# 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

March 2006

## Abstract

We consider the plant location decision of a multinational, which can 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 firm in that country is 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). Our model's predictions are consistent with the trends of FDI inflows observed over the last two decades in Europe.

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

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

**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

# The effects of technological asymmetries on strategic foreign direct investment location

## 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 (Hapaaranta, 1996; Barros and Cabral, 2000; Fumagalli, 2003; Skaksen, 2005).[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 firm 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 firm 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 (2003)

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

[2] Also see Dewit et al. (2003) who consider the effects of employment protection laws on FDI location decisions.

focuses on the effects of subsidy competition between the host countries, we show the 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 presents some stylized facts aimed at motivating our theoretical analysis. Section 3 describes our basic model and shows the importance of technological differences between the multinational and the firms in the host countries on the plant location decision of the former. Section 4 extends the basic model considering the implications of exporting by the local firms. In Section 5, we assess the extent to which our model's main predictions help us to rationalize the stylized facts about FDI. Welfare implications for the host countries are discussed in Section 6. Section 7 concludes.

## 2. Stylized facts

During the past two decades, there has been a growing trend of FDI inflows into the European region. It has been witnessed that these inflows have accounted for nearly half of the world's FDI (UNCTAD, 2005). Even though a great portion of FDI is directed towards European countries, the distribution of the flows among these countries is very disproportionate. As shown in Table 1, Western Europe has captured, on average, 39.7 per cent of the world's inflows during the period 1990-2000. On the contrary, only 2.8 per cent of these inflows has been directed towards

[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.

the Central and Eastern European Countries (CEECs)[5], starting from a situation with virtually non-existent FDI inflows.

However, only looking at FDI levels might lead to misperceptions regarding the actual trends of FDI inflows. Figure 1, which focuses on FDI shares shows a descending trend faced by Western European economies between 1991 and 1997, which was reversed thereafter. These countries' share of the world FDI dropped in fact from 50 per cent in 1991 to 28.3 percent in 1997, to rise again to 50.2 per cent by 2000 (Figure 1; Table 1).[6]

In the same period, the reverse has happened for the CEECs, whose share of the world FDI rose from virtually 0 prior to 1990 and 0.3 percent in 1990, to 4.3 per cent in 1997, and then declined to 2.0 per cent by 2000 (Figure 1; Table 1)[7].

Although FDI inflows in the CEECs remained quite low throughout the 1990s, in the global context, they drastically sprung up from less than 1 to almost 5 per cent of the world FDI.[8] Yet, the CEECs register levels of productivity considerably lower than those recorded in Western economies. Table 2 documents in fact that, measuring productivity in terms of GDP per person employed, the productivity of ten selected CEECs (referred to as CEEC-10 hereafter) was only 43.1 per cent of that of 15 selected Western European countries (referred to as EU-15 hereafter) in 1990[9]. This number declined to 39.2 per cent by 1995. It is noteworthy that this decline was not

[5] 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.

[6] It should be noted that the descending trend characterizing the period 1991-97 is not perfectly monotonic.

[7] As in the case of the Western European economies, these trends are not perfectly monotonic.

[8] FDI inflows soared to record levels particularly in those countries which registered high growth rates, and a successful economic transition, such as the Czech Republic, Hungary, and Poland (Buch et al., 2003).

[9] The EU-15 comprise Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK. The CEEC-10 comprise Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. It should be noted that prior to 1990, many of the CEEC-10 were not autonomous and independent states, but part of larger states. For this reason, we do not report data for these countries prior to 1990 in Tables 2 and 3.

driven by a deterioration of the technological conditions characterizing the CEECs, but by the strong decline in GDP that followed the collapse of the communist regimes, and the termination of the central economic planning. After 1995, the productivity growth of the CEEC-10 started to gradually recover and their GDP per person employed reached 44 per cent of that of the EU-15 by 2000. Also considering that the growth rate in productivity, which took place between 1995 and 2000 was 3.3 per cent for the CEEC-10, compared to only 1.4 per cent for the EU-15, this suggests that the productivity gap between the two groups of countries was shrinking.

