The University of Nottingham

research paper series

Theory and Methods

Research Paper 2006/35

Technological asymmetries and strategic plant location: the case of export-platform foreign direct investment

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The Centre acknowledges financial support from The Leverhulme Trust under Programme Grant F114/BF

GEP Leverhulme Centre for Research on Globalisation and Economic Policy

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Acknowledgements

We thank Spiros Bougheas, Douglas Nelson, Pascalis Raimondos-Møller, Nils Karl Sørensen, Jørgen Ulff-Møller Nielsen, and the participants to the Second Danish International Economics Workshop for useful comments. A. Guariglia and A. Mukherjee gratefully acknowledge financial support from The Leverhulme Trust under Programme Grant F114/BF. K. Suetrong thanks the Royal Thai Government for financial support. The usual disclaimer applies.

Technological asymmetries and strategic plant location: the case of export-platform foreign direct investment*

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Abstract

We consider the plant location decision of a multinational corporation (MNC), which has the option to invest in a more or in a less technologically lagging country, and which aims to use its foreign plant as an export-platform. We show that the plant location decision of the MNC depends on whether the host country firms can export, and on whether they are able to compete in the product market. We also show that a conflict of interest does not necessarily arise between the plant location decision of the MNC and the preferences of the host countries' governments.

Key Words: Export-platform foreign direct investment; Plant location; Technological asymmetries

JEL Classifications: D43; F12; F23; L11; L13

Outline

Non-technical summary

We develop a simple game theoretic model to analyze the plant location decision of a multinational corporation (MNC), which has the option to invest in a more or in a less technologically lagging country, and which aims to use its foreign plant as an export-platform.

Our model predicts that in the absence of exporting by the host country firms, and if the technological differences between firms are such that all firms always compete in the product market, the MNC will invest in the more technologically lagging host country. However, if large technological differences prevent the firm in the more technologically lagging host country from competing in the product market, then the MNC will invest in the less lagging host country, as long as the technological difference between the MNC and the firm in the latter country is sufficiently large.

The effects of exporting by the host country firms on the MNC's plant location decision are ambiguous. When all firms can compete in the product market (i.e. when the technological differences are relatively small), exporting by the host country firms reduces the MNC's incentive for investment in the more technologically lagging country. On the other hand, if the technological differences prevent the firm in the more lagging host country from competing, the possibility of exporting by the firm in the less lagging host country raises the MNC's incentive for investment in the more technologically lagging country. Our model's predictions are consistent with the general trends of FDI inflows observed over the last two decades in Europe.

Finally, our model also suggests that a conflict of interest does not necessarily arise between the MNC's investment decision and the preferences of the host countries' governments, implying that there might be no scope for subsidy competition.

1. Introduction

A fascinating development in economics in recent decades has been the phenomenal growth of foreign direct investment (FDI). This has generated a large theoretical and empirical literature.[1] A number of papers have attempted to explain why multinational corporations (MNCs) invest in a host country with the aim of serving either that host country market (horizontal FDI), or the home country by exporting back to it (vertical FDI). However, another type of equally important FDI, the so called "export-platform FDI", is still not well understood and has started getting attention only recently. Export-platform FDI refers to a situation where a MNC invests in a host country and exports its products from the host country to one or more third countries.[2]

As documented in Ekholm et al. (2005): "In 2000, 64% of total sales of foreign manufacturing affiliates of US multinationals were sold domestically, while 36% were exported. Out of the latter figure, about a third were exported back to the US and about two thirds were exported to third countries." Based on data from Markusen and Maskus (2001, 2002) about US MNCs operating in the EU, Southeast Asia, and Canada and Mexico (the US's NAFTA partners), Ekholm et al. (2005) also document that countries such as Ireland, Belgium, and Holland have the highest proportions of affiliate sales going to third countries (respectively 71, 57, and 60 percent), while Canada and Mexico have the lowest shares (respectively 5 and 8 percent). The above evidence shows the importance of export-platform FDI, which certainly deserves attention.

Theoretical works explaining the rationale for undertaking export-platform FDI are growing in number. Norman and Motta (1993), Motta and Norman (1996), Neary (2002), Fumagalli (2003), and Ekholm et al. (2005) show how differences between external and internal tariff barriers, market size, and host country subsidies can create an incentive for foreign firms to undertake export-platform FDI.

