will be willing to give is $\chi = W_1^{G1} - W_1^{A1}$. This subsidy is positive when

$$(CS_1^{G1} - CS_1^{A1}) + (\pi_{11}^{G1} - \pi_{21}^{G1}) - AqPrice_1 > 0 \quad (11)$$

The first term is positive as consumer surplus is higher for greenfield investment because of the presence of an additional firm, while the second term is also positive. The acquisition price is positive, hence the third term is negative.

When $\chi > 0$, the government is prepared to offer a subsidy. The subsidy required to change the form of investment is equal to \tilde{S} , hence when $\chi > \tilde{S}$ the government will offer a subsidy of \tilde{S} , the minimum which will be accepted by the firm.

Clearly from equation (11) an increase in α , which raises the acquisition price, will reduce the incentive to offer a subsidy. ■

3 Subsidy competition

We now introduce two active governments, and solve for the equilibrium of the three-stage game described in the previous section.

3.1 The lump-sum subsidy game

To keep things simple, we focus on a single-plant investment project with rival governments offering lump-sum subsidies. As already explained, we assume away acquisition subsidies. The MNC may now choose between two modes of investment and two locations, maximising profits inclusive of subsidies.

Before we turn to first-stage subsidisation decisions and solve the game by backward induction, we introduce some useful notation. Denote by S_1 and S_2 the subsidies simultaneously committed to by governments 1 and 2, respectively.¹² Denote by θ the investment type (location and mode) belonging to $\{G1, G2, A1, A2\}$, as defined in Section 2.

Denote by $\Delta_{ii'}^{kk'}$ the difference between gross profits (*excluding subsidies*), in location i using mode k and profits in location i' using mode k' , with $i, i' \in \{1, 2\}$ and $k, k' \in \{A, G\}$. This allows us to compare the payoffs associated with each investment type more easily. As an illustration, condition (6) may be rewritten as $\Delta_{11}^{GA} > 0$.

In an analogous way, denote by $\chi_{ii'}^{kk'}(i)$ the difference between gross welfare (*excluding subsidies*) in country i with location i' and mode k , and welfare in country i with location i'' and mode k' . As an illustration, government 1 prefers acquisition at home to greenfield investment in country 2 if $\chi_{12}^{AG}(1) > 0$.

The solution to the three-stage game will be denoted by a *triple* (S_1, S_2, θ) . There will be many different solutions to that game, depending on the particular form of welfare and profit functions. We therefore turn to a systematic exploration of all possible subgame-perfect equilibria.

The determination of the equilibrium of the subsidy game will depend on the location choice of the MNC in the absence of subsidisation. By convention, we suppose that country 1 hosts the MNC when subsidies are zero.¹³

We now state a Proposition determining which equilibrium prevails for general payoff functions. The proof, given in the Appendix, uses backward induction. In the next subsection, we shall apply this framework to our specific profit and welfare functions.

¹²We assume credible commitments. In real economic situations, concerns for reputation towards future investors may arguably be enough to discipline governments. However, they remain beyond the scope of our single-investment model.

¹³This simplifies the exposition. If we did not suppose this, the determination of the equilibrium would rest on how the MNC chooses its location in case of profit indifference. This amounts to labelling country 1 the country where the investment is most profitable. We later assume $a_1 > a_2$, which implies this.

Proposition 2 (Existence and unicity of the subgame-perfect equilibrium)

There exists a unique equilibrium of the three-stage game. The determination of the prevailing equilibrium follows the exhaustive set of conditions below:

1. $F < \tilde{F}$

- (a) If $\chi_{21}^{GG}(2) < \Delta_{12}^{GG}$ Equilibrium 1: $(0, 0, G1)$
- (b) If $\chi_{21}^{GG}(2) \geq \Delta_{12}^{GG}$
 - i. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} > \chi_{21}^{GG}(2)$ Equilibrium 2: $(\chi_{21}^{GG}(2) - \Delta_{12}^{GG}, 0, G1)$
 - ii. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} \leq \chi_{21}^{GG}(2)$ Equilibrium 3: $(0, \chi_{12}^{GG}(1) + \Delta_{12}^{GG}, G2)$

2. $F \geq \tilde{F}$

- (a) If $\chi_{11}^{GA}(1) \leq \Delta_{11}^{AG}$ and $\chi_{21}^{GA}(2) \leq \Delta_{12}^{AG}$ Equilibrium 4: $(0, 0, A1)$
- (b) If $\chi_{11}^{GA}(1) \leq \Delta_{11}^{AG}$ and $\chi_{21}^{GA}(2) > \Delta_{12}^{AG}$
 - i. If $\chi_{12}^{GG}(1) \leq \Delta_{11}^{AG}$ Equilibrium 5 : $(0, \Delta_{12}^{AG}, G2)$
 - ii. If $\chi_{12}^{GG}(1) > \Delta_{11}^{AG}$
 - A. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} > \chi_{21}^{GG}(2)$ Equilibrium 6: $(\chi_{21}^{GG}(2) - \Delta_{12}^{GG}, 0, G1)$
 - B. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} \leq \chi_{21}^{GG}(2)$ Equilibrium 7: $(0, \chi_{12}^{GG}(1) + \Delta_{12}^{GG}, G2)$
- (c) If $\chi_{11}^{GA}(1) > \Delta_{11}^{AG}$ and $\chi_{21}^{GA}(2) \leq \Delta_{12}^{AG}$
 - i. If $\chi_{21}^{GG}(2) < \Delta_{12}^{AG}$ Equilibrium 8: $(\Delta_{11}^{AG}, 0, G1)$
 - ii. If $\chi_{21}^{GG}(2) \geq \Delta_{12}^{AG}$
 - A. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} > \chi_{21}^{GG}(2)$ Equilibrium 9: $(\chi_{21}^{GG}(2) - \Delta_{12}^{GG}, 0, G1)$
 - B. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} \leq \chi_{21}^{GG}(2)$ Equilibrium 10: $(0, \chi_{12}^{GG}(1) + \Delta_{12}^{GG}, G2)$
- (d) If $\chi_{11}^{GA}(1) > \Delta_{11}^{AG}$ and $\chi_{21}^{GA}(2) > \Delta_{12}^{AG}$
 - i. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} > \chi_{21}^{GG}(2)$ Equilibrium 11: $(\chi_{21}^{GG}(2) - \Delta_{12}^{GG}, 0, G1)$
 - ii. If $\chi_{12}^{GG}(1) + \Delta_{12}^{GG} \leq \chi_{21}^{GG}(2)$ Equilibrium 12: $(0, \chi_{12}^{GG}(1) + \Delta_{12}^{GG}, G2)$

Proof. See the Appendix. ■

We may remark that these twelve potential cases give rise to only six different equilibria. In two of them (1 and 4), no intervention occurs. In another two (5 and 8), only one government chooses to intervene. The amount of subsidy offered is then the smallest necessary to induce the desired type of investment. In the last two (2 and 3, or 6 and 7, or 9 and 10, or 11 and 12)

both governments are willing to subsidise the MNC. Either one may outbid its opponent, hence two equilibria. Which country hosts the MNC depends on governments' valuations of the investment, in what amounts to a second-price auction for greenfield investment.

