The effects of technological asymmetries on strategic foreign direct investment location

Alessandra Guariglia[1, 2]
Arijit Mukherjee[1, 2]
and
Kullapat Suetrong[1]

[1] University of Nottingham, UK

[2] The Leverhulme Centre for Research in Globalisation and Economic Policy, UK

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Abstract

We consider the plant location decision of a multinational, which has the option to invest in a more or a less technologically advanced country. We find that in the absence of exporting by the local firms, the multinational will invest in the country lagging behind, unless the firms in that country are unable to compete in the product market. Exporting by the local firms reduces (increases) the multinational's incentive to invest in the country lagging behind if the technological gap between the two is small (large).

Key Words: Foreign direct investment; Plant location; Technological asymmetries; Exports

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Correspondence to: Arijit Mukherjee, School of Economics, University of Nottingham, University Park, Nottingham, NG7 2RD, UK.
E-mail: arijit.mukherjee@nottingham.ac.uk; Fax: +44-115-951 4159.

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1. Introduction

A vast literature has tried to explain the rationale for multinationals' decisions to undertake Foreign Direct Investment (FDI).[1] Yet, plant location choices among foreign countries did not generate much attention. The few attempts that have been made to explain the location decisions of multinationals have mainly focused on the strategic interactions of the potential host country governments.[2] In contrast, this paper analyzes the role played by technological factors in determining the plant location decision of a multinational.

Specifically, we assess the plant location decision of a multinational, which has the option to invest in a more or a less technologically advanced country. Our results suggest that in the absence of exporting by the local firms, the multinational will invest in the country lagging behind, unless the technological differences are such that the firms in the less advanced country cannot compete in the product market. Exporting by the local firms has an ambiguous effect on the multinational's location decision, reducing its incentive to invest in the country lagging behind if the technological differences between the multinational and the local firms are small, and increasing it if they are large.

Though our theoretical approach is closely related to Fumagalli's (2003), our analysis differs from hers in two important ways. First, while Fumagalli's (2003)

[1] We do not attempt to review this literature (see Pack and Saggi, 1997; and Saggi, 2002, for recent surveys).

[2] See for instance Hapaaranta (1996), Haufler and Wooton (1999), Barros and Cabral (2000), Fumagalli (2003), Skaksen (2005), and Bjorvatn and Eckel (2006). Also see Dewit et al. (2003) who consider the effects of employment protection laws on FDI location decisions.

main focus is on the effects of subsidy competition between two host countries, differentiated by the technology of their local firms, we show the direct importance of technological factors in determining the plant location choice of a multinational.[3] Second, unlike Fumagalli (2003), we consider segregated markets, asymmetric market structure, and transportation costs between the host countries.[4]

The rest of the paper is organized as follows. Section 2 describes our model and illustrates the effects of technological differences between the multinational and the local firms on the plant location decision of the former, both in the absence and in the presence of exporting by the local firms. Welfare implications for the host countries are discussed in Section 3. Section 4 concludes.

2. The model

2.1 Setup

Consider a multinational firm, X, which intends to serve the demand of two countries, A and B. We assume that there is a local firm operating in both countries, and call these firms, respectively, A and B. By assumption, firm X cannot (or is not willing to) export from its home country, X.[5] Moreover, because of fixed costs or due to resource constraints, it chooses to locate in only one of the host countries, while supplying both host countries. Hence, firm X can choose to locate a plant in country A and export to country B, or locate a plant in country B and export to country A. We further assume that the markets in A and B are segmented.

[3] In a situation comparable to ours (i.e. when there is no subsidy competition), Fumagalli (2003) shows that the multinational will *always* invest in the host country with relatively cost efficient local firms. In contrast, our results show that the multinational may prefer to invest in the relatively less technologically advanced host country.

[4] Segregated markets allow price discrimination to take place between the host countries.

[5] A similar assumption is also made in a number of other studies (Haaparanta, 1996; Barros and Cabral, 2000, Bjorvatn and Eckel, 2006, etc.) It can be motivated in the light of the fact that the global sales by foreign affiliates of multinationals exceed worldwide exports of goods and services (United Nations, 1995, 1996), which suggests that firms tend to serve foreign markets by establishing foreign production subsidiaries rather than by producing domestically and exporting.

