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A Game Theoretic Model Of Multinational Firm Location

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A game theoretic-model of multinational firm location

José Pedro Pontes

The paper deals with a location game involving two symmetric firms. The players choose strategies in a spatial setting made up by two asymmetric countries, where the smallest country has a labour cost advantage.

Determination of equilibrium location patterns enables to assess under what conditions both forms of foreign direct investment (horizontal and vertical) will take place in terms of a set of parameters (namely market size, relative size of the small country, and extent of its cost advantage). The firms interact through input transactions that bring about multiplicity of equilibria. An application to the evolution of the Portuguese car industry is performed.

J.E.L. classification: F23; R30; C72.

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A game theoretic model of multinational firm location

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1 Introduction¹

Theoretical research on foreign direct investment (henceforth named FDI) has addressed two different questions (see Krugman and Obstfeld, 1994). The first one treats decision on FDI as a *location* problem. The problem is to explain why does a firm choose to produce a good (or complementary parts of it) in several countries, instead of clustering production in just one location. The second one concerns *internalisation*: how to explain that two plants located in different countries and producing the same good (or complementary parts of the same good) decide to become members of the same firm, instead of remaining independent corporations. This paper is exclusively concerned with the locational aspect of the multinationalisation of economic activity.

Literature on FDI usually treats separately two kinds of investment. On one hand, horizontal investment concerns the production of the same good in several countries in plants usually addressed to local demand. Therefore FDI behaves as a substitute to trade. According to Markusen and Venables, 1998, FDI has increased faster than trade and aggregate income since 1980 (although it endured a slowdown in the 90's). On the other hand, vertical investment is defined by the production of complementary parts of a good or the performance of successive stages of production and distribution in different countries, so that plants of the same firm are tied by trade in intermediate goods (Gao,1999). A simple example of vertical investment was provided by Helpman, 1984, where investment arises on account of the physical separation of headquarters and the productive unit. Each unit produces complementary outputs: the headquarter provides specialized services (financial, strategic planning, R&D and others) and the plant performs production. Clearly, vertical investment is complementary rather than a substitute for trade. The complementariness of investment and trade is a well known fact according to the World Trade Organisation (Several authors, 1997).

In this paper, we try to bridge the gap between the literature on horizontal and vertical investment by presenting the two kinds of investment as special cases that arise in a location model for specific values of the parameters. A first attempt to reach this goal for the case of a multi-plant monopolist firm

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was made in Pontes, 1999.

We consider a spatial economy made by two countries A and B. By definition, A is the large country and B is the small one in terms of the population of consumers. On the other hand, B has lower labour costs than A. Two firms play a location game. By definition, they both have headquarters in the large country A. Each firm has the following locational strategies: location of a single plant in A; location of a single plant in B; and location of a plant in both markets. We interpret the location of a single plant in B, away from the headquarter, as vertical investment and the location of two plants in A and B as horizontal investment. The concentration of production in A, near the headquarter, is regarded as absence on FDI.

The firms' strategies are driven by several locational forces. The first one are economies of scale at the plant level, that drive firms to cluster production in one country. On the other hand, trade costs tend to disperse production in both countries. Labour cost advantages attract the productive activity to the small country if transport costs are low enough. Lastly, following here Fujita,1981, there are linkages in production that follow from the fact each firm's end product is sold as an intermediate good to other firm. These linkages favour symmetric location strategies, e.g., identical locations of production for both firms.

We study the Nash equilibria for different values of the following parameters: the relative size of the small market in terms of its share on the total population, the transport cost and the intensity of linkages as measured by the quantity of intermediate good that must be used in order to produce one unit of output. According to the assumptions, a pair of strategies are a Nash equilibrium only if they are symmetric.

The standard result of the "new economic geography" (see Fujita and others,1999) strand of literature is replicated with a change due to technological linkages of firms. High values of the transport cost imply that the firms decide to stay near the demand by local consumers, so that they choose to locate a plant in each market. This corresponds to horizontal investment. On the other hand, if trade costs are very low, the firms decide to produce only in the low cost, small market and export the product to the large market. This fits the definition of vertical investment. For intermediate values of the trade cost, the firm decides to concentrate production in the large market in order to be near to the majority of consumers provided that technological linkages are not too strong. Otherwise, multiple equilibria arise and the degree of multiplicity increases with the size of input transactions. The "new

economic geography” result is maintained in the sense that the two firms locating in the large market is a Nash equilibrium in every region of multiple equilibria. In this case, direct investment may either exist or not, depending on the history of the situation.