Our focus is different. Instead of focusing on the rationale for export-platform FDI, we construct a game-theoretic model aimed at explaining the plant location decision of a MNC, which has already decided to undertake export-platform FDI, and has the option to locate its plant in one of two host countries differentiated by the technological capabilities

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

[2] The MNC may or may not also sell its products in the host country and/or export them back to the home country.

of their local firms.[3] Hence, our paper falls in the area of the literature explaining the plant location decisions of those MNCs performing export-platform FDI.[4] Most previous studies have focused on the implications of strategic government policies on MNCs' plant location decisions. In contrast, we discuss the platform choice through technological factors and in the absence of government policies.

Our model predicts that in the absence of exporting by the host country firms, and if all host country firms are able to compete in the product market, the MNC will invest in the more technologically lagging country. On the other hand, if technological differences prevent the firm in the more technologically lagging host country from competing in the product market, the MNC will invest in the less technologically lagging country, as long as the technological difference between the MNC and the firm in the less lagging country is sufficiently large. If the technological gap between the firms is such that all firms can compete in the market, exporting by the host country firms reduces the MNC's incentive for investing in the more technologically lagging country. On the other hand, if the firm in the more technologically lagging host country cannot compete in the market, exporting by the firm in the less lagging host country increases the MNC's incentive to invest in the more lagging country. Finally, our model also suggests that a conflict of interest does not necessarily arise between the MNC's investment decision and the preferences of the host countries' governments.

Our model is strongly related to Fumagalli's (2003), who also considers technological differences between firms. However, our analysis differs from hers in five important ways. First, contrary to her, we consider segmented markets (and therefore, price discrimination between the host country markets), and allow for transportation costs between the host countries. Second, Fumagalli (2003) restricts her attention to a situation where the technological differences are such that all firms always produce positive outputs in the market, whereas, along with this possibility, we also consider the situation where technological differences prevent a host country firm from producing (leading to an asymmetric host country market structure). Third, unlike Fumagalli (2003), we consider an effective patent protection in the host countries that prevents knowledge spillovers between the MNC and the host country firms. Fourth, contrary to Fumagalli (2003), we show that whether the host country firms export or not has important implications on the plant

[3] It should be noted that, in our analysis, the MNC is technologically superior compared to the host country firms.

[4] Other papers in this literature include Hapaaranta (1996), Haufler and Wooton (1999), Barros and Cabral (2000), Fumagalli (2003), Skaksen (2005), and Bjorvatn and Eckel (2006).

location decision of the foreign firm. Lastly, Fumagalli's (2003) main focus is on the effects of subsidy competition between two host countries which happen to be differentiated by the technology of their local firms, while we show the direct implications of the technological differences between the firms on the plant location decision of the MNC.

Our results differ from Fumagalli's (2003) in two main respects. First, in a situation comparable to ours (i.e. when there is no subsidy competition and technological differences allow all firms to compete in the product market), Fumagalli (2003) shows that if the MNC decides to invest in a host country, it always invests in the less technologically lagging country. On the contrary, our results show that if the host country firms do not export, the MNC always prefers to invest in the more technologically lagging host country, whereas if the host country firms do export, there are situations where the MNC may prefer to invest in the less technologically lagging country. Second, contrary to Fumagalli (2003), our results show that a conflict between the interest of the MNC and the preferences of the host countries' governments does not necessarily arise, implying that there might be no scope for subsidy competition. Our assumptions of segmented markets and transportation costs between the host countries are responsible for these differences in results.

Our model is also close to Bjorvatn and Eckel's (2006). Yet, their main focus is on the policy competition for foreign direct investment between asymmetric countries. Moreover, while they consider a scenario where there is a local firm only in one of the two host countries, we consider a MNC's plant location decision when there is a host country firm in each of the host countries, and characterise the equilibrium location decision with respect to the cost differences between the firms.[5] Finally, we show the implications of both exporting and non-exporting by the host country firms, while Bjorvatn and Eckel's (2006) always consider exporting by the host country firms.[6]

The remainder of the paper is organized as follows. Section 2 describes the model and illustrates the effects of technological difference between the MNC and the host country firms on the plant location decision of the former, both in the absence and in the

[5] In a situation comparable to ours (i.e. with no government intervention and the same host country market size), Bjorvatn and Eckel's (2006) analysis suggests that the MNC will always invest in the country with no host country firm. Like them, we envisage a scenario with no firm in one of the host countries if large technological differences prevent the firm operating in that host country to compete in the product market. However, contrary to Bjorvatn and Eckel's (2006), we show that in this scenario, the MNC will not necessarily invest in the country with no host country firm, as long as the MNC and the firm in the other (less technologically lagging) country are sufficiently differentiated from a technological viewpoint.