Throughout the nineties, all European countries, and the CEECs in particular, also became increasingly open. This is documented in Table 3, according to which the average share of exports to GDP in the CEEC-10 (EU-15) increased from 31.2 (38.1) per cent in 1990 to 56.2 (52.8) per cent by 2000.[10] The CEEC-10 registered higher average exports to GDP ratios than the EU-15 in all the years considered except 1990.

These patterns can be summarized as follows:

(i) Prior to 1990, FDI flows directed toward the low-productivity CEECs were virtually non-existent.

(ii) The share of world FDI received by the increasingly more productive and more open CEECs significantly rose over the period 1991-97.

(iii) This trend was reversed in the late nineties, when FDI flowed more and more towards the Western European economies.

In the following section, we develop a model which attempts to explain these stylized facts.

[10] Although precise data are not available, Salvatore (2001) claims that the share of transition economies trade with the West increased from about 10-15 percent in 1990 to between 65 and 93 percent by 2000.

## 3. The basic model

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, $X$.[11] 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.

We consider the following cost structure for the firms: the marginal cost of firm $i$ ($c_i$, where $i = X, A, B$) is constant[12], and such that: $0 = c_X \leq c_A < c_B$.[13] 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 $t$.[14] Both firms $A$ and $B$ are assumed to only serve the

[11] A similar assumption is also made in a number of other studies (Haaparanta, 1996; Barros and Cabral, 2000, 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.

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

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

[14] 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.

respective local markets.[15] Finally, firm $X$ is not allowed to enter the foreign markets by licensing its technology to either of these firms.[16]

To determine whether the multinational will locate its plant in country $A$ or country $B$, we will consider two scenarios. In the first one, 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 $B$. In the second scenario, the technological differences between the firms are such that all host country firms always produce in the respective markets, leading to a situation of competition between the local firms and the multinational in each country.[17]

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 $X$.

[15] Resource constraints or sufficiently high transportation costs may prevent firms $A$ and $B$ from exporting to other countries. The scenario in which firms *A* or *B* are allowed to export is analyzed in Section 4.

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

[17] There are in fact three more possible scenarios: (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.

### *3.1 Large technological differences between firms $X$ and $B$*

#### *3.1.1 Setup*

Our objective is now to analyze 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.

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:

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

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:

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

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 $A$:

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

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

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:

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

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 given by:

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

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 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:

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

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

*3.1.2 Plant location decision of firm $X$*

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

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

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 therefore 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 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 analysis of this sub-section 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 firms is sufficiently large and/or the integration between the host countries (measured by lower transportation cost) is sufficiently high.

### *3.2 Small technological differences between firm X, and firms A and B*

#### *3.2.1 Setup*

In the presence of small technological differences between firm *X*, on the one hand, and firms *A* and *B*, on the other, all firms always produce in the respective markets, regardless of firm $X$'s FDI decision. Hence, to ensure a positive output for all firms, $c_B$ must be less than $\frac{a}{2}$.

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

$$\pi_X^A = \left(a - q_A - q_X^A\right)q_X^A - f + \left(a - q_B - q_{XB} - t\right)q_{XB}, \qquad (10)$$

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:

$$\pi_A = \left(a - q_A - q_X^A - c_A\right)q_A \quad \text{and} \quad \pi_B = \left(a - q_B - q_{XB} - c_B\right)q_B. \quad (11)$$

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:

$$\pi_X^A = \left(\frac{a + c_A}{3}\right)^2 - f + \left(\frac{a - 2t + c_B}{3}\right)^2 \tag{12}$$

$$\pi_A = \left(\frac{a - 2c_A}{3}\right)^2 \quad \text{and} \quad \pi_B = \left(\frac{a - 2c_B + t}{3}\right)^2. \tag{13}$$

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:

$$\pi_X^B = (a - q_X^B - q_B)q_X^B - f + (a - q_A - q_{XA} - t)q_{XA}, \tag{14}$$

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:

$$\pi_A = (a - q_A - q_{XA} - c_A)q_A \quad \text{and} \quad \pi_B = (a - q_B - q_X^B - c_B)q_B. \tag{15}$$

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:

$$\pi_X^B = \left(\frac{a + c_B}{3}\right)^2 - f + \left(\frac{a - 2t + c_A}{3}\right)^2 \tag{16}$$

$$\pi_A = \left(\frac{a - 2c_A + t}{3}\right)^2 \quad \text{and} \quad \pi_B = \left(\frac{a - 2c_B}{3}\right)^2. \tag{17}$$

### *3.2.2 Plant location decision of firm $X$*

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

Comparison of equations (12) and (16) suggests that $\pi_X^A < \pi_X^B$. This leads to the following proposition:

**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).*

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 $B$.