The impact of the variation in the values of the other parameters have been treated by Markusen and Venables, 1998 for the case of horizontal investment. Here we study these effects for both types of FDI. Therefore, an increase in either the relative size of the small country or in its labour cost advantage enhances direct investment, enlarging the domain of values of the trade cost for which vertical investment (concentration of production in the low cost country) and horizontal investment (multi-plant firms) arise. Total population and income in the global economy favour horizontal investment, and have no sensible effect on vertical investment. Fixed costs at plant level have an opposite and symmetric effect.

2 The model

We suppose a spatial economy that obeys the following assumptions:

1. There are two countries A and B. The population of consumers in country A, n_a , is larger than the population in country B, n_b . The wage rate in country A, w_a , is higher than the wage rate in country B, w_b .
2. There are two firms, labeled 1 and 2, that have headquarters in country A. The headquarters’ locations are irreversible.
3. Each firm is a monopolist for the good it produces.
4. Each firm has three strategies for the location of production. The first option is to locate a single plant in A, which corresponds to the option of not investing abroad. The second option is to locate a single plant in country B, which fits with the definition of vertical investment.² The third alternative consists of fostering two plants, each one of them being

²The location of single plant in B can be named ”vertical investment” since the headquarter in A and the unit in B perform complementary tasks. The headquarter supplies specialized services (financial services, strategic planning, R&D and others) while the plant performs productive tasks.

located in a separate market. This option corresponds to horizontal investment.

5. Each consumer buys k_i units of product i ($i = 1, 2$) if $p_i \leq v_i$, where v_i is the reservation price of good i . Otherwise the consumer refrains from buying product i .
6. Transport cost of one unit of product i ($i = 1, 2$) between the two countries is given by t_i .
7. Each firm uses its output and the other firm's product as intermediate goods. Let α_{ij} ($i, j = 1, 2; i \neq j$) be the amount of firm i 's output that is used by firm j in order to produce a unit of output. In order to ensure the feasibility of firms' technologies we assume that the matrix $[\alpha_{ij}] - I$ (where I is the identity matrix) is negative definite so that

$$\begin{aligned} \alpha_{ii} &< 1 \\ (\alpha_{11} - 1)(\alpha_{22} - 1) - \alpha_{12}\alpha_{21} &> 0 \end{aligned} \tag{1}$$

8. In both end product and intermediate good transactions, the selling firm carries and delivers the product to the customer.
9. In intermediate goods transactions, the supplying firm j and the buying firm i agree to exchange the input at the delivered price \bar{p}_i ($i, j = 1, 2; i \neq j$).
10. If firm i has a single productive plant, its total production cost function is

$$C_i = F_i + G_i + (l_i w_n + \alpha_{ji} \bar{p}_i) q_i \tag{2}$$

where

- $C_i \equiv$ Total production cost
- $F_i \equiv$ Fixed cost at firm level (cost of headquarter operation)
- $G_i \equiv$ Fixed cost at plant level
- $l_i \equiv$ Quantity of labour required to produce one unit of output
- $w_n \equiv$ Wage rate in country $n \in \{A, B\}$ where the productive plant is located
- $q_i =$ Total output of firm i

11. If firm i is multiplant, its total production cost function is

$$C_i = F_i + 2G_i + (l_i w_a + \alpha_{ji} \bar{p}_i) q_a + (l_i w_b + \alpha_{ji} \bar{p}_i) q_b \quad (3)$$

where

$$q_a, q_b \equiv \text{output sold in markets A,B} \quad (4)$$

12. A multiplant firm supplies the intermediate good through the plant that is contiguous to the buying firm, without incurring in delivery cost.

In order to simplify the exposition, we suppose that the cost functions and the demand functions addressed to the firms are symmetric so that

$$v_1 = v_2 = v \quad (5)$$

$$k_1 = k_2 = 1$$

$$t_1 = t_2 = t$$

$$l_1 = l_2 = l$$

$$F_1 = F_2 = F$$

$$G_1 = G_2 = G$$

With the same purpose, we assume that technological interdependence of firms is symmetric. Therefore, we have

$$\bar{p}_1 = \bar{p}_2 = \bar{p} \quad (6)$$

$$\alpha_{21} = \alpha_{12} = \alpha$$

An additional simplification consists to assume that requirements for feasibility of the technology expressed in 1 and symmetry requirements expressed in 6 are met with

$$\alpha_{11} = \alpha_{22} = 0 \quad (7)$$

$$\alpha < 1$$

With the same purpose of simplifying, we assume that a product has the same price as an intermediate good and as an end product, that is

$$\bar{p} = v \quad (8)$$

Lemma 1 *With the assumptions and simplifications enunciated above, the output of each firm is $\frac{N}{1-\alpha}$, where $N \equiv n_a + n_b$ is the total population of the economy.*