We consider the following cost structure for the firms: the marginal cost of firm i (c_i, where $i = X, A, B$) is constant[6], and such that: $0 = c_X \leq c_A < c_B$.[7] We assume that the difference in marginal costs is the outcome of different technologies adopted by the firms in each country. Hence, firm X is the technologically most efficient firm. Furthermore, investment by firm X in either country A or B requires a fixed investment f, and exporting from one host country to another involves a per-unit transportation cost t.[8] Finally, firm X is not allowed to enter the foreign markets by licensing its technology to either of these firms.[9]

To determine whether the multinational will locate its plant in country A or country B, we will consider the following two scenarios:

(i) both firms A and B are assumed to only serve the respective local markets

(ii) firms A and B can also export.

Within each of these two scenarios, the following two situations will be considered:

(i) the technological difference between firms X and B is so large that firm B cannot compete with firm X, irrespective of whether X undertakes FDI in country A or country B

(ii) the technological differences between the firms are such that all host country firms always produce in the respective markets, leading to

[6] The implicit assumption here is that factor prices are taken as given in our analysis.

[7] The assumption that $c_X = 0$ is made for analytical convenience. It does not affect our qualitative results.

[8] Milner (2005) shows that even if tariff barriers have been reduced in recent years, international transportation costs are still significant and create sufficiently large trade costs. This conclusion echoes Hummels (1991), according to whom transport costs often represent a greater barrier to trade than tariffs.

[9] This could be motivated by a prohibitive cost of technology licensing.

competition between the local firms and the multinational in each country.[10]

To eliminate the effect of local market size on the multinational's investment decision, we assume that demand is the same in both countries A and B. A higher market size in one country would in fact increase the incentive for investment in that country. The inverse demand function in each host country is given by: $p = a - q$, where q is total output sold in the country, and p the associated market price. Throughout the analysis, we will also assume that $a > 2t$, which always ensures a positive output for firm X.

2.2 Case in which the local firms do not export

We initially assume that both firms A and B only serve the respective local markets.[11] We start by analyzing the plant location choice of firm X, under the assumption that firm B is very inefficient technologically, and therefore unable to compete with firm X. Under these circumstances, firm X becomes a monopolist in country B.

We consider the following game. In stage 1, firm X decides whether to invest in country A or B. In stage 2, the firms make their output decisions as Cournot duopolists with homogenous products. We solve the game through backward induction.

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[10] There are in fact three more possible situations: (i) one in which firm B can compete with firm X only if firm X exports to country B, (ii) another in which firm A can compete with firm X only if firm X exports to country A, and (iii) another in which firm A cannot compete with firm X irrespective of whether firm X undertakes FDI in country A or country B. We will not focus on these situations, since they do not add new insight to our analysis, and follow easily from the main scenarios that we develop.

[11] Resource constraints or sufficiently high transportation costs may prevent firms A and B from exporting to other countries.

Let us first consider the situation where firm X decides to invest in country A and export to country B. In this situation, firm X's profit is given by:

$$\pi_X^A = (a - q_A - q_X^A)q_X^A - f + (a - q_{XB} - t)q_{XB}, \quad (1)$$

where q_X^A and q_{XB} denote the outputs of firm X in countries A and B respectively, and q_A is the output of firm A.

If firm X invests in country A, the profit of firm A is given by:

$$\pi_A = (a - q_A - q_X^A - c_A)q_A. \quad (2)$$

The equilibrium outputs are then:

$$q_X^A = \frac{a + c_A}{3},\ q_A = \frac{a - 2c_A}{3},\ q_{XB} = \frac{a - t}{2},$$

and the second order conditions for profit maximization are satisfied. It should be noted that the equilibrium output of firm A is positive if and only if $c_A < \frac{a}{2}$.