We have proved the existence of a unique subgame-perfect equilibrium. The determination of the prevailing equilibrium relies on the relative profitability of each investment type. Therefore our predictions must depend on the amount of fixed costs incurred by a greenfield investor. We introduce the following useful notation:

$$\begin{aligned}
\tilde{F} &= \Delta_{11}^{GA} + F \\
\hat{F} &= \chi_{11}^{GA}(1) + \Delta_{11}^{GA} + F \\
F_{56} &= \chi_{12}^{GG}(1) + \Delta_{11}^{GA} + F \\
\widehat{F} &= \chi_{21}^{GA}(2) + \Delta_{21}^{GA} + F \\
F_{89} &= \chi_{21}^{GG}(2) + \Delta_{21}^{GA} + F
\end{aligned} \tag{12}$$

Using these thresholds, we may now discuss the desirability of subsidy competition between governments for any potential investment project.

3.2 Welfare effects of subsidy competition

Recall from Proposition 2 that not all outcomes of the subsidy game may qualify as 'subsidy competition'. For instance if Equilibrium 1 or Equilibrium 4 prevails, then no intervention should take place. As a first step towards our welfare discussion, we give a characterisation of the prevailing equilibrium. We will then be able to discuss the welfare effects of subsidy competition, when it takes place at the equilibrium of the subsidy game.

Lemma 2 *For a particular investment project, the outcome of the subsidy game will depend on the value of the fixed cost incurred by a greenfield investor.*

- *Low fixed costs ($F < \tilde{F}$). Equilibrium 2 with subsidy competition obtains, unless country sizes (tastes) are too different, in the sense of Equation (18) (Equilibrium 1). In the special cases of symmetric countries and frictionless trade, Equilibrium 3 obtains.*

- *Intermediate fixed costs ($\tilde{F} \leq F < \bar{F}$). For a low acquisition price, Equilibrium 9 obtains for the lower part of the fixed-cost interval, and Equilibrium 8 obtains for the higher part. For an intermediate acquisition price, only Equilibrium 9 obtains. For a high acquisition price the fixed-cost interval does not exist (Equilibrium 4). Special cases occur if country sizes (tastes) are too different (Equilibrium 8 irrespective of α) or in case of symmetry of perfect integration (Equilibrium 10 instead of Equilibrium 9).*
- *High fixed costs ($F \geq \bar{F}$). Equilibrium 4 occurs and no subsidy competition takes place.*

Proof. See the Appendix. ■

We may now use this prediction to assess the welfare effects of subsidy competition. Whenever subsidy competition takes place in equilibrium, we measure regional welfare against the benchmark case of no intervention.

Proposition 3 (Effects of subsidy competition on regional welfare)

For low values of the fixed cost ($F < \tilde{F}$), subsidy competition reduces social welfare, compared to no intervention.

For intermediate values of the fixed cost ($\tilde{F} \leq F < F_{89}$), subsidy competition is socially harmful when the acquisition price is higher than some threshold price, and socially beneficial otherwise.

For higher values of the fixed cost, subsidy competition increases welfare.

Proof. See the Appendix. ■

This proposition states that in many cases, putting an end to subsidy competition should enhance welfare in the region as a whole.

In particular, this is always true when fixed costs are low, in the sense that greenfield investment is relatively more profitable without any subsidies. In that case, the ability of both governments should affect neither the location outcome nor the mode of investment (G1). Indeed, save for the knife-edge cases of symmetric countries or perfect trade integration, country 1 hosts the MNC. But it will pay government 2's willingness to subsidise. Subsidy

expenditure is clearly a pure transfer of social surplus from the region to the multinational.

Higher fixed costs imply that the most profitable investment mode is by acquisition. This should put a check on governments' ability to subsidise the MNC, as they must now compensate for the profit differential between investment modes.

For intermediate values of the fixed costs, however, both governments are willing to subsidise the MNC. As in the low fixed costs case, government 1 should win the contest, save for two special cases. But how desirable this outcome is will depend on the opportunity cost of greenfield investment. This opportunity cost depends strongly on the foregone acquisition price, and therefore on the parameter α . Hence for a high α , subsidy competition is harmful because the distortion on the MNC's preferred investment type goes in a socially unwanted direction.

By contrast, for higher values of the fixed cost, but still lower than predicted in Lemma 4 ($F > F_{89}$), government 2 will refrain from bidding. Government 1 will therefore be able to replicate a single government's intervention. This leads to a welfare gain. Indeed, greenfield investment is in that case less profitable but socially more desirable, justifying government 1's intervention.

3.3 The scope for policy co-ordination

We conclude this section by a word on policy co-ordination. We just saw that a bilateral ban of subsidies to greenfield FDI may actually benefit member countries of a PTA. However, could a superior policy not be implemented by way of a co-ordination agreement?

To answer this question, we need once again to take into account the value of fixed costs. For low fixed costs ($F < \tilde{F}$) the first-best policy is to allow for greenfield investment in country 1 without intervention. This may be achieved by an outright ban of subsidies, as explained above. For very high fixed costs ($F \geq \bar{F}$), subsidy competition never occurs and the first-best outcome is achieved (Lemma 4).

For intermediate values of the fixed cost, we have just seen that the most desirable outcome would be greenfield investment in country 1 with the minimum necessary subsidy. This would replicate a single government's intervention. However, this outcome is only reached for relatively high-fixed-cost projects.

There is therefore some scope for policy co-ordination. Targeting the likely winner of the auction and enforcing a subsidy cap could increase total welfare. Implementing such co-ordination seems more realistic at the sub-national level, as a central government could monitor targeting programs and subsidy caps.

In practice however, only one such agreement has ever been implemented. Through the 1995 'Internal Trade Agreement', Canadian provinces have committed to 'avoid engaging into bidding wars'. While no formal subsidy cap has been implemented, our model suggests that this is a step in the right direction. But the provision, allowing provinces to raise expenditure when potential foreign (U.S.) rival locations exist, underlines the need for co-ordination at a higher level of jurisdiction.

4 Comparative statics

We may now see how our predictions are affected by exogenous changes in parameter values. These comparative statics shed some light on the effects of trade integration, increased competition for targets, and the generation of positive spillovers on the host country.

4.1 Effects of trade integration

The effects of reductions in trade costs may be categorised as follows:

- a change in the scope of fixed costs under which a particular equilibrium prevails;
- a change in the prevailing equilibrium, for a given fixed cost;
- an increase in the amount of subsidies, for a given fixed cost.

The desirability of subsidy competition will depend on the amount of subsidy expenditure, but also on changes in the prevailing equilibrium that may be translated into welfare changes. We know from the previous analysis that equilibrium conditions are sensitive to changes in τ . We also know that Equilibria 2 and 9 (for high values of the acquisition price) imply that subsidy competition generates social waste compared to no intervention. On the other hand, under equilibria 8 and 9 (for a sufficiently low α) welfare is greater than in the case of harmonisation. In order to investigate the effects

of regional integration on the effects of subsidy competition, we can simply ask how reductions in τ affect the likelihood of these harmful or beneficial equilibria.