Proof. Since in equilibrium each firm charges the delivered price v , each consumer buys one unit and final demand for each firm's product is N . Total output is determined by the following system of linear equations (written in matrix form)

$$\begin{bmatrix} 0 & \alpha \\ \alpha & 0 \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \end{bmatrix} + \begin{bmatrix} N \\ N \end{bmatrix} = \begin{bmatrix} q_1 \\ q_2 \end{bmatrix} \quad (9)$$

It is easily checked that the solution of this system of equations is

$$\begin{bmatrix} q_1 \\ q_2 \end{bmatrix} = \begin{bmatrix} \frac{N}{1-\alpha} \\ \frac{N}{1-\alpha} \end{bmatrix} \quad (10)$$

■

Then, the output of intermediate good by each firm is given by

$$\frac{N}{1-\alpha} - N = \frac{N\alpha}{1-\alpha} \quad (11)$$

We introduce the notation

$$\rho = \frac{n_b}{N} \quad (12)$$

where $0 < \rho < \frac{1}{2}$. ρ is the share of the small country's population in total population and is a measure of symmetry in the economy. The matrix of this location game of two firms can be sketched by

		Firm 2			
		A	B	A and B	
Firm1	A	1	4	7	(13)
	B	2	5	8	
	A and B	3	6	9	

As the matrix is symmetric, we specify only in each cell the payoff of firm 1. The matrix of payoffs of firm 2 is just the transpose of the matrix of firm 1's payoffs.

We now specify profit of firm 1 for each outcome of locations. In each case, we have

Profit=Receipts of consumer goods-Transport cost of consumer goods+Receipts of intermediate goods-
 -Transport cost of intermediate goods-Production cost of total output.

Underlying the profit expressions that are enunciated below, three possible situations concerning input transactions may arise. The first possible outcome consists of two single plant firms, where each firm supplies the whole amount of input that is required by the other. In the second situation, we have a multiplant firm and a single plant firm. In this case, the single plant firm supplies the input to each plant of the multi-plant firm, while the latter supplies the input to the former only through the plant that is adjacent to the single plant firm without transport cost. The third case consists of two multiplant firms, where each firm supplies the other through plants located in the same country, without incurring in transport cost.

In what follows, we name profit by π

In location outcome (A,A) (cell 1 in matrix 13), firm 1's profit is:

$$\pi = Nv - tn_b + \frac{N\alpha}{1-\alpha}v - 0 - (lw_a + \alpha v) \frac{N}{1-\alpha} - F - G \quad (14)$$

which simplifies to

$$\pi = Nv - t\rho N - lw_a \frac{N}{1-\alpha} - F - G \quad (15)$$

In location outcome (B,A) (cell 2 in matrix 13), firm 1's profit is

$$\pi = Nv - tn_a + \frac{N\alpha v}{1-\alpha} - \frac{N\alpha t}{1-\alpha} - (lw_b + \alpha v) \frac{N}{1-\alpha} - F - G \quad (16)$$

which simplifies to

$$\pi = Nv - t(1-\rho)N - \frac{tN\alpha}{1-\alpha} - \frac{lw_b N}{1-\alpha} - F - G \quad (17)$$

In location outcome (A and B,A) (cell 3 in matrix13), firm 1's profit is:

$$\pi = Nv - 0 + \frac{N\alpha v}{1-\alpha} - 0 - (lw_a + \alpha v) \left(\frac{\alpha N}{1-\alpha} + n_a \right) - (lw_b + \alpha v)n_b \quad (18)$$

which simplifies to

$$\pi = Nv - \frac{lw_a\alpha N}{1-\alpha} - (lw_a n_a + lw_b n_b) - F - 2G \quad (19)$$

In location outcome (A,B) (cell 4 of matrix 13), firm 1's profit is

$$\pi = Nv - t\rho N + \frac{\alpha v N}{1-\alpha} - \frac{t\alpha N}{1-\alpha} - (lw_a + \alpha v) \frac{N}{1-\alpha} \quad (20)$$

which simplifies to

$$\pi = Nv - t\rho N - \frac{t\alpha N}{1-\alpha} - \frac{lw_a N}{1-\alpha} - F - G \quad (21)$$