Substituting the equilibrium outputs into the profit function, we get the optimal profits for firm X and firm A:

$$\pi_X^A = \left(\frac{a + c_A}{3}\right)^2 + \left(\frac{a - t}{2}\right)^2 - f \quad (3)$$

$$\pi_A = \left(\frac{a - 2c_A}{3}\right)^2. \quad (4)$$

Next, let us consider the case where firm X locates FDI in country B and exports to country A. In this situation, the profit of firm X is given by:

$$\pi_X^B = (a - q_X^B)q_X^B - f + (a - q_A - q_{XA} - t)q_{XA}, \quad (5)$$

where q_{XA} and q_X^B denote the outputs of firm X in countries A and B respectively. The profit of firm A is given by:

$$\pi_A = (a - q_A - q_{XA} - c_A)q_A; \quad (6)$$

The equilibrium outputs are:

$$q_X^B = \frac{a}{2},\ q_A = \frac{a+t-2c_A}{3},\ q_{XA} = \frac{a+c_A-2t}{3},$$

and the second order conditions for profit maximization are satisfied. The equilibrium output of firm A is positive if and only if $c_A < \frac{a+t}{2}$.

In order to ensure that the equilibrium output of firm A is positive both when FDI takes place in country A or country B, the maximum c_A must be less than $\frac{a}{2}$. We assume that this is the case to avoid a corner solution.

Substituting the equilibrium outputs into each firm's profit function, we obtain:

$$\pi_X^B = \left(\frac{a}{2}\right)^2 + \left(\frac{a+c_A-2t}{3}\right)^2 - f \qquad (7)$$

$$\pi_A = \left(\frac{a+t-2c_A}{3}\right)^2. \qquad (8)$$

The comparison of (3) and (7) shows that $\pi_X^A \gtreqless \pi_X^B$ provided that

$$\left(\frac{a+c_A}{3}\right)^2 + \left(\frac{a-t}{2}\right)^2 \gtreqless \left(\frac{a}{2}\right)^2 + \left(\frac{a-2t+c_A}{3}\right)^2 \quad ,$$

which is equivalent to:

$$c_A \gtreqless \frac{2a+7t}{16} \equiv c_A^*, \qquad (9)$$

for $t > 0$. Whether $c_A > c_A^*$ or $c_A < c_A^*$ depends both on technological factors and on transportation costs, *t*. Given that, by assumption, $a > 2t$, it follows that $c_A^* < \frac{a}{2}$. If $t = 0$, firm X is indifferent between investing in country A or in country B.

The following Proposition follows:

Proposition 1: *If the technological inefficiency of firm B is such that it cannot produce in the market (i.e. $c_B \geq \frac{a+t}{2}$), firm X invests in country A (country B) if the marginal cost of firm A is larger (smaller) than a threshold c_A^* (i.e. if $c_A > (<) c_A^*$).*

The above result can be intuitively explained as follows. Let us consider the case where $c_A = \frac{a}{2}$. In this situation, if firm X invests in country A, it gets a monopoly profit in both markets, whereas if it invests in country B, it gets a monopoly profit in country B and a duopoly profit in country A. Since the size of both markets is the same, firm X's monopoly profit in country A when it invests in country A, and its monopoly profit in country B when it invests in country B, are equal. However, since firm X's monopoly profit in country B, when it invests in country A, is greater than its duopoly profit in country A, when it invests in country B, firm X earns a higher profit by investing in country A. Although a slightly lower value of c_A would create competition in country A irrespective of firm X's investment in country A or B, firm X would get a near monopoly profit in country A.

If the technological asymmetry is sufficiently large and/or if transportation costs are sufficiently low (i.e. if $c_A > c_A^*$), investing in country A helps therefore firm X to monopolise both markets, and is its optimal strategy.

If, on the other hand, the technological difference between firm X and firm A is sufficiently small and/or if transportation cost are sufficiently high (i.e. if $c_A < c_A^*$), investment in country A does not allow firm X to monopolise the market in country A. In this situation, firm X prefers to avoid the distortion on its monopoly

profit in country B, which would be created by the transportation cost while exporting from country A. Thus, for small technological differences between firm X and firm A and/or high transportation costs, firm X would invest in country B.