[6] Non-exporting by the host country firms may be motivated by resource constraints or inefficient transportation technologies, which may make exporting unprofitable to them.

presence of exporting by the latter. Welfare implications for the host countries are discussed in Section 3. Section 4 concludes.

2. The model

2.1. Setup

Consider a MNC, firm X, which intends to serve the demand of two countries, A and B. We assume that the markets in A and B are segmented. We also assume that there is a local firm in each country, and call these firms, respectively, A and B. By assumption, firm X does not find it profitable to export to these host countries from its home country, X.[7] Moreover, as in Barros and Cabral (2003), Dewit et al. (2003), Fumagalli (2003), Bjorvatn and Eckel (2006) and many others, because of fixed costs or due to resource constraints, firm X chooses to locate in only one of the host countries, while selling to 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 consider the following cost structure for the firms: the constant marginal cost of firm i is c_i, where $i = X, A, B$,[8] and $0 = c_X \leq c_A < c_B$.[9] We also assume that the difference in marginal costs is the outcome of technological differences between the firms. 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 for firm X.[10] Finally, like other

[7] A similar assumption is also made in a number of other studies (Haaparanta, 1996; Barros and Cabral, 2000; Bjorvatn and Eckel, 2006 etc.) This assumption may 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, due to relatively high trade costs, firms tend to serve foreign markets by establishing foreign production subsidiaries rather than by producing domestically and exporting. The assumption of no exporting to the host countries from the home country also rules out the possibility of exporting back to the home country from either of these host countries. If there is demand in the home country, it will be satisfied by home production. Given that the markets are segmented, the inclusion of home demand will not add any new feature to our analysis. We, therefore, ignore demand in the home country for simplicity. Norman and Motta (1993), Motta and Norman (1996), Barros and Cabral (2000), Neary (2002), Fumagalli (2003), Bjorvatn and Eckel (2006) etc. also assume that no exporting to the home country can take place from the host countries.

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

[9] The assumption of $c_X = 0$ is due to analytical convenience. It does not affect our qualitative results.

[10] 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 is echoed in Hummels (1991), according to whom transport costs often represent a greater barrier to trade than tariffs.

studies in this area (mentioned above), we assume that firm X cannot enter foreign markets by licensing its technology to either of these firms.[11]

To determine whether firm X 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 serve only the respective local markets. This may happen if the host country firms face resource constraints or if the transportation technologies of the host country firms are so inefficient to make exporting by these firms unprofitable.

(ii) Firms A and B can also export and, like firm X, each host country firm faces the transportation cost t.

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, thus creating an asymmetric market structure in the host countries.

(ii) The technological differences between the firms are such that all host country firms always produce in the respective markets, leading to competition between the host country firms and the MNC in each of the host countries.[12]

To eliminate the effect of market size on the investment decision of firm X, 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 that country, and p the associated market price. Throughout the analysis, we assume that $a > 2t$, which always ensures positive outputs by firm X in both markets.

2.2. No exporting by the host country firms

We initially assume that both firms A and B serve the respective local markets only. We start by analysing the plant location choice of firm X, under the assumption that firm B is

[11] This could be motivated by a prohibitive cost of technology licensing. See Teece (1977, 1981) for a discussion of the "resource costs" of technology transfer.

[12] There are in fact three more possible situations: (i) firm B can compete with firm X only if firm X exports to country B, (ii) firm A can compete with firm X only if firm X exports to country A, and (iii) 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.

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

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

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

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

$$\pi_A = \left(a - q_A - q_X^A - c_A\right)q_A. \tag{2}$$

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 functions, we get the equilibrium profits of firms X and A, which are respectively

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

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

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

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

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

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

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 always positive both when plant X is located in country A and when it is located in country B, c_A must be less than $\frac{a}{2}$. For simplicity, we assume that this is always the case (i.e. $c_A < \frac{a}{2}$). This helps us to avoid corner solutions, without sacrificing any insight for our analysis.

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

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

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

The comparison of (3) and (7) shows that $\pi_X^A \underset{<}{\geq} \pi_X^B$ provided that

$$\left(\frac{a+c_A}{3}\right)^2 + \left(\frac{a-t}{2}\right)^2 \underset{<}{\geq} \left(\frac{a}{2}\right)^2 + \left(\frac{a-2t+c_A}{3}\right)^2,$$

which is equivalent to

$$c_A \underset{<}{\geq} \frac{2a+7t}{16} \equiv c_A^*, \tag{9}$$

for $t > 0$. Whether $c_A > c_A^*$ or $c_A < c_A^*$ depends both on the technological factors and the transportation cost, *t*. Given that $a > 2t$, 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 from the above discussion.