We begin with the case of low fixed costs ($F < \tilde{F}$). We state the following result:

Proposition 4 *Trade integration leads to increased socially inefficient competition for low-fixed-cost projects. In particular, it causes subsidy expenditure to rise.*

Proof. This result may be decomposed and proved in three parts, following our categorisation of the effects of trade integration.

First, a reduction in τ increases \tilde{F} , as may be seen from:

$$\frac{\partial \tilde{F}}{\partial \tau} = \frac{1}{72} [(a_1 - 2a_2)(2 + 7\alpha) + (5\alpha + 18)c_1 - (2 + 7\alpha)c_2 + (35\alpha + 10)\tau + 9\alpha - 14]$$

which is negative. Therefore, regional integration also increases the scope of investment projects for which Equilibrium 2 obtains.

Second, trade integration also affects the prevailing equilibrium for a given fixed cost. Whenever $F < \tilde{F}$, only Equilibria 1, 2 and 3 may occur. Recalling that Equilibrium 3 is possible only under very special conditions, we may focus on Equilibria 1, under which subsidy competition has no effect, and 2, which implies social waste. We first prove how integration may lead to an equilibrium with intervention from government 1, and then assess the welfare loss in comparison to the absence of such subsidies. Straightforward calculations show that:

$$\chi_{21}^{GG}(2) - \Delta_{12}^{GG} = -\tau \frac{1}{32} (2 + 8a_1 - 14a_2 + 2c_2 + 2\alpha + 19\tau)$$

Rewriting this expression, it follows that whenever fixed costs are low ($F < \tilde{F}$), an equilibrium with subsidies (Equilibrium 2) exists if and only if:

$$a_2 > \frac{4}{7}a_1 + \frac{1}{7}(1 + c + \alpha) + \frac{19}{14}\tau \iff \tau < \frac{14}{19}a_2 - \frac{8}{19}a_1 - \frac{2}{19}(1 + c + \alpha) \quad (13)$$

Therefore country differences or trade costs must be low enough to allow for subsidy competition. Denote by $\bar{\tau}$ the above threshold trade cost. It follows

that trade integration beyond this threshold causes socially harmful subsidy competition.

Finally, let us determine how integration affects the amount of subsidies. Observe that the derivative of Equilibrium 2 subsidies with respect to τ equals:

$$\frac{\partial \chi_{21}^{GG}(2) - \Delta_{12}^{GG}}{\partial \tau} = \frac{1}{16}(7a_2 - 4a_1 - c_1 - c_2 - 19\tau - 1) \quad (14)$$

This derivative will be positive only at intermediate stages of trade integration (in particular, when $\tau > \frac{\tau}{2}$). Beyond this threshold, trade integration increases the amount of subsidies under Equilibrium 2. It therefore raises the transfer of social surplus to the MNC.

To conclude, significant trade integration increases both the likelihood and intensity of harmful subsidy competition. ■

We now turn to the case of high fixed costs. We are interested in Equilibria 8 and 9 since Equilibrium 4 involves no intervention. Welfare gains from subsidy competition may only arise when either Equilibrium 8 or 9 with a low acquisition price obtain. How likely this is depends on the extent of regional integration. We state the following result.

Proposition 5 *Trade integration has mixed effects on subsidy competition for high-fixed-cost investment projects. It makes the existence of beneficial subsidy competition likelier, but it increases the amount of subsidy expenditure, which reduces the welfare gain from subsidy competition.*

Proof. Notice that in the high-fixed-cost interval, which equilibrium prevails is entirely determined by the fixed cost. We prove the first part of the Proposition by showing how trade integration widens the fixed-cost interval consistent with beneficial subsidy competition. To prove the second part, we show that subsidy expenditure decreases in τ .

The first part of the proposition means that equilibrium 8 is more likely with lower transport costs. To prove it, we need to differentiate \bar{F} and F_{89} . Recall from Lemma 2 that $\bar{F} = \hat{F}$. Hence:

$$\begin{aligned}\frac{\partial \widehat{F}}{\partial \tau} &= \frac{1}{144}(-35 + 9a_1 - 8a_2 + 45c_1 - 11c_2 + 13\tau) \\ \frac{\partial F_{89}}{\partial \tau} &= \frac{1}{144}(-37 + 27c_1 - 13c_2 + a_2(55 - 28\alpha) + 18\alpha \\ &\quad + 10c_1\alpha - 14c_2\alpha + 2a_1(-16 + 7\alpha) - 151\tau + 70\alpha\tau)\end{aligned}$$

To sign these derivatives, we need to distinguish between symmetric and asymmetric regions, in the sense of Equation (13). For a symmetric region, observe that both derivatives are positive. The first derivative implies a reduction in the likelihood of Equilibrium 8. The second one implies the opposite, so we need to sign $\frac{\partial \widehat{F}}{\partial \tau} - \frac{\partial F_{89}}{\partial \tau}$ in order to determine the net effect. Since this is negative, Equilibrium 8 will be more likely. For an asymmetric region, we know from Equation (13) that government 2 never intervenes. Therefore, only Equilibria 4 or 8 obtain. Since the derivative in Equation (15) is negative for sufficiently different countries, Equilibrium 8 will be more likely as integration proceeds. This proves the first part of the Proposition.

As to subsidies, notice first that subsidies under Equilibrium 9 are identical to those offered under Equilibrium 2. As we have already shown, these increase as a result of integration. Second, subsidies under Equilibrium 8 equal Δ_{11}^{AG} , whose derivative with respect to τ writes

$$\frac{\partial S(8)}{\partial \tau} = \frac{1}{72}(14 - 9\alpha - c_1(5\alpha + 18) + c_2(7\alpha + 2) - (a_1 - 2a_2)(7\alpha + 2) - 10\tau - 35\alpha\tau)$$

This expression is positive for sufficiently similar sizes and negative otherwise. Hence subsidy expenditure rises as a result of integration. ■

To understand Propositions 4 and 5 we need to consider the effects of trade integration on welfare under the alternative forms of investment. Both $G1$ and $A1$ become more attractive to country 1 (and $G2$ and $A2$ to country 2) as the gains from having the firm located in a country are higher with lower τ . Indeed, total output, and hence national welfare, decreases more with tariffs when the investment is made abroad rather than at home. This in itself explains why equilibria with subsidies and subsidy competition are more likely with lower τ when fixed costs are low, as acquisition never occurs in such cases and the incentive for each government to try to attract investment increases. However, with higher fixed costs, we need to explain why higher subsidies are given for greenfield investment when acquisition is a feasible

alternative. In this case, we need to compare the (positive) effects on welfare of reducing τ on welfare under the two types of investment. We find that the welfare gain with greenfield investment is higher, again because of a higher marginal effect of a tariff decrease on total surplus. Hence again the incentive for both countries to offer subsidies increases.

That subsidy competition may have beneficial welfare effects in our framework should now be clear. Subsidy competition may be justified on welfare grounds whenever social preferences over investment modes are at odds with the MNC's. Trade integration raises the scale of intervention, shifting up expenditure for a typical project, as well as its scope, making ever costlier projects eligible. Welfare gains from intervention should be lower both at the intensive and extensive margins.