Lower transportation costs increase therefore the multinational's incentive for investment in the relatively more technologically advanced country. According to Equation (9), c_A^* declines in fact with transportation cost. If lower transportation costs reflect an increased level of integration between countries, this implies that integration between countries A and B will increase the multinational's incentive to invest in the relatively more technologically advanced country.

In sum, the above analysis predicts that, if there is no exporting by the local firms, and the firm in the country lagging behind is unable to compete in the product market, then the multinational is more likely to undertake FDI in the relatively more advanced country when the technological gap between the multinational and the local firm is sufficiently large and/or the integration between the host countries (measured by lower transportation cost) is sufficiently high. Focusing on the FDI inflows towards European countries documented in Table 1, this Proposition can help us to understand why, prior to 1990, the flows directed toward the low-productivity Central and Eastern European Countries (CEECs)[12] were virtually non-existent.[13]

[12] The main cause of the inefficiencies characterizing the former centrally planned economies were the soft budget constraints, i.e. the subsidies typically paid by the state to loss-making firms to guarantee their survival (Kornai, 1986, 1993). In the presence of soft budget constraints, the natural selection which market competition performs by eliminating non-viable organizations fails to occur, conserving inefficiency.

[13] This link between our model's predictions and the actual FDI trends observed in Europe can be established considering firm X as a "world" multinational, which has the option to invest either in a more technologically advanced Western European country (country A) or in a less advanced CEEC (country B). It should be noted, however, that, while our model only focuses on the effects of technological factors on multinationals' location decisions, other factors such as wage and tax differentials, as well as the level of bureaucracy and corruption in the possible host countries also pay a prominent role in these decisions. Moreover, because our model is micro-based and refers therefore to the behavior of individual firms, all links established between the model's predictions and country-level FDI trends should be interpreted with caution.

We next release the assumption that firm *B* is very technologically inefficient. This is equivalent to assuming small technological differences between firm *X*, on the one hand, and firms *A* and *B*, on the other. The following Proposition holds:

Proposition 2: *If the technological difference between the firms is such that all firms always produce in the respective markets regardless of the investment decision of firm* X *(i.e.* $c_A, c_B < \frac{a}{2}$*), it is always profitable for firm* X *to invest in country B (i.e. in the relatively less technologically advanced country).*

Proof: See the Appendix.

The intuition for the above Proposition is as follows. Since the market size is the same in both host countries, and since firm A is more cost efficient than firm B, firm X earns a higher profit both when it undertakes FDI in country *B* (compared to country *A*) and when it exports to country *B* (compared to country *A*). However, since transportation costs create a distortion in the output choice of firm X, firm X's total gain from investing in country *B* (which comprises the sum of its profits from undertaking FDI in country *B* and exporting in country *A*) is always higher than its total gain from investing in country A (which includes its profits from undertaking FDI in *A* and exporting in *B*). This induces firm *X* to invest in country B. This Proposition can be used to explain why over the period 1991-97, the share of world FDI received by the increasingly productive post-transition CEECs significantly rose (Table 1).

2.3 Case in which the local firms export

So far we have considered that the local firms only serve their local market. This may be due to high costs of exporting or financial constraints. We now show how our results are affected if we allow the local firms to export to other countries, facing the same transportation costs as firm X.

Let us initially consider a situation where only firms A and X can compete in the market. The following Proposition holds:

Proposition 3: *If the marginal costs of the local firms are such that firm B cannot compete in the market (i.e. $c_B \geq \frac{a+t}{2}$), the possibility of exporting by firm A increases firm X's incentive for investment in country B, compared to a situation where the local firms do not export.*

Proof: See the Appendix.

The comparison of Propositions 1 and 3 shows that when the technological differences between the multinational and the local firms are large, the possibility of exporting by firm A reduces firm X's incentive for investment in country A. This is due to the fact that by investing in country B, firm X can reduce firm A's incentive to export to country B, thus securing a monopoly position in country B.

Considering now a situation where all firms compete in the market irrespective of the investment decisions of firm X, the following Proposition holds:

Proposition 4: *If the marginal costs of the local firms are such that they can always serve the respective local markets (i.e. $c_A, c_B < \frac{a}{2}$), the possibility of exporting by the*

local firms may encourage firm X to invest in country A, while the absence of exporting by the local firms always induced firm X to invest in country B.