## 4. Allowing for exporting by the local firms

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 the other countries, facing the same transportation costs as firm $X$.

### *4.1 Large technological difference between firms $X$ and $B$*

#### *4.1.1 Setup*

Let us now consider a situation where only firms $A$ and $X$ can compete in the market. We will show that in this scenario, the possibility of exporting by firm $A$ can increase firm $X$'s incentive for investment in country $B$.

When firm $X$ invests in country $A$, the profit of firm $X$ is:

$$\pi_X^A = \left(a - q_A - q_X^A\right)q_X^A - f + \left(a - q_{XB} - q_{AB} - t\right)q_{XB}, \tag{18}$$

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

The profit of firm $A$ is given by:

$$\pi_A = \left(a - q_A - q_A^X - c_A\right)q_A + \left(a - q_{XB} - q_{AB} - c_A - t\right)q_{AB}. \tag{19}$$

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:

$$\pi_X^A = \left(\frac{a + c_A}{3}\right)^2 - f + \left(\frac{a + c_A - t}{2}\right)^2, \qquad \text{for } c_A < \frac{a - t}{2} \tag{20}$$

$$\pi_A = \left(\frac{a - 2c_A}{3}\right)^2 + \left(\frac{a - 2c_A - t}{3}\right)^2, \qquad \text{for } c_A < \frac{a - t}{2}. \tag{21}$$

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:

$$\pi_X^B = (a - q_{AB} - q_X^B)q_X^B - f + (a - q_{XA} - q_A - t)q_{XA} \tag{22}$$

$$\pi_A = (a - q_A - q_{XA} - c_A)q_A + (a - q_B^X - q_{AB} - c_A - t)q_{AB}. \tag{23}$$

The optimal outputs are:

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

$$\pi_X^B = \left(\frac{a + c_A + t}{3}\right)^2 - f + \left(\frac{a + c_A - 2t}{3}\right)^2, \quad \text{for } c_A < \frac{a - 2t}{2} \tag{24}$$

$$\pi_A = \left(\frac{a + t - 2c_A}{3}\right)^2 + \left(\frac{a - 2c_A - 2t}{3}\right)^2, \quad \text{for } c_A < \frac{a - 2t}{2}. \tag{25}$$

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.

### *4.1.2 Plant location decision of firm X*

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 (20) and (22). 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, (20) 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 compare are (3) and (7). This situation is similar to that described in Section 3, where exporting by firm $A$ was not allowed. In this scenario, firm $X$ invests in country $A$ if $c_A^* < c_A$. We further obtain that $c_A^*$ is lower than $c_A = \left(\frac{a-t}{2}\right)$ if and only if $2a - 5t > 0$ or $2(a-t) - 3t > 0$.

Hence, the following proposition follows:

**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.*

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 $B$.

### *4.2 Small technological differences between the firms*

#### *4.2.1 Setup and plant location decision of firm X*

Let us initially consider the situation where all firms compete in the market irrespective of the investment decisions of firm $X$. In this scenario, the profit values of firm $X$ from investing in countries $A$ and $B$ are respectively:

$$\pi_X^A = \frac{(a + c_A + c_B + t)^2 + (a + c_A + c_B - 2t)^2}{16} - f \qquad (26)$$

$$\pi_X^B = \frac{(a + c_A + c_B + t)^2 + (a + c_A + c_B - 2t)^2}{16} - f . \qquad (27)$$

Since (26) and (27) are equal, firm $X$ is indifferent between investing in countries $A$ and $B$. This is in contrast to Proposition 2, which showed that, when local firms were not allowed to export, firm $X$ always preferred to invest in country $B$.