4.2 Increased competition for targets

In our model, a structural increase in competition for corporate targets should lead to a rise in the acquisition price captured by a rise in α . We have already shown how sensitive to changes in the acquisition price the possibility of social waste under subsidy competition may be. We formally tackle this issue here by performing comparative statics of our model with respect to α .

Proposition 6 (Welfare effects of increased competition for targets)

Under subsidy competition, a rise in the acquisition price increases the range of possibilities for social waste.

Proof. We know from Section 3 that there is social waste whenever the prevailing Equilibrium is 2, 3, 9 or 10. To see how changes in α modify the plausibility of such equilibria, we simply have to differentiate the pertinent thresholds with respect to α .

$$\begin{aligned} \frac{\partial F_{89}}{\partial \alpha} = \frac{\partial \tilde{F}}{\partial \alpha} &= \frac{1}{9} [(a_2 - 2c_1 + c_2 - 2\tau)^2 + (a_1 - 2c_1 + c_2 + \tau)^2] \\ &\quad - \frac{1}{16} [(a_2 - 3c_1 + 1 + c_2 - 2\tau)^2 + (a_1 - 3c_1 + 1 + c_2 + \tau)^2] \\ \frac{\partial \hat{F}}{\partial \alpha} &= 0 \\ \frac{\partial \chi_{21}^{GG}(2) - \Delta_{12}^{GG}}{\partial \alpha} &= 0 \end{aligned}$$

where the last expression determines whether subsidy competition takes place for low fixed costs, as shown in Equation (14).

Recalling that $c_1 \geq 1$, it becomes evident that the sign of the first derivative is positive¹⁴. Recall as well that an increase of \tilde{F} expands the areas in which Equilibria 2 or 3 are possible. Increasing F_{89} also implies a greater plausibility of Equilibrium 9. We know from Proposition 3 that Equilibria 2, 3 and 9 (for high acquisition prices) imply social waste. Thus, tougher competition for corporate targets should lead to increased harmful subsidy competition, all else equal. This completes the proof. ■

The intuition behind this result comes directly from considering the effects of raising the acquisition price on the type of equilibrium. From the firm's point of view, a higher α automatically makes acquisition more costly and biases the firm towards greenfield investment. Hence we would expect financial integration to lead to more equilibria with the latter type of entry. Additionally, for cases where the firm would still choose acquisition without intervention, the subsidy required to induce investment will fall, leading to more cases where either one or both governments are willing to pay the subsidy needed to induce greenfield investment.

4.3 The effect of spillovers

One important justification for granting subsidies to foreign direct investors has been the existence of positive spillovers to the host country¹⁵. MNC activities may generate both horizontal (within-sector) or vertical (inter-sector) externalities. Vertical spillovers might arise for a number of reasons, most notably due to employment effects or improved technological learning in a vertically linked sector. Horizontal spillovers are also plausible through imitation and increased competition.

In this section we bring the possibility of FDI spillovers into the analysis. Empirical research on the field finds evidence of vertical FDI spillovers but it is less conclusive on the relevance of horizontal spillovers¹⁶. For this reason,

¹⁴Notice that it is equal to twice the acquisition price when $\alpha = \frac{1}{2}$, and hence must be positive.

¹⁵See, for instance, Blömstrom and Kokko (2003)

¹⁶Aitken and Harrison (1999) find no evidence of horizontal spillovers in Venezuelan manufacturing. Blyde et al. (2004) replicate the same results for horizontal spillovers but find significant positive vertical spillovers. Kugler (2005) and Javorcik (2004) provide evidence of vertical spillovers taking place through contacts with local upstream suppliers

we focus on vertical spillovers¹⁷.

Vertical spillovers are assumed to be proportional to the output of the foreign firm producing in 1 or 2, hence equal to $\phi(q_{13} + q_{23})$. They will not depend on the investment mode chosen by the MNC. While governments are assumed to recognise these spillovers, we maintain the assumption of subsidies being conditional on greenfield investment.

Using augmented welfare functions, we can predict the outcome of the subsidy game¹⁸.

Lemma 3 *There exists a threshold $\bar{\phi}$ such that when the spillover parameter exceeds that threshold, the prevailing equilibrium is predicted to be as follows:*

- if $F < \tilde{F}$, then Equilibrium 2 prevails;
- if $\tilde{F} \leq F < \hat{F}$, then Equilibrium 11 prevails;
- if $\hat{F} \leq F < \widehat{\hat{F}}$, then Equilibrium 6 prevails;
- if $F \geq \widehat{\hat{F}}$, then Equilibrium 4 obtains.

Proof. Notice that this ranking of threshold fixed costs may depend on the acquisition price, as the interval $[\tilde{F}, \hat{F}]$ may not exist for values of α close to one.

First, it may be seen that F_{56} is always greater than $\widehat{\hat{F}}$, from:

$$F_{56} - \widehat{\hat{F}} = \frac{1}{288} [14(a_1)^2 - 3(a_2)^2 - 90c_1 - 45(c_1)^2 - 26c_2 - 61(c_2)^2 + 198c_1c_2 + 16c_2\tau - a_1(36c_1 + 20c_2 - 28 - 70\tau) + a_2(18 + 18c_1 - 30c_2 - 54\tau) + 35 - 32\tau - 94\tau^2]$$

Second, recall that absent spillovers, $\hat{F} > \widehat{\hat{F}}$ always holds. However, consider the following derivatives with respect to ϕ :

¹⁷For an analysis of the effects of subsidy competition for greenfield investment in presence of horizontal spillovers see Fumagalli (2004).

¹⁸We rule out the possibility of countries being asymmetric in the sense of Equation (13), as well as the special cases of perfectly symmetric countries and perfect trade integration. The occurrence of the corresponding equilibria, 1 and 3, should now be well understood.

$$\begin{aligned}\frac{\partial \tilde{F}}{\partial \phi} &= 0 \\ \frac{\partial \hat{F}}{\partial \phi} &= \frac{1}{288} (96(a_1 + a_2) + 192c_2 - 384 - 96\tau) \\ \frac{\partial \tilde{F}}{\partial \phi} &= -\frac{1}{288} (24(a_1 + a_2) - 144c_1 + 48c_2 + 48 - 24\tau)\end{aligned}$$

\tilde{F} , being a profit differential, is left unchanged, by the existence of spillovers. However, \hat{F} increases in ϕ , while \tilde{F} decreases. In addition, the magnitude of the former derivative is larger than that of the latter.

Straightforward though tedious calculations also show that, in the absence of spillovers, $\tilde{F} - \hat{F} > \hat{F} - \tilde{F}$. By continuity, it follows that for a high enough $\phi > \bar{\phi}$, we have the following ranking: $\tilde{F} < \hat{F} < \tilde{F} < F_{56}$. The prediction of the prevailing Equilibrium directly follows from Proposition 2.