Proof: See the Appendix.

Even if the host country firms have the option to export, the investment decision of firm X may deter exporting by one or both host country firms. Since firm B is relatively more cost inefficient than firm A, firm X's decision is more likely to deter it from exporting. This may encourage firm X to invest in country A.

This Proposition can be used to rationalize the increase in the share of world FDI inflows received by the Western European countries over the period 1998-2000 (Table 1), when the technological gap between Eastern and Western European countries was further reduced and the CEECs became increasingly open.

3. Welfare implications for the host countries

We now look at the implications of the plant location decision of the multinational on the welfare of the host countries. We define welfare as the sum of consumer surplus and profit of the local firm. We study the welfare implications for our basic model, focusing on the scenario where local firms do not export. The analysis can easily be extended to incorporate exporting by the local firms.

First, let us consider the situation where large cost inefficiencies of firm B prevent it from entering the market. If firm X invests in country A, the welfare values of countries A and B are respectively given by:

$$W^{A/A} = \frac{2(a-2c_A)^2 + (2a-c_A)^2}{18} \qquad (10)$$

$$W^{B/A} = \frac{(a-t)^2}{8}. \qquad (11)$$

If, on the other hand, firm X invests in country B, the welfare values of countries A and B are respectively:

$$W^{A/B} = \frac{2(a-2c_A+t)^2 + (2a-c_A-t)^2}{18} \qquad (12)$$

$$W^{B/B} = \frac{a^2}{8}. \qquad (13)$$

Comparison of the welfare values in (10) and (12), on the one hand; and (11) and (13), on the other, gives the following Proposition:

Proposition 5: *(i) Country A prefers investment by firm X in country A if* $c_A \in (\frac{t}{2}, \frac{a}{2})$.

(ii) Country B always prefers investment by firm X in country B.

If there is no local competition in country B, the welfare in this country is only determined by its consumer surplus, which is higher when firm X invests in country B rather than in country A. Hence, in the absence of local competition, country B is always better off if firm X invests in B. This result does not necessarily hold in the presence of local competition in country B.

Let us now consider the alternative situation where technological differences are small and all firms can compete in the market. If firm X invests in country A, the welfare values of countries A and B are respectively:

$$W^{A/A} = \frac{2(a-2c_A)^2 + (2a-c_A)^2}{18} \qquad (14)$$

$$W^{B/A} = \frac{2(a-2c_B+t)^2 + (2a-c_B-t)^2}{18}. \qquad (15)$$

If, on the other hand, firm X invests in country B, the welfare values of countries A and B are respectively:

$$W^{A/B} = \frac{2(a-2c_A+t)^2 + (2a-c_A-t)^2}{18} \qquad (16)$$

$$W^{B/B} = \frac{2(a-2c_B)^2 + (2a-c_B)^2}{18}. \qquad (17)$$

Comparison of the welfare values given in (14) and (16), on the one hand; and (15) and (17), on the other, gives the following Proposition:

Proposition 6: *Country A (B) prefers investment by firm X in country A (B) if* $c_A \in (\frac{t}{2}, \frac{a}{2})$ *($c_B \in (\frac{t}{2}, \frac{a}{2})$).*[14]

Comparing Propositions 1 and 5, on the one hand, and Propositions 2 and 6, on the other, suggests that a conflict of interest between the multinational and the host country does not necessarily arise. In some cases, FDI would in fact automatically flow to a given country, making it unnecessary for this country to pay subsidies in order to attract FDI. Whether a conflict of interest actually exists between the multinational and the host country, and whether the governments of the local countries have incentives for attracting investment by multinationals depends therefore on technological differences, and more in general, on the parameter configurations. Consequently, there may be scenarios in which there is no scope for subsidy competition between the possible host countries of the type illustrated in Barros and Cabral (2000) and Fumagalli (2003).

[14] Note that t must be less than a to generate a positive output for firm X when it exports.