Proposition 1: *If the technological inefficiency of firm B is such that it cannot compete 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 $c_A > (<) c_A^*$). Lower transportation cost increases firm X's incentive for investing in country A.*

The above result can be 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. Therefore, ceteris paribus, if the technological asymmetry is sufficiently large (i.e. $c_A > c_A^*$), investing in country A helps firm X to (almost) monopolise both markets, and becomes the preferred investment strategy.

If, on the other hand, the technological difference between firms X and A is sufficiently small (i.e. $c_A < c_A^*$), 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. Therefore, in the presence of small technological differences between firms X and A, firm *X* invests in country *B*.

Since a lower transportation cost reduces firm *X*'s cost of exporting to country *B* from country *A*, it increases firm *X*'s incentive for monopolising the market in country *A*. As a result, a lower transportation cost increases the range of c_A for which firm *X* finds it profitable to invest in country *A* (note that c_A^* declines with *t*). If a lower transportation cost reflects an increased level of integration between countries, our result implies that integration between countries A and B increases the MNC's incentive to invest in the less technologically lagging country.

In sum, the above analysis predicts that, if there is no exporting by the host country firms and if the firm in the more technologically lagging host country is unable to compete in the product market, the MNC undertakes FDI in the less lagging host country when the technological gap between the MNC and the firm in the latter country is sufficiently large and/or when the integration between the host countries (measured by the inverse of the transportation cost) is sufficiently high. Focusing on the FDI inflows towards European

countries documented in Table 1, Proposition 1 may help us to understand why, prior to 1990, the flows directed toward the low-productivity Central and Eastern European Countries (CEECs)[13] were virtually non-existent.[14]

Let us now relax the assumption that firm B is so technologically inefficient that it cannot compete in the product market. Instead, let us assume that the technological inefficiency of firm B is not so large, and that all firms always compete in the product market. The following Proposition shows the equilibrium investment decision of firm X for this situation.

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 more technologically lagging host country).*

Proof: See Appendix A.

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 higher profits in country B (compared to country A) irrespective of whether it serves country B through FDI or exporting. 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 country B under FDI and from country A under export) is always higher than its total gain from investing in country A (which includes its profits from country A under FDI and from country B under export). This induces firm X to invest in country B.

[13] 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 the 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.

[14] This link between our model's predictions and the actual FDI trends observed in Europe can be established by considering firm X as a "world" multinational, which has the option to invest either in a less technologically lagging Western European country (country A) or in a more technologically lagging 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 host countries also play prominent roles in these decisions. Moreover, because our model is micro-based and refers to the behavior of a single MNC, all links established between our predictions and country-level FDI trends should be interpreted with caution.

Proposition 2 may be used to explain why, over the period 1991-97, the share of world FDI received by the increasingly productive post-transition CEECs rose significantly (Table 1).

2.3. Exporting by the host country firms

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

Let us first consider the situation where only firms A and X can compete in the market (i.e. firm B is characterized by a large technological inefficiency, which prevents it from competing in the product market). The following Proposition shows the investment decision of firm X in this situation.

Proposition 3: *If the marginal costs of the host country 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 host country firms do not export.*

Proof: See Appendix B.

The above result is due to the fact that, by investing in country B, firm X can reduce firm A's incentive for exporting to country B, thus securing a monopoly position in country B.

Let us now consider the situation where the technological inefficiency of firm B is not very large, and all firms can always serve the respective local markets, irrespective of the investment decisions of firm X. In this situation, the following Proposition shows the investment decision of firm X.

Proposition 4: *If the marginal costs of the host country firms are such that all firms always serve the respective local markets (i.e. $c_A, c_B < \frac{a}{2}$), the possibility of exporting by the host country firms may encourage firm X to invest in country A, while the absence of exporting by the host country firms always induced firm X to invest in country B.*

Proof: See Appendix C.

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, which may encourage firm X to invest in country A.

Proposition 4 may 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 MNC on the welfare of the host countries. As in Bjorvatn and Eckel (2006), 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 the host country firms do not export, and show that a conflict of interest between the MNC's investment decision and the preferences of the host countries' governments does not necessarily arise. The analysis can easily be extended to incorporate exporting by the host country firms.