Lastly, recall that \hat{F} (measuring government 1's preference for greenfield investment) decreases with α , while \tilde{F} (measuring the MNC's preference for greenfield investment) increases. There must therefore be some critical value of the acquisition price for which the former becomes lower than the latter. According to Proposition 2, Above that critical value no Equilibrium 11 may exist. ■

Recall that Equilibria 2, 11, and 6 are all essentially identical and resemble the outcome of a second-price auction won by government 1.

Let us now comment on the difference with our previous characterisation. When spillovers through backward or forward linkages are significantly high, government 2 has a stronger incentive to enter subsidy competition when acquisitions are more likely. Hosting the MNC now becomes socially more valuable against the alternative of acquisition abroad, which previously proved beneficial to local firms. Meanwhile, introducing mode-independent spillovers does not affect social preferences over investment types in country 1.

Raising 2's willingness to subsidise results in equilibria with higher subsidy levels. We may now describe the welfare effects of subsidy competition in that setting.

Proposition 7 (Welfare evaluation with vertical spillovers) *Consider the existence of significantly high vertical spillovers in the sense of Lemma 3.*

If fixed costs are low, then subsidy competition reduces social welfare compared to no intervention.

If fixed costs are high, subsidy competition reduces social welfare compared to no intervention, except for a low acquisition price. The threshold price decreases with the extent of spillovers.

Proof. By Lemma 3, Equilibrium 2 obtains when $F < \tilde{F}$. In that case, as proved earlier, subsidisation does not affect the chosen investment mode while subsidy expenditure reduces welfare. Spillovers are enjoyed by the host country independent of subsidy competition. Hence a ban on subsidies may increase welfare.

When $\tilde{F} \leq F < \bar{F}$, then a Bertrand-like equilibrium obtains, in which government 1 wins the bidding contest. While subsidies are greater than necessary, they still allow to distort the MNC's choice towards greenfield investment. The overall welfare effect will therefore depend on α .

Define the welfare differential between subsidy competition at Equilibria 11 or 6 and no intervention as:

$$K(\alpha, \phi) = \chi_{11}^{GA}(1) + \chi_{11}^{GA}(2) - (\chi_{21}^{GG}(2) - \Delta_{12}^{GG})$$

By the proof of Proposition 3, we already know that the function $K(\alpha, 0)$ has a unique root denoted by α^{***} . Notice that $K(\alpha, \phi)$ is decreasing in ϕ , and that the cross-derivative is equal to zero. It follows that for a strictly positive ϕ , the root of $K(\alpha)$ must be smaller than α^{***} . Tedious calculations show that the sign of $K(\alpha, \bar{\phi})$ will depend on other variables such as production and trade costs. In any case, overlooking vertical spillovers understates the detrimental welfare effects of subsidy competition.

Lastly, note that $\chi_{21}^{GG}(2) - \Delta_{12}^{GG}$ is increasing in ϕ , implying even greater subsidy expenditure than in the absence of spillovers. ■

Paradoxically, it is when FDI is most beneficial that competition is most often harmful. This may be understood if one considers that the likely winner of that competition would also host the MNC without such competition. When spillovers are negligible, as in the previous analysis, government 2's intervention is less likely. From a welfare point of view, it may accommodate acquisition in the other country due to the beneficial effect on its producer

surplus. However, when there are significant vertical spillovers, government 2 always joins the bidding contest, which results in Bertrand-like outcomes.

Whether subsidy competition raises welfare ultimately depends on the acquisition price. Indeed, that price equals a transfer from the MNC to the region. If it is high, then distorting the choice of the investment mode towards greenfield investment will prove detrimental. Otherwise, it will have positive welfare consequences.

5 Conclusions

We have developed a model of subsidy competition for MNCs' location in PTAs, that brings into the analysis the possibility of acquisitions as an alternative to greenfield investment.

With a single government, introducing acquisitions creates a particular motive for subsidisation: to align the firm's preferences with social preferences over investment modes. This will have relevance when acquisition is more desirable to the MNC than to home residents. In particular, this occurs when the acquisition price is not high enough to offset the pro-competitive effect of greenfield FDI on the host country.

When governments compete over FDI, however, this motive for subsidisation is partially lost. In most cases, governments are able and willing to offer more than what is necessary to distort the investment mode chosen by the MNC. Under these situations, a simple ban on subsidies (subsidy harmonisation) should improve regional welfare.

Subsidisation will remain justifiable for an interval of moderately large fixed costs (resulting in what we call Equilibrium 8). Interestingly, our analysis rejects the intuitive view that the largest investment projects are the most socially valuable, and hence more eligible for subsidisation. Indeed, we always find a fixed-cost threshold above which governments should not impede acquisition. In practice, determining if a project's expected fixed costs actually fall short of our threshold may be difficult. Hence subsidy competition, even in the most favourable cases, should in our view be considered with caution.

These results complement those previously found in the literature which, focusing exclusively on greenfield investment, generally make a positive assessment of subsidy competition.

Adding positive vertical spillovers to the picture may alter the prediction on the outcome of the subsidy game. Without any spillovers, efficiency gains may sometimes make the non-host country prefer acquisition abroad than greenfield investment at home. When significant spillovers arise from FDI, this phenomenon does not occur, which raises the potential non-host country's willingness to pay. We predict fiercer competition than in the absence of spillovers. We then find it even more doubtful that subsidy competition might increase welfare relative to subsidy harmonisation.

The model also predicts that falling trade costs, or upward pressure on acquisition prices, widen the scope for harmful subsidy competition, or reduce its gains when it is beneficial.

We believe that our model provides rich insights on the effects of subsidy competition between trading partners. With the issue of subsidy competition becoming more relevant, and problematic, reflection on potential institutional solutions is surely needed. In this respect, we point out that most of our analysis may be carried at the sub-national level. This suggests that emerging solutions to intra-national subsidy wars could serve as an inspiration in an international setting. Still, the political economy aspects of implementing such co-ordination are left for future research.

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Appendix 1: Existence and unicity of equilibrium (Proof of Proposition 2)

We solve for subgame-perfect equilibria of the three-stage game using backward induction. It is assumed throughout that no acquisition subsidies are available and that greenfield subsidies are constrained to be non-negative.

Anticipating later results, we may put a bit more structure on social preferences over investment types. Suppose that A2 always leads to lower

profits than $A1$, and that each government prefers greenfield investment at home to abroad. We will later show that these inequalities hold weakly.

Third stage As mentioned in the main text, third stage outputs are not affected by government intervention, because subsidies are lump-sum. Outputs are given by equations (3-4), and profits equal the sum over countries of squared outputs.

Second stage The MNC will choose an investment type $\theta \in \{G1, G2, A1, A2\}$ so as to maximise profits inclusive of subsidies. Since $A2$ is payoff-dominated for the MNC, it will maximise profits (inclusive of subsidies) over three location alternatives rather than four. It is then straightforward to write the optimal decision rule:

$$\theta(S_1, S_2) = \begin{cases} A1 & \text{if } 0 \leq S_1 \leq \Delta_{11}^{AG} \text{ and } 0 \leq S_2 < \Delta_{12}^{AG} \\ G1 & \text{if } S_1 > \Delta_{11}^{AG} \text{ and } S_1 > S_2 - \Delta_{12}^{GG} \\ G2 & \text{if } S_2 \geq \Delta_{12}^{AG} \text{ and } S_1 \leq S_2 - \Delta_{12}^{GG} \end{cases} \quad (15)$$

In case of indifference, we make the arbitrary assumption that $G2$ is chosen ahead of $G1$, and $A1$ ahead of $G1$ and $G2$.