4. Conclusion

This paper has analysed the effects of technological asymmetries on the plant location decisions of a multinational. We have constructed a simple game theoretic model to show that whether the multinational prefers to invest in a relatively more technologically advanced country or a relatively more backward country depends on the technological differences between the foreign and local firms, and on the possibility of exporting by the latter.

Specifically, our model predicts that in the absence of exporting by the firms in the host countries, the multinational will generally invest in the country lagging behind. It may invest in the more advanced country only if the technological differences are such that the firms in the more backward country cannot compete in the product market.

The effects of exporting by the local firms on the multinational's plant location decision are ambiguous. If the technological differences between the firms are sufficiently large, the possibility of exporting by the local firms raises the multinational's incentive for investment in the more backward country. On the other hand, when all firms can compete in the product market (i.e. when the technological differences are relatively small), exporting by the local firms reduces the multinational's incentive for investment in the country lagging behind. Our model's predictions are consistent with the trends of FDI inflows observed over the last two decades in Europe.

Though we have focused on technological aspects to explain the plant location decision of a multinational, it also emerges from our analysis that the governments of the host countries might have incentives to compete in order to attract foreign

investment. A natural extension to this paper would therefore aim at considering the strategic interactions between host governments to attract FDI. We intend to explore this issue in future research.

Appendix

1. Proof of Proposition 2

Let us first consider the situation where firm X decides to invest in country A and export to country B. In this situation, considering that all firms compete in the market regardless of the investment decision of firm X, the profit of firm X is given by:

$$\pi_X^A = \left(a - q_A - q_X^A\right)q_X^A - f + \left(a - q_B - q_{XB} - t\right)q_{XB}, \qquad \text{(A.1)}$$

where q_X^A and q_{XB} denote the outputs of firm X in countries A and B respectively, and q_A and q_B are the outputs of firms A and B respectively.

If firm X invests in country A, the profit of firms A and B are respectively:

$$\pi_A = \left(a - q_A - q_X^A - c_A\right)q_A \quad \text{and} \quad \pi_B = \left(a - q_B - q_{XB} - c_B\right)q_B. \qquad \text{(A.2)}$$

The equilibrium outputs for these firms are then:

$$q_X^A = \frac{a + c_A}{3},\ q_A = \frac{a - 2c_A}{3},\ q_{XB} = \frac{a - 2t + c_B}{2},\ q_B = \frac{a - 2c_B + t}{3},$$

and the second order conditions for profit maximization are satisfied. Substituting the equilibrium outputs into the profit function, we get the equilibrium profits as:

$$\pi_X^A = \left(\frac{a + c_A}{3}\right)^2 - f + \left(\frac{a - 2t + c_B}{3}\right)^2 \qquad \text{(A.3)}$$

$$\pi_A = \left(\frac{a - 2c_A}{3}\right)^2 \quad \text{and} \quad \pi_B = \left(\frac{a - 2c_B + t}{3}\right)^2. \qquad \text{(A.4)}$$

Next, let us consider the case where firm X locates FDI in country B and exports to country A. In this situation, the profit of firm X is given by:

$$\pi_X^B = (a - q_X^B - q_B)q_X^B - f + (a - q_A - q_{XA} - t)q_{XA}, \qquad \text{(A.5)}$$

where q_{XA} and q_X^B denote the outputs of firm X in countries A and B respectively. The profits of firms A and B are respectively:

$$\pi_A = (a - q_A - q_{XA} - c_A)q_A \quad \text{and} \quad \pi_B = (a - q_B - q_X^B - c_B)q_B. \qquad \text{(A.6)}$$

The equilibrium outputs for these firms are then:

$$q_X^B = \frac{a + c_B}{3},\ q_B = \frac{a - 2c_B}{3},\ q_{XA} = \frac{a - 2t + c_A}{2},\ q_A = \frac{a - 2c_A + t}{3},$$

and the second order conditions for profit maximization are satisfied. Substituting the equilibrium outputs into each firm's profit function, we obtain:

$$\pi_X^B = \left(\frac{a + c_B}{3}\right)^2 - f + \left(\frac{a - 2t + c_A}{3}\right)^2 \qquad \text{(A.7)}$$

$$\pi_A = \left(\frac{a - 2c_A + t}{3}\right)^2 \quad \text{and} \quad \pi_B = \left(\frac{a - 2c_B}{3}\right)^2. \qquad \text{(A.8)}$$

We are now in a position to evaluate the effects of technological asymmetry on the plant location decision of firm X: the comparison of equations (A.3) and (A.7) suggests that $\pi_X^A < \pi_X^B$. It is therefore always profitable for firm X to invest in country B. QED.