Let us first consider the situation where the large cost inefficiency of firm B prevents it from competing. If firm X invests in country A, welfare of country A is

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

and welfare of country B is

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

If, on the other hand, firm X invests in country B, welfare of country A is

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

and welfare of country B is

$$W^{B/B} = \frac{a^2}{8}. \tag{13}$$

A comparison of (10) and (12), on the one hand, and of (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, welfare in this country is determined only 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 such that all firms compete in the market. If firm X invests in country A, welfare of country A is

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

and welfare of country *B* is

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

If, on the other hand, firm X invests in country B, then welfare of country A is

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

and welfare of country *B* is

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

Comparisons of (14) and (16), on the one hand, and of (15) and (17), on the other, give the following Proposition.

Proposition 6: *Country A (B) prefers investment by firm X in country A (B) if $c_A \in (\frac{t}{2}, \frac{a}{2})$ ($c_B \in (\frac{t}{2}, \frac{a}{2})$).*[15]

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

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 MNC 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 MNC and the host country, and whether the governments of the host countries have incentives for attracting investment by the MNCs depend 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).

4. Conclusion

We have developed a simple game theoretic model to analyze the effects of technological asymmetries on the plant location decisions of a MNC, which has the option to invest in a more or in a less technologically lagging country, and which aims to use its foreign plant as an export-platform. We have shown that whether the MNC prefers to invest in the relatively more or in the relatively less technologically lagging host country depends on the technological differences between the MNC and the host country firms, and on the possibility of exporting by the latter.

Specifically, our model predicts that in the absence of exporting by the host country firms, and if the technological differences between the firms are such that all firms always compete in the product market, the MNC will invest in the more technologically lagging host country. However, if large technological differences prevent the host country firms in the more technologically lagging country from competing in the product market, then the MNC will invest in the less lagging host country, as long as the technological difference between the MNC and the firm in the latter country is sufficiently large.

The effects of exporting by the host country firms on the MNC's plant location decision are ambiguous. When all firms can compete in the product market (i.e. when the technological differences are relatively small), exporting by the host country firms reduces the MNC's incentive for investment in the more lagging country. On the other hand, if the technological difference prevents the firm in the more lagging country from competing, the possibility of exporting by the firm in the less lagging host country raises the MNC's incentive for investment in the more lagging country. Our model's predictions are

consistent with the general 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 our MNC, it also emerges from our analysis that the governments of the host countries may or may not have incentives to compete in order to attract foreign investment. A natural extension to this paper would therefore aim at considering the effects of strategic host country policies to attract FDI, in the case of conflicting interests between the MNC and the host countries' governments. We intend to explore this issue in future research.

It is also worth mentioning that considering more than two symmetric host country firms would not affect our qualitative results when all firms are competing, provided that the number of firms in all host countries is the same. However, if the number of firms differs between host countries, this will affect the MNC's incentive for investment in a particular country. For example, a sufficiently large number of firms in the more technologically lagging host country (compared to the less lagging one) may reduce the MNC's incentive for investing there, by significantly reducing its profits in that country.

Finally, it should also be noted that our analysis has abstracted from product differentiation, as we have assumed that all firms produce homogeneous products. The presence of product differentiation would reduce the possibility of monopolization, and would therefore affect the MNC's investment decision accordingly. For example, if technological differences prevented the more technologically inefficient host country firm from competing, then product differentiation could increase the possibility of investment in the more lagging country by reducing the monopolization effect in the less lagging country.

Appendix

A. 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

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

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 profits of firms A and B are respectively

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

The equilibrium outputs are

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

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

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

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

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

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

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

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

The equilibrium outputs are

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

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

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

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

We are now in a position to evaluate the effects of technological asymmetry on the plant location decision of firm X. The comparison between (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.

B. 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

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

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

The profit of firm A is

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

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 equilibrium outputs that firm A will export if and only if $c_A < \frac{a - t}{2}$. Hence, the equilibrium profits of firms X and A are respectively

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

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

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

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

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

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

The equilibrium outputs are

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

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

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

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

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

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 prefers 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 prefers to invest in country B.

Lastly, let us consider the situation where $c_A \in \left(\frac{a - t}{2}, \frac{a}{2}\right)$. In this situation, 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 $2(a-t) - 3t \leq 0$.

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

C. Proof of Proposition 4

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

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

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

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 the host country firms are not exporting, firm X always prefers 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 host country firms.

For example, if $c_B \geq \frac{a - 3t + c_A}{3}$, firm B does 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

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

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

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).

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