It should be noted that (26) and (27) 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 taking 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 $c_B < \frac{a-2t+c_A}{3}$. Hence, in this situation, the profit of firm $X$ from investing in country $B$ is given by (27), whereas its profit from investing in country $A$ is given by the following expression:

$$\pi_X^A = \frac{(a+c_A)^2}{9} + \frac{(a+c_A+c_B-2t)^2}{16} - f\,, \qquad (28)$$

which is greater than (27).

The following proposition follows:

**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* $B$*.*

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 $A$.

In sum, when the technological differences between the multinational and the local firms are relatively small, exporting by the latter increases the multinational's incentive to invest in the technologically more advanced country.

## 5. Linking the model's predictions to the data

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*), we are now in a position to assess the extent to which our model's predictions can help us to rationalize the trends of FDI inflows towards the European region observed over the last two decades, and illustrated in Section 2.[18]

A vast literature has shown that multinationals are typically more productive than local firms (Caves, 1996; Harris and Robinson, 2003; Benfratello and Sembenelli, 2006). Yet, it is difficult to empirically determine whether the technological gap between the two is relatively small or large. Due to their generally obsolete, inefficient and insufficient productive capacities, as well as their limited local financial resources, many Eastern European firms were typically unable to compete with foreign firms in the product markets prior to 1990[19]. We will therefore consider the technological gap between the two groups of firms as large over that period. As the productivity gap kept shrinking during the course of the nineties (Table 2), we will consider the gap as small in the periods 1991-1997, and 1998-2000.

Focusing on exporting activities by European countries, on average, only 37.0 per cent of the GDP in the region was exported in 1990[20]: it is therefore reasonable to assume that a majority of firms were not exporting prior to 1990. We make a similar

[18] It should be noted that our model is micro-based and refers therefore to the behaviour of individual firms, while our data are country-level macro data. The links between the model and the data hereby discussed should therefore be interpreted with caution.

[19] 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.

[20] This percentage is based on the export to GDP shares of the CEEC-10 and the EU-15 (World Bank, 2004).

assumption for the period 1991-97, when the average share of exports to GDP was 44.0 per cent. On the other hand, due to the strong increase in the share of exports to GDP over the period 1998-2000 (which reached an average value of 50.3 per cent), it is legitimate to assume that a majority of European firms were exporting over that period.

In sum, we will use our basic model (where local firms are assumed not to export) to explain the behaviour of inward FDI in the European region in the pre-1990 period (case of large technological gap between the multinational and the firm in the relatively less advanced country); and over the period 1991-97 (case of small technological gap). We will use our extended model, in which local firms are assumed to be able to export, under the case of a small technological gap, to explain FDI behaviour over the period 1998-2000.

Specifically, considering that transportation costs are relatively low within Europe, Proposition 1 provides an explanation for why FDI flows towards the CEECs were virtually non-existent prior to 1990 (Table 1). According to this proposition, under the assumptions that the local firms do not export, and that the technological gap between the multinational and the firm operating in the backward host country is large, the multinational invests in fact in the advanced country, in the presence of low transportation costs.

Similarly, Proposition 2 can be used to rationalize the stylized fact according to which, over the period 1991-97, FDI flowed increasingly towards the CEECs (Figure 1; Table 1). According to this proposition, in the presence of a relatively small technological gap, and in the absence of exporting by the local firms, the multinational invests in fact in the relatively less advanced country.

Finally, we can use Proposition 4 to rationalize the increase in the share of world FDI inflows received by the Western European countries over the period 1998-2000 (Figure 1; Table 1). According to this proposition, in the presence of a relatively small technological gap, and under the assumption that the local firms export, the multinational invests in fact in the technologically advanced country.

## 6. 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 focus on the welfare implications for our basic model. The analysis can easily be extended to incorporate exporting by the local firms.

### *6.1 Large technological differences between firms $X$ and $B$*

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:

$$W^{A/A} = \frac{2(a-2c_A)^2 + (2a-c_A)^2}{18} \tag{29}$$

$$W^{B/A} = \frac{(a-t)^2}{8}. \tag{30}$$

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

$$W^{A/B} = \frac{2(a-2c_A+t)^2 + (2a-c_A-t)^2}{18} \tag{31}$$

$$W^{B/B} = \frac{a^2}{8}. \tag{32}$$

Comparison of the welfare values in (29) and (31), on the one hand; and (30) and (32), 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 $B$.