The above location decision rule invites us to distinguish between two cases: when the MNC would prefer greenfield investment without intervention ($F < \tilde{F}$), or when it would prefer acquisition ($F \geq \tilde{F}$).

First stage: $F < \tilde{F}$ Governments maximise national welfare minus subsidy expenditure. Both governments prefer investment at home than abroad, and will pay no subsidies if the MNC is predicted to invest abroad¹⁹. The MNC prefers greenfield investment to acquisition in the absence of subsidies. Hence we must have three types of candidate equilibria: $(0, 0, G1)$, $(S_1, 0, G1)$, $(0, S_2, G2)$.

Consider the candidate equilibrium $(0, 0, G1)$. Governments' willingness to subsidise will equal the welfare gain due to investment at home to abroad, i.e. $\chi_{12}^{GG}(1)$ and $\chi_{21}^{GG}(2)$ for governments 1 and 2 respectively. Obviously government 1 will not intervene against a zero subsidy by its rival. Then

¹⁹In addition, we assume that in case of a tie, governments offer a subsidy anyway. The widespread popularity of greenfield investment among policy-makers suggests this assumption is realistic.

using Equation (15), Equilibrium $(0, 0, G1)$ obtains if government 2's best-reply to a zero subsidy is a zero subsidy, or:

$$0 > \chi_{21}^{GG}(2) - \Delta_{12}^{GG}$$

If this inequality holds, then Equilibrium 1 exists and is the unique subgame-perfect equilibrium.

When this inequality does not hold, subsidy competition occurs. Recall that investment at home is preferred to abroad, but that subsidies enter welfare functions additively and negatively. Therefore, governments' best-reply subsidies must equal:

$$\begin{aligned} S_1^*(S_2) &= \min\{S_2 - \Delta_{12}^{GG} - \epsilon, \chi_{12}^{GG}(1)\} \\ S_2^*(S_1) &= \min\{S_1 + \Delta_{12}^{GG} - \epsilon, \chi_{21}^{GG}(2)\} \end{aligned}$$

where ϵ may be arbitrarily small.

The exact intersection depends on a comparison of governments' willingness to subsidise. Government 2 (respectively, 1) receives the investment if the following inequality holds (does not hold):

$$\chi_{12}^{GG}(1) + \Delta_{12}^{GG} \leq \chi_{21}^{GG}(2)$$

This proves the existence and unicity of Equilibria 2 and 3. Note that the prevailing equilibrium resembles an asymmetric Bertrand equilibrium, or a second-price auction with complete information and asymmetric valuations.

First stage: $F \geq \tilde{F}$ The MNC prefers acquisition in the absence of intervention. Since incentives only apply to greenfield investment, an equilibrium with acquisition exists if and only if governments' willingness to subsidise falls short of profit differentials. Note that by Equation (15), $\forall S_1 \in [0, \Delta_{11}^{AG}], \forall S_2 \in [0, \Delta_{12}^{AG}], \theta(S_1, S_2) = A1$. Hence against a subsidy conducive to A1, the maximum willingness to subsidise is given by welfare differentials between A1 and greenfield investment at home. This may be written as :

$$\chi_{11}^{GA}(1) \leq \Delta_{11}^{AG} \tag{16}$$

$$\chi_{21}^{GA}(2) \leq \Delta_{12}^{AG} \tag{17}$$

This is true in particular if the left-hand-side terms are negative, meaning that $A1$ is strictly preferred by both governments to all other investment types. More generally, if these inequalities hold, then governments will remain inactive rather than offer subsidies likely to overturn the MNC's location decision. From Equation (15) the Equilibrium is: $(0, 0, A1)$. This proves the existence and unicity of Equilibrium 4.

When Equations (16) and (17) do not hold jointly, we are left with three alternatives. From Equation (15) we know that all remaining alternatives will involve greenfield investment, as at least one government will successfully intervene. Indeed, in each case at least one government will prefer greenfield investment at home by a large enough welfare differential.

Consider first the case where Equation (16) holds and Equation (17) does not hold. Government 2 will consider intervention. We must distinguish between two sub-cases, according to government 1's best-reply to an S_2 large enough to influence the MNC. In the first sub-case, if $\chi_{12}^{GG}(1) \leq \Delta_{11}^{AG}$, then government 1 never finds it in its interest to intervene against a subsidy conducive to $G2$. But we already had that government 1 would not intervene against a subsidy conducive to $A1$. Hence government 1's best-reply strategy is to refrain from intervention (a horizontal flat best-reply schedule at zero). Thus when the above condition holds, the equilibrium must be $(0, \Delta_{12}^{AG}, G2)$, independent of 2's behaviour. This proves the existence and unicity of Equilibrium 5. In the second sub-case, if $\chi_{12}^{GG}(1) > \Delta_{11}^{AG}$, then intervention from 1 is possible. Again, the game resembles a Bertrand pricing game, but it is made more complicated due to the possibility of acquisition in country 1. Indeed, government 1's best-reply against a subsidy conducive to $A1$ is not to intervene; however, its best-reply against a subsidy conducive to $G2$ is to make a slightly better bid. Hence the discontinuity in government 1's best-reply. Government 2's best-reply against a subsidy conducive to $A1$ is to simply compensate for the profit differential. Against a larger subsidy it needs to make a slightly better bid. Thus governments' best-reply subsidies must equal:

$$S_1^*(S_2) = \begin{cases} 0 & \text{if } S_2 < \Delta_{12}^{AG} \\ \min\{S_2 - \Delta_{12}^{GG} - \epsilon, \chi_{12}^{GG}(1)\} & \text{if } S_2 \geq \Delta_{12}^{AG} \end{cases}$$

$$S_2^*(S_1) = \begin{cases} \Delta_{12}^{AG} & \text{if } S_1 < \Delta_{11}^{AG} \\ \min\{S_1 + \Delta_{12}^{GG} - \epsilon, \chi_{21}^{GG}(2)\} & \text{if } S_1 \geq \Delta_{11}^{AG} \end{cases}$$

where ϵ may be arbitrarily small. As previously, the outcome of the sub-

sidy game hinges on the comparison between governments' willingness to subsidise. Government 2 (respectively, 1) receives the investment if the inequality in Equation (5) holds (does not hold). This proves the existence and unicity of Equilibria 6 and 7.