2. Proof of Proposition 3

In a scenario where only firms A and X can compete in the product market, the profit of firm X when it invests in country A is:

$$\pi_X^A = (a - q_A - q_X^A)q_X^A - f + (a - q_{XB} - q_{AB} - t)q_{XB}, \qquad \text{(A.9)}$$

where q_{AB} denotes firm A's exports.

The profit of firm A is given by:

$$\pi_A = \left(a - q_A - q_A^X - c_A\right)q_A + \left(a - q_{XB} - q_{AB} - c_A - t\right)q_{AB}. \qquad \text{(A.10)}$$

The equilibrium outputs are:

$$q_A^X = \frac{a + c_A}{3},\ q_A = \frac{a - 2c_A}{3},\ q_{XB} = \frac{a - t}{3},\ q_{AB} = \frac{a - 2c_A - t}{3},$$

and the second order conditions for profit maximization are satisfied. It is clear from the optimal outputs that firm A will export if and only if $c_A < \frac{a - t}{2}$. Hence, the optimal profits of firms X and A are respectively:

$$\pi_X^A = \left(\frac{a + c_A}{3}\right)^2 - f + \left(\frac{a + c_A - t}{2}\right)^2, \qquad \text{for } c_A < \frac{a - t}{2} \qquad \text{(A.11)}$$

$$\pi_A = \left(\frac{a - 2c_A}{3}\right)^2 + \left(\frac{a - 2c_A - t}{3}\right)^2, \qquad \text{for } c_A < \frac{a - t}{2}. \qquad \text{(A.12)}$$

If $c_A > \frac{a - t}{2}$, on the other hand, the profits of firms X and A are given by (3) and (4) respectively.

Next, let us consider the case where firm X invests in country B. The profits of firms X and A are respectively:

$$\pi_X^B = \left(a - q_{AB} - q_X^B\right)q_X^B - f + \left(a - q_{XA} - q_A - t\right)q_{XA} \qquad \text{(A.13)}$$

$$\pi_A = \left(a - q_A - q_{XA} - c_A\right)q_A + \left(a - q_B^X - q_{AB} - c_A - t\right)q_{AB}. \qquad \text{(A.14)}$$

The optimal outputs are:

$$q_X^B = \frac{a + c_A + t}{3},\ q_A = \frac{a + t - 2c_A}{3},\ q_{XA} = \frac{a + c_A - 2t}{3} \text{ and } q_{AB} = \frac{a - 2c_A - 2t}{3},$$

and the second order conditions for profit maximization are satisfied. Under these circumstances, firm A will export if and only if $c_A < \frac{a - 2t}{2}$. Hence, the profits of firms X and A are respectively:

$$\pi_X^B = \left(\frac{a + c_A + t}{3}\right)^2 - f + \left(\frac{a + c_A - 2t}{3}\right)^2, \quad \text{for } c_A < \frac{a - 2t}{2} \qquad \text{(A.15)}$$

$$\pi_A = \left(\frac{a + t - 2c_A}{3}\right)^2 + \left(\frac{a - 2c_A - 2t}{3}\right)^2, \quad \text{for } c_A < \frac{a - 2t}{2}. \qquad \text{(A.16)}$$

If on the other hand, $c_A > \frac{a - 2t}{2}$, then the profits of firms X and A are given by (7) and (8) respectively.

The following three intervals need to be considered to determine the investment decision of firm X:

(i) $c_A \in \left(0, \frac{a - 2t}{2}\right)$,

(ii) $c_A \in \left(\frac{a - 2t}{2}, \frac{a - t}{2}\right)$, and

(iii) $c_A \in \left(\frac{a - t}{2}, \frac{a}{2}\right)$.