*6.2 Small technological differences between the firms*

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

$$W^{A/A} = \frac{2(a-2c_A)^2 + (2a-c_A)^2}{18} \tag{33}$$

$$W^{B/A} = \frac{2(a-2c_B+t)^2 + (2a-c_B-t)^2}{18}. \tag{34}$$

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

$$W^{A/B} = \frac{2(a-2c_A+t)^2 + (2a-c_A-t)^2}{18} \tag{35}$$

$$W^{B/B} = \frac{2(a-2c_B)^2 + (2a-c_B)^2}{18}. \qquad (36)$$

Comparison of the welfare values given in (33) and (35), on the one hand; and (34) and (36), on the other, gives the following proposition:

**Proposition 6:** *Country $A$ ($B$) prefers investment by firm $X$ in country $A$ ($B$) if* $c_A \in (\frac{t}{2}, \frac{a}{2})$ *(*$c_B \in (\frac{t}{2}, \frac{a}{2})$*).*[21]

*6.3 Can there be a conflict of interest between the multinational and the host country?*

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).

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

## 7. 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 firm 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 have helped us to understand why prior to 1990, FDI flows directed toward the low-productivity CEECs were virtually non-existent. The model has also helped us to rationalize why over the period 1991-97, the share of world FDI received by the increasingly open and increasingly productive CEECs

significantly rose; while the trend was reversed over the period 1998-2000, when FDI flowed more and more towards the Western European economies.

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.

## References

**Barros, P. P. and L. Cabral**, 2000, 'Competing for foreign direct investment', *Review of International Economics*, **8**: 360 – 71.

**Benfratello, L. and A. Sembenelli,** 2006, 'Foreign ownership and productivity: is the direction of causality so obvious?' *International Journal of Industrial Organization* (forthcoming).

**Buch, C. M., R. M. Kokta and P. Daniel**, 2003, 'Foreign direct investment in Europe: is there redirection from the South to the East?' *Journal of Comparative Economics*, **31**: 94 –109.

**Caves, R.,** 1996, *Multinational enterprise and economic analysis* (second edition). Cambridge University Press, Cambridge.

**Conference Board and Groningen Growth and Development Centre**, 2006, 'Total Economy Database'. http://www.ggdc.net.

**Dewit, G., D. Leahy and C. Montagna**, 2003, 'Employment protection and globalisation in dynamic oligopoly', *Mimeograph*, Department of Economics, Maynooth, Ireland.

**Fumagalli, C.**, 2003, 'On the welfare effects of competition for foreign direct investments', *European Economic Review*, **47**: 963 – 83.

**Hapaaranta, P.,** 1996, 'Competition for FDI'**,** *Journal of Public Economics***, 63:** 141–153.

**Harris, R. and C. Robinson**, 2003, 'Foreign ownership and productivity in the United Kingdom. Estimates for UK manufacturing using the ARD', *Review of Industrial Organization,* **22**: 207-23.

**Hummels, D.**, 1991, 'Have international transaction costs declined?' *Mimeograph,* University of Chicago.

**Kolasa, M.,** 2005, 'What drives productivity growth in the new EU member states? The case of Poland', *European Central Bank Working Paper, No. 486*.

**Kornai, J.,** 1986, 'The soft budget constraint,' *Kyklos*, **39:**3-30.

**Kornai, J.,** 1993, 'The evolution of financial discipline under the postsocialist system,' *Kyklos*, **6**: 153-69.

**Milner, C.**, 2005, 'Protection by tariff barriers and international transaction costs', *Scottish Journal of Political Economy*, **52**: 105 – 21.

**Pack, H. and K. Saggi**, 1997, 'Inflows of foreign technology and indigenous technological development', *Review of Development Economics*, **1**: 81 – 98.

**Salvatore, D.,** 2001, 'The problems of transition, EU enlargement, and globalization,' *Empirica,* **28:** 137-57.

**Skaksen, M.,** 2005, 'Should governments subsidize inward foreign direct investment?' *Scandinavian Journal of Economics,* **107:** 123-40.

**United Nations Conference on Trade and Development (UNCTAD),** 2005, Foreign direct investment database.

**United Nations,** 1995, *World Investment Report: Transnational Corporations and Competitiveness,* United Nations, New York.