Consider now the second of our three cases, where Equation (16) does not hold and Equation (17) holds. This means that government 1 prefers greenfield investment at home to $A1$ by some margin, unlike government 2. Government 1 will consider intervention. We must distinguish between two sub-cases, according to government 2's best-reply against a subsidy conducive to $G1$. In the first sub-case, if $\chi_{21}^{GG}(2) \leq \Delta_{12}^{AG}$, then government 2 never finds it in its interest to intervene against a subsidy conducive to $G1$. But we already had that government 2 would not intervene against a subsidy conducive to $A1$. Hence government 2's best-reply strategy is to refrain from intervention (a flat vertical best-reply schedule). Thus when the above condition holds, the equilibrium must be $(\Delta_{11}^{AG}, 0, G1)$, independent of 2's behaviour. This proves the existence and unicity of Equilibrium 8. In the second sub-case, if $\chi_{21}^{GG}(2) > \Delta_{12}^{AG}$, then intervention from 2 is possible. Again, the game resembles a Bertrand pricing game, but it is made more complicated due to the possibility of acquisition in country 1. Indeed, in this sub-case, government 2's best-reply against a subsidy conducive to $A1$ is not to intervene, whereas its best-reply against a subsidy conducive to $G2$ is to make a slightly better bid. Hence the discontinuity in government 2's best-reply schedule. Government 1's best-reply against a subsidy conducive to $A1$ is to simply compensate for the profit differential. Against a larger subsidy it need make a slightly better bid. Thus governments' best-reply subsidies must equal:

$$S_1^*(S_2) = \begin{cases} \Delta_{11}^{AG} & \text{if } S_2 < \Delta_{12}^{AG} \\ \min\{S_2 - \Delta_{12}^{GG} - \epsilon, \chi_{12}^{GG}(1)\} & \text{if } S_2 \geq \Delta_{12}^{AG} \end{cases}$$

$$S_2^*(S_1) = \begin{cases} 0 & \text{if } S_1 \leq \Delta_{11}^{AG} \\ \min\{S_1 + \Delta_{12}^{GG} - \epsilon, \chi_{12}^{GG}(2)\} & \text{if } S_1 > \Delta_{11}^{AG} \end{cases}$$

where ϵ may be arbitrarily small. As previously, the outcome of the subsidy game will depend on which government's willingness to subsidise is the greater. Government 2 (respectively, 1) receives the investment if the inequality in Equation (5) holds (does not hold). This proves the existence and unicity of Equilibria 9 and 10.

In the third and last case, Equations (16) and (17) both hold, implying that governments prefer greenfield investment at home rather than $A1$ and will intervene. It should now be clear that governments' best-reply subsidies will be given by:

$$S_1^*(S_2) = \begin{cases} \Delta_{11}^{AG} & \text{if } S_2 < \Delta_{12}^{AG} \\ \min\{S_2 - \Delta_{12}^{GG} - \epsilon, \chi_{12}^{GG}(1)\} & \text{if } S_2 \geq \Delta_{12}^{AG} \end{cases}$$

$$S_2^*(S_1) = \begin{cases} \Delta_{11}^{AG} & \text{if } S_1 \leq \Delta_{11}^{AG} \\ \min\{S_1 + \Delta_{12}^{GG} - \epsilon, \chi_{21}^{GG}(2)\} & \text{if } S_1 > \Delta_{11}^{AG} \end{cases}$$

Once again, government 2 (respectively, 1) receives the investment if the inequality in Equation (5) holds (does not hold). This proves the existence and unicity of Equilibria 11 and 12.

The proof of the Proposition is now complete.

Appendix 2: Subsidy Competition and its consequences for social welfare

We proceed in two steps. First, we show which equilibrium prevails for a given fixed cost. Then we discuss the desirability of this particular equilibrium.

Characterisation of the equilibrium (Proof of Lemma 2)

We first address the case of equilibria involving no intervention (Equilibria 1 and 4). According to Proposition 2, Equilibrium 1 occurs whenever:

$$\chi_{21}^{GG}(2) - \Delta_{12}^{GG} < 0 \iff \tau \frac{1}{32} (14a_2 - 8a_1 - 2c_2 - 2 - 2c_1 - 19\tau) < 0 \quad (18)$$

Hence when the willingness to pay for the good is not too different between the two countries, subsidy competition always takes place. This may be seen as a restriction on consumer preferences. Therefore Equilibrium 1 may be ruled out of the subsequent analysis provided the condition in Equation (18) is met.

By Proposition 2, Equilibrium 4 is likelier for high-fixed-cost investment projects, taking social preferences as given. More precisely, it must be too costly to compensate the MNC for the distortion on the investment mode. Hence the following Lemma.

Lemma 4 *There exists an upper bound on fixed costs \bar{F} such that for any $F > \bar{F}$, no government intervention occurs.*

Proof. The proof follows from inspection of the set of conditions established in Proposition 2.

We know from Proposition 2 that for values of the fixed cost greater than \tilde{F} , Equilibria 4 to 12 may occur. Equilibrium 4 is the only one without intervention of any of the governments. For all other potential equilibria (i.e. 5-12), we now prove that if $F > \bar{F}$, then none of the conditions leading to these equilibria may be verified.

By Proposition 2, if $F \geq \tilde{F}$ then a necessary and sufficient condition for equilibrium 4 is that Equations (16) and (17) from Appendix 1 jointly hold. Since Δ_{11}^{AG} and Δ_{12}^{AG} are both increasing in F , by definition, there always exists an \bar{F} such that the conditions for existence of Equilibrium 4 always hold

for $F > \bar{F}$. This upper bound equals the maximum between the levels of fixed cost that make Δ_{11}^{AG} and Δ_{12}^{AG} negative. In particular, $\bar{F} = \max\{\hat{F}, \hat{\hat{F}}\}$. ■

We now turn to equilibria leading to subsidy competition. To start with, note that

$$\chi_{12}^{GG}(1) + \Delta_{12}^{GG} - \chi_{21}^{GG}(2) = \frac{5}{16} (a_1 - a_2) \tau \quad (19)$$

is always positive, except for the very special cases of perfect integration ($\tau = 0$) or equally sized countries ($a_1 = a_2$). Therefore, all auctions are won by country 1: the MNC chooses to locate in country 1 and pocket the second-price subsidy. Therefore Equilibria 3, 7, 10 and 12 may occur only in these very special cases.

We may now give finer predictions of the prevailing equilibrium according to the value of fixed costs.

Low fixed costs We begin with the case of low fixed costs ($F < \tilde{F}$). Consider again Equation (18):

When subsidy competition takes place, Equation (19) tells us that Equilibrium 2 always prevails ahead of Equilibrium 3, except in the particular case of equal country sizes (identical tastes). In other words, when both governments are able to bid for greenfield investment, government 1 always wins the auction.

High fixed costs Consider now the case of high fixed costs ($F \geq \tilde{F}$). For very high fixed costs ($F > \max\{\hat{F}, \hat{\hat{F}}\}$), we know by Lemma 4 that no intervention occurs. There is then no scope for socially wasteful subsidy competition.