In location outcome (B,B)(cell 5 of matrix 13), firm 1's profit is

$$\pi = Nv - t(1-\rho)N + \frac{\alpha N v}{1-\alpha} - 0 - (lw_b + \alpha v) \frac{N}{1-\alpha} - F - G \quad (22)$$

which simplifies to

$$\pi = Nv - t(1-\rho)N - \frac{lw_b N}{1-\alpha} - F - G \quad (23)$$

In location outcome (A and B, B) (cell 6 of matrix 13), firm 1's profit is

$$\pi = Nv - 0 + \frac{\alpha v N}{1-\alpha} - 0 - (lw_a + \alpha v) n_a - (lw_b + \alpha v) \left(\frac{\alpha N}{1-\alpha} + n_b \right) - F - 2G \quad (24)$$

which simplifies to

$$\pi = Nv - (lw_a n_a + lw_b n_b) - lw_b \frac{\alpha N}{1-\alpha} - F - 2G \quad (25)$$

In location outcome (A, A and B) (cell 6 of matrix 13), firm 1's profit is

$$\pi = Nv - t\rho N + \frac{\alpha v N}{1-\alpha} - t\rho \frac{\alpha N}{1-\alpha} - (lw_a + \alpha v) \frac{N}{1-\alpha} - F - G \quad (26)$$

which simplifies to

$$\pi = Nv - t\rho N - t\rho \frac{\alpha N}{1-\alpha} - \frac{lw_a N}{1-\alpha} - F - G \quad (27)$$

In location outcome (B, A and B) (cell 8 of matrix 13), firm 1's profit is

$$\pi = Nv - t(1-\rho)N + \frac{\alpha v N}{1-\alpha} - \frac{t(1-\rho)N}{1-\alpha} - (lw_b + \alpha v) \frac{N}{1-\alpha} - F - G \quad (28)$$

which simplifies to

$$\pi = Nv - t(1 - \rho)N - \frac{t\alpha(1 - \rho)N}{1 - \alpha} - \frac{lw_bN}{1 - \alpha} - F - G \quad (29)$$

In location outcome (A and B, A and B) (cell 9 of matrix 13), firm 1's profit function is

$$\pi = Nv - 0 + \frac{\alpha v N}{1 - \alpha} - 0 - (lw_a + \alpha v) \frac{n_a}{1 - \alpha} - (lw_b + \alpha v) \frac{n_b}{1 - \alpha} - F - 2G \quad (30)$$

which simplifies to

$$\pi = Nv - \frac{l}{1 - \alpha} (w_a n_a + w_b n_b) - F - 2G \quad (31)$$

We can easily prove the following

Proposition 2 *With the symmetric simplifications 5,6,8 and 7, if a pair of location strategies is a Nash equilibrium, then the strategies are symmetric.*

Proof. If $\alpha = 0$, there is no interdependence of location strategies. Then, on account of symmetry of strategy sets and payoff functions, the firms choose necessarily symmetric locations. If $\alpha > 0$, payoffs in the main diagonal of matrix 13 rise more than payoffs outside, because the receipts of sales of intermediate goods are independent of location, while transport cost of inputs are zero for symmetric locations and are positive (at least for one firm) for asymmetric locations. ■

On account of the symmetry of the game, Nash equilibria can be assessed comparing firm 1's symmetric payoff with the asymmetric payoffs for each column of matrix 13. Calculations are tedious, so that we present only the results.

(i) (A,A) is a Nash location equilibrium if and only if

$$\frac{l(w_a - w_b)}{(1 - 2\rho)(1 - \alpha) + \alpha} \leq t \leq \frac{G - l\rho N(w_a - w_b)}{\rho N} \quad (32)$$

Clearly, a necessary condition for the equilibrium (A,A) to exist for a non null set of parameters is

$$\frac{l(w_a - w_b)}{(1 - 2\rho)(1 - \alpha) + \alpha} < \frac{G - l\rho N(w_a - w_b)}{\rho N} \quad (33)$$

which is equivalent to

$$\alpha \geq \frac{Nl(w_a - w_b)}{2[G - l\rho N(w_a - w_b)]} - \frac{1 - 2\rho}{2\rho} \quad (34)$$

(ii) If $2\rho + \frac{\alpha}{1-\alpha} > 1$, a necessary and sufficient condition that (B,B) is a Nash equilibrium is

$$t \leq \frac{G}{N(1-\rho)} + l(w_a - w_b) \quad (35)$$

If $2\rho + \frac{\alpha}{1-\alpha} \leq 1$, a necessary and sufficient condition that (B,B) is a Nash equilibrium is

$$t \leq \min \left\{ \frac{l(w_a - w_b)}{(1-2\rho)(1-\alpha) - \alpha}, \frac{G}{N(1-\rho)} + l(w_a - w_b) \right\} \quad (36)$$

The first expression in the r.h.s. of 36, establishes the condition that B is a better reply to itself than A. It is fulfilled trivially if the share of country B in global population (ρ) is high. The second expression on the r.h.s. of 36 is related with the fact that B is a better reply to itself than A and B.