**United Nations,** 1996, *World Investment Report: Investment Trade and International Policy Arrangements*, United Nations, New York.

**World Bank,** 2004, World development indicators.

## Table 1. FDI inflows by host region

| Year | Developed Countries | Western Europe | EU | CEECs |
|---|---|---|---|---|
| | | **Value (billions of US dollars)** | | |
| 1984-1989 (annual average) | 93.2 | 39.8 | 37.7 | 0.06 |
| 1990 | 171.1 | 103.4 | 96.8 | 0.6 |
| 1991 | 112.8 | 80.1 | 77.7 | 2.6 |
| 1992 | 107.1 | 72.3 | 72.4 | 4.7 |
| 1993 | 137.0 | 74.3 | 73.3 | 7.1 |
| 1994 | 145.7 | 83.5 | 77.3 | 6.3 |
| 1995 | 204.4 | 119.1 | 114.6 | 15.4 |
| 1996 | 221.9 | 117.6 | 111.0 | 14.7 |
| 1997 | 268.4 | 138.0 | 126.6 | 21.1 |
| 1998 | 472.5 | 263.0 | 249.9 | 24.3 |
| 1999 | 828.4 | 500.0 | 479.4 | 26.5 |
| 2000 | 1108.0 | 697.4 | 671.4 | 27.5 |
| | | **Share in total (per cent)** | | |
| 1984-1989 (annual average) | 80.7 | 34.5 | 32.7 | 0.05 |
| 1990 | 82.0 | 49.5 | 46.4 | 0.3 |
| 1991 | 71.1 | 50.5 | 49.0 | 1.7 |
| 1992 | 64.4 | 43.4 | 43.5 | 2.8 |
| 1993 | 60.7 | 32.9 | 32.5 | 3.1 |
| 1994 | 55.9 | 32.0 | 29.6 | 2.4 |
| 1995 | 60.9 | 35.5 | 34.1 | 4.6 |
| 1996 | 57.1 | 30.3 | 28.6 | 3.8 |
| 1997 | 55.0 | 28.3 | 25.9 | 4.3 |
| 1998 | 68.4 | 38.1 | 36.2 | 3.5 |
| 1999 | 76.2 | 46.0 | 44.1 | 2.4 |
| 2000 | 79.8 | 50.2 | 48.4 | 2.0 |

*Source*: Authors' calculations based on the Foreign Direct Investment Database (UNCTAD, 2005).

**Table 2. Labour productivity levels and growth in selected CEECs**

| Country | GDP per person employed<br><br>1990 Level | GDP per person employed<br><br>1995 Level | GDP per person employed<br><br>1997 Level | GDP per person employed<br><br>2000 Level | GDP per person employed<br><br>1995-2000 Growth |
|---|---|---|---|---|---|
| *Bulgaria* | 33.04 | 32.91 | 28.07 | 31.72 | 0.80 |
| *Czech Republic* | 47.84 | 44.09 | 43.95 | 45.39 | 1.83 |
| *Estonia* | 56.89 | 48.24 | 54.97 | 63.95 | 6.47 |
| *Hungary* | 38.51 | 41.17 | 41.94 | 42.89 | 2.02 |
| *Latvia* | 50.98 | 35.91 | 37.82 | 43.76 | 4.79 |
| *Lithuania* | 46.97 | 28.46 | 30.12 | 37.36 | 6.27 |
| *Poland* | 31.32 | 36.34 | 38.44 | 43.36 | 4.39 |
| *Romania* | 20.14 | 18.79 | 18.50 | 17.68 | 0.44 |
| *Slovak Republic* | 42.00 | 43.15 | 44.73 | 48.19 | 3.20 |
| *Slovenia* | 63.64 | 62.99 | 61.83 | 65.69 | 2.04 |
| *Average* | 43.14 | 39.20 | 40.03 | 44.00 | 3.28 |
| *EU-15* | 100 | 100 | 100 | 100 | 1.36 |