Let us now determine the outcome of the subsidy game in the intermediate case of $\tilde{F} \leq F < \max\{\hat{F}, \hat{\hat{F}}\}$. Straightforward calculations yield :

$$\begin{aligned}
\widehat{F} - \widetilde{F} &= \frac{1}{288}[-14(a_1)^2 + 3(a_2)^2 + 36a_1c_1 + 20a_1c_2 + 18a_2c_1 - 30a_2c_2 + 45(c_1)^2 + 61(c_2)^2 \\
&\quad - 198c_1c_2 - 28a_1 + 18a_2 + 90c_1 + 26c_2 - \tau(42a_1 + 90a_2 + 18c_1 + 34c_2 - 14 + 77\tau)] \\
\widehat{F} - \widetilde{F} &= \begin{cases} \frac{1}{288}[17(a_1)^2 - 54a_1c_1 + 9(c_1)^2 + (1 + c_2 + \tau)(10a_1 + 18c_1 - 7c_2 - 7 - 7\tau)] \\ \text{if } \alpha = 0 \\ \frac{1}{288}[3(a_1)^2 - 14(a_2)^2 - 2a_1(17c_1 + 9c_2 - 23 + 9\tau) + 2a_2(10c_1 - 14c_2 + 18 + 28\tau) \\ + 77(c_1)^2 - 35(c_2)^2 - 198c_1 + 58c_1c_2 + 58c_2 + 29 + \tau(2c_1 + 14c_2 - 50 - 77\tau)] \\ \text{if } \alpha = 1 \end{cases} \\
\widehat{F} - F_{89} &= \begin{cases} \frac{1}{288}[17(a_1)^2 - 54a_1c_1 + 9(c_1)^2 - 7(c_2)^2 \\ + (10a_1 + 18c_1 + 4\tau)(1 + c_2 + \tau) - 14c_2 + 160\tau^2 + 62a_1\tau - 126a_2\tau - 7] \\ \text{if } \alpha = 0 \\ \frac{1}{288}[3(a_1)^2 - 14(a_2)^2 - 2a_1(17c_1 + 9c_2 - 23 - 27\tau) + 2a_2(10c_1 - 14c_2 + 18 - 35\tau) \\ + 77(c_1)^2 - 35(c_2)^2 - 198c_1 + 58c_1c_2 + 58c_2 + 29 + \tau(16c_1 + 32c_2 - 32 + 94\tau)] \\ \text{if } \alpha = 1 \end{cases} \\
F_{89} - \widetilde{F} &= -\frac{\tau}{32}(8a_1 - 14a_2 + 2c_1 + 2c_2 + 19\tau)
\end{aligned}$$

Let us discuss the values of the above equations and determine a ranking of these fixed costs thresholds.

The right-hand-side in the first equation is negative for a symmetric region for parameter values that lead to positive outputs. In addition, it is increasing in differences in a 's and decreasing in $c_2 - c_1$. This term is still negative when taking limit values for c_2 . We conclude that for all high-fixed-cost investment projects, government 2 will prefer the prospect of an acquisition in country 1 rather than costly intervention.

The right-hand-side of the second equation is equal to the welfare differential between G1 and A1 for country 1, hence must depend on the acquisition price received by the host country. This term will be positive for low values of α and negative for high values of α . The right-hand-side of the third equation depends on α in the same manner. Interestingly, the derivatives of these terms w.r.t. α are identical and constant. Hence these two right-hand-side expressions must equal zero for unique values of α . Lastly, the fourth equation tells us that when country sizes (tastes) are not too different for subsidy competition to occur, then $F_{89} - \widetilde{F} > 0$.

We may therefore rank predicted equilibria according to α . Using the fourth equation and continuity, the root of the third equation must be lower

than the root of the second equation. Denote these values by $\{\alpha^*, \alpha^{**}\}$. Hence for a low acquisition price, $\widehat{F} < \widetilde{F} < F_{89} < \widehat{F}$ and Equilibria 8 or 9 may occur. In that case, the median fixed cost interval is divided into two segments, with Equilibrium 9 for the lower part of the interval. For an intermediate acquisition price ($\alpha \in [\alpha^*, \alpha^{**}]$), only Equilibrium 9 obtains. Lastly, for a high acquisition price, Equilibrium 4 obtains and no subsidy competition occurs.

Welfare analysis (Proof of Proposition 3)

Using Lemmata 1, 2, and 4, we measure the effect of subsidy competition on welfare for an arbitrary investment project, within the relevant intervals of fixed costs.

Again, we begin with the low fixed costs case. Note that in the absence of intervention, the outcome would be Equilibrium 1. Thus subsidy competition does not alter the type of investment. Because of the transfer to the MNC, it must therefore lead to a social welfare loss compared to no intervention. This also applies to a comparison between subsidy competition and a single government's intervention.

In the intermediate fixed costs case, subsidy competition may arise at both Equilibria 8 and 9.

Subsidy competition at Equilibrium 8 is socially harmful if regional welfare with A1 and no subsidies is larger than welfare with G1 and a subsidy equal to Δ_{11}^{GA} . This condition may be written as:

$$\begin{aligned} \chi_{11}^{GA}(1) - \Delta_{11}^{AG} + \chi_{11}^{GA}(2) &< 0 \\ \widehat{F} - F_{89} + \widehat{\widehat{F}} &< 0 \end{aligned}$$

Calculations show that this condition is never met.

Subsidy competition at Equilibrium 9 is socially harmful if regional welfare with A1 and no subsidies is larger than welfare with G1 and a subsidy equal to $\chi_{21}^{GG}(2) - \Delta_{21}^{GG}$. This condition may be written as:

$$\begin{aligned} \chi_{11}^{GA}(1) - (\chi_{21}^{GG}(2) - \Delta_{21}^{GG}) + \chi_{11}^{GA}(2) &< 0 \\ \iff \widehat{F} - F_{89} + \widehat{\widehat{F}} - F_{89} &< 0 \end{aligned}$$

Again, we prove the existence of harmful subsidy competition by continuity. Denote the last left-hand-side expression by $K(\alpha)$. Since $\widehat{\widehat{F}} - F_{89}$ does not depend on the acquisition price, $K(\alpha)$ must have the same derivative w.r.t. α as $\widehat{F} - F_{89}$. In addition, we know from the last subsection that $\widehat{\widehat{F}} - F_{89} < 0 < \widehat{F} - F_{89} < \widehat{F} - \widetilde{F}$. By continuity, $\widehat{F} + \widehat{\widehat{F}} - 2F_{89}$ must equal zero for an α lower than α^* . Denote this last threshold α^{***} . Straightforward

calculations show that $K(0) > 0$. We conclude that a welfare loss should occur at Equilibrium 9 whenever $\alpha > \alpha^{***}$. This is the threshold value referred to in the Proposition.

Summarising:

- Low fixed costs ($F < \tilde{F}$). When subsidy competition takes place, it reduces social surplus compared to no intervention.
- Intermediate fixed costs ($\tilde{F} \leq F < \bar{F}$). For a low acquisition price, Equilibrium 9 obtains for the lower part of the fixed-cost interval, and Equilibrium 8 obtains for the higher part. Competition is beneficial, except at Equilibrium 9 with $\alpha > \alpha^{***}$. For an intermediate acquisition price, only Equilibrium 9 obtains and subsidy competition reduces welfare compared to no intervention. For a high acquisition price subsidy competition does not occur.
- High fixed costs ($F \geq \bar{F}$). No subsidy competition takes place.

This completes the proof.