Let us first consider firm X's location decision for $c_A \in \left(0, \frac{a - 2t}{2}\right)$. In this situation, firm A always exports irrespective of the investment decision of firm X. Hence, to determine the investment strategy of firm X, we need to compare (A.11) and (A.13). The comparison of these functions shows that firm X will prefer to invest in country B.

If $c_A \in \left(\frac{a - 2t}{2}, \frac{a - t}{2}\right)$, firm A exports if firm X invests in country A, but not if firm X invests in country B. Hence, (A.11) and (7) are the relevant expressions to be compared in order to determine the investment decision of firm X. The comparison shows that firm X will prefer to invest in country B.

Lastly, let us consider the situation in which $c_A \in \left(\frac{a-t}{2}, \frac{a}{2}\right)$. In this case, firm A does not export, irrespective of the investment decision of firm X. Hence, the relevant profit values to be compared are (3) and (7). This situation is similar to that described in Section 2.2, where exporting by firm A was not allowed. In this scenario, firm X invests in country B if $c_A^* \geq c_A$. We further obtain that c_A^* is higher than $c_A = \left(\frac{a-t}{2}\right)$ if and only if $2a - 5t \leq 0$ or $2(a-t) - 3t \leq 0$.

Thus, when only firms A and X can compete in the product market, the possibility of exporting by firm A generally increases firm X's incentive to invest in country B. QED.

3. Proof of Proposition 4

In a scenario where all firms compete in the market regardless of the investment decision of firm X, the profit values of firm X from investing in countries A and B are respectively:

$$\pi_X^A = \frac{(a + c_A + c_B + t)^2 + (a + c_A + c_B - 2t)^2}{16} - f \qquad \text{(A.17)}$$

$$\pi_X^B = \frac{(a + c_A + c_B + t)^2 + (a + c_A + c_B - 2t)^2}{16} - f. \qquad \text{(A.18)}$$

Since (A.17) and (A.18) are equal, firm X is indifferent between investing in country A or B. This is in contrast to Proposition 2, which showed that, when local firms were not exporting, firm X always preferred to invest in country B.

It should be noted that (A.17) and (A.18) assume that all firms *always* produce positive outputs. However, even if firms A and B have the option to export, transportation costs may not make exporting profitable for them. This is more likely

to affect firm B since it is relatively cost inefficient compared to firm A. Therefore, while making its investment decision, it is important for firm X to consider the implication of its decisions on the profitability of exporting by the local firms.

For example, if $c_B \geq \frac{a-3t+c_A}{3}$, firm B will not find exporting profitable if firm X invests in country A. On the other hand, exporting by firm B is profitable if firm X invests in country B and $c_B < \frac{a-2t+c_A}{3}$. In this situation, the profit of firm X from investing in country B is given by (A.18), whereas its profit from investing in country A is given by the following expression:

$$\pi_X^A = \frac{(a+c_A)^2}{9} + \frac{(a+c_A+c_B-2t)^2}{16} - f\,, \qquad \text{(A.19)}$$

which is greater than (A.18). Hence, the possibility of exporting by the local firms may encourage firm X to invest in country A. QED.

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Table 1. Share of total world FDI inflows by host region (in percentage terms)

Years	Western Europe	CEECs
1984-1989 (annual average)	34.5	0.05
1990	49.5	0.3
1991	50.5	1.7
1992	43.4	2.8
1993	32.9	3.1
1994	32.0	2.4
1995	35.5	4.6
1996	30.3	3.8
1997	28.3	4.3
1998	38.1	3.5
1999	46.0	2.4
2000	50.2	2.0

Note: Western Europe comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the UK, Gibraltar, Iceland, Malta, Norway, and Switzerland. The CEECs are Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, the Republic of Moldova, Poland, Romania, the Russian Federation, Serbia and Montenegro, Slovakia, Slovenia, TFYR Macedonia, and Ukraine.
Source: Authors' calculations based on the Foreign Direct Investment Database (UNCTAD, 2005).