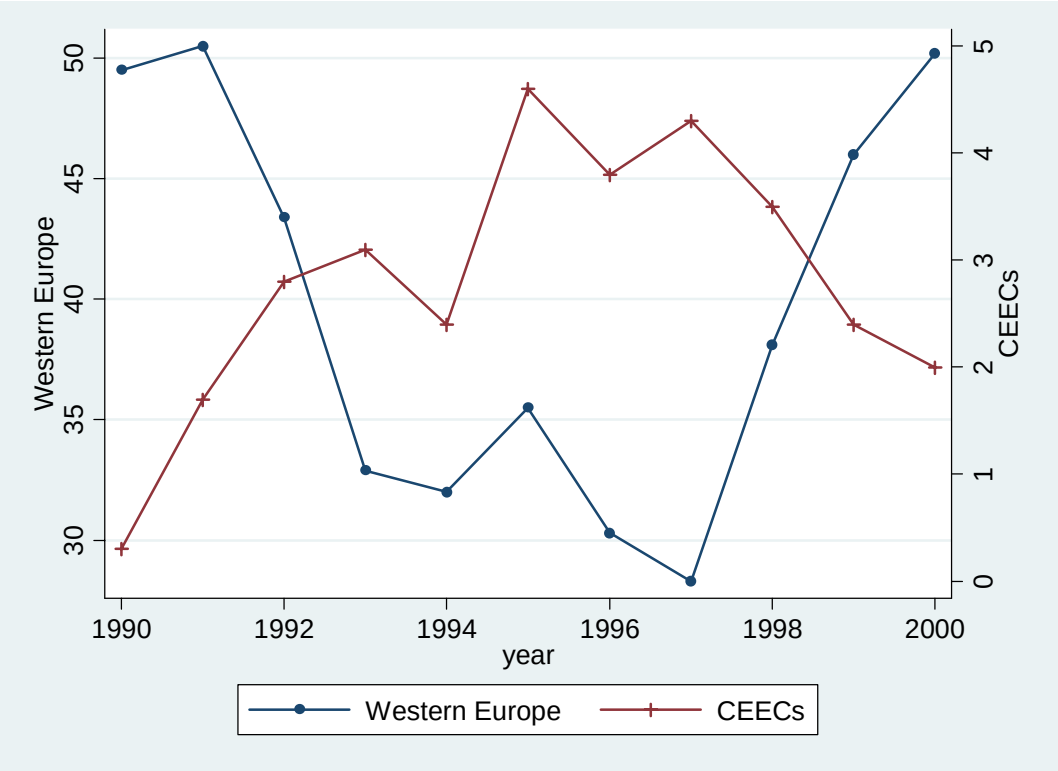
*Notes*: EU-15=100. GDP per person employed is measured in 1990 US dollars (converted at Geary Khamis PPPs). EU-15 comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK.
*Source*: Authors' calculations based on Total Economy Database (Conference Board and Groningen Growth and Development Centre, 2006).

**Table 3. Shares of exports of goods and services to GDP in selected CEECs**

| Country | 1990 | 1995 | 1997 | 2000 |
|---|---|---|---|---|
| *Bulgaria* | 33.12 | 44.66 | 58.25 | 55.70 |
| *Czech Republic* | 45.21 | 50.71 | 52.73 | 64.46 |
| *Estonia* | NA | 68.37 | 73.49 | 88.26 |
| *Hungary* | 31.14 | 44.41 | 55.14 | 74.88 |
| *Latvia* | 47.70 | 47.27 | 51.05 | 45.63 |
| *Lithuania* | 52.09 | 51.51 | 53.07 | 44.89 |
| *Poland* | 28.65 | 25.37 | 23.88 | 27.84 |
| *Romania* | 16.73 | 27.62 | 29.20 | 32.87 |
| *Slovak Republic* | 26.55 | 58.28 | 56.87 | 70.82 |
| *Slovenia* | NA | 55.19 | 57.40 | 56.54 |
| *Average* | 31.24 | 47.34 | 51.11 | 56.19 |
| *EU-15* | 38.10 | 42.20 | 45.25 | 52.79 |

*Source*: World Development Indicators (World Bank, 2004).

**Figure 1. Shares of world FDI accounted for by Western European countries and the CEECs (in per cent)**




*Source*: Authors' calculations based on the Foreign Direct Investment Database (UNCTAD, 2005).