(iii) (A and B, A and B) is a Nash equilibrium if and only if

$$t \geq \max \left\{ \frac{(1-\alpha)G}{\rho N} - l(w_a - w_b), \frac{(1-\alpha)G}{(1-\rho)N} + l(w_a - w_b) \right\} \quad (37)$$

The first expression on the r.h.s. of 37 establishes the condition that A and B is a better reply to itself when the alternative strategy is A. The second expression on the r.h.s. of 37 states the condition that B is a better reply to itself when compared to B.

Direct inspection of conditions (i),(ii) and (iii) allows to evaluate the impact of parameter values on the size of the regions of Nash equilibria in parameter space.

It is easy to recognise the non monotonic effect that transport cost t has on the equilibrium location pattern. As was noticed by the "new economic geography" strand of literature (see Fujita and others, 1999), if transport cost is high, equilibrium (A and B,A and B) prevails, which corresponds to horizontal investment. In this case, the firm aims to be close to local demands. If transport cost is low, (B,B) is the prevailing equilibrium, corresponding to vertical investment. In this case, the locations of firms are pulled by the

cost of labour. For intermediate values of t , (A,A) is an equilibrium. In this situation, the firm aims to supply the global demand by locating at the central point of the spatial distribution of consumers, so that it minimises delivery costs to the majority of them.

An increasing share of the small country in total population, ρ , shrinks the region in parameter space where (A,A) is an equilibrium and widens the region where (B,B) is an equilibrium. The reason for that is intuitive. The impact of ρ on the region of equilibrium of (A and B, A and B) depends on which condition in 37 is binding. If the alternative to A and B being a best reply to itself is to choose location strategy A, which occurs if ρ is low, an increasing ρ widens (A and B, A and B) region. If the alternative to A and B being a best response to itself is to select location strategy B, which occurs for high values of ρ , an increasing value of this parameter diminishes the region where equilibrium (A and B, A and B) prevails. We can summarise the impact of an increasing ρ by saying that it favours both (B,B) and (A and B, A and B), that is to say, it promotes both forms of foreign direct investment.

The difference of labour cost between the two countries, which is a cost advantage for the small country, has a similar influence. An increasing $l(w_a - w_b)$ shrinks (A,A) region, expands (B,B) region and has a non monotonic effect on (A and B, A and B) region. If the alternative to A and B being a best response to itself is to choose A, which happens for low values of the cost advantage, then an increasing $l(w_a - w_b)$ widens (A and B, A and B) region. If the alternative to A and B being a best reply to itself is to choose location strategy B, which happens for high values of the cost advantage of country B, an increasing $l(w_a - w_b)$ diminishes the region of (A and B, A and B) equilibrium. We can sum up saying that an increasing cost advantage of country B, favours both forms of foreign direct investment, vertical and horizontal.

It is also easy to check that an increasing total population N shrinks (A,A) region, diminishes (B,B) region or does not change it (if ρ and α are high-see condition (i)), and widens (A and B, A and B). In the whole, an increasing total population promotes horizontal foreign direct investment. Fixed costs at plant level G have the symmetric opposite effect of expanding (A,A) region, expanding or not changing (B,B) region (provided that ρ and α are high) and shrinking region (A and B, A and B).

These effects have already been defined for horizontal investment by Markusen and Venables, 1998. However, the assessment of parameter change

on vertical foreign direct investment are new. The main concern of this paper is input transactions and the technological interdependence that they imply. It is direct to conclude that increasing exchange of intermediate goods, that is to say, increasing α , widens each equilibrium region, thus introducing multiplicity of equilibria. This effect was identified by Fujita,1981. If the firms exchange intermediate goods, the profitability of a location depends on the location of the other firm. If technological interdependence is high, every joint locations become equilibrium locations for both firms.

In order to assess the influence of α on multiplicity of equilibrium, we plot in figure 1 equilibrium regions in parameter space (α, t) .

[Insert here figure 1]

It is possible to draw several conclusions from figure 1. Multiplicity of equilibria arises for intermediate values of the transport cost. If t is either high or low, we have a unique equilibrium as was outlined above. Typically, in the region of multiple equilibria, (A,A) is a possible equilibrium, because it occurs when transport cost assumes intermediate values. Lastly, the degree of multiplicity increases with α . If the coefficient of input transactions is close to zero, it is likely that the equilibrium is unique. If it is close to 1, it is possible to have three equilibria.

As Fujita,1981 pointed out, multiplicity of equilibria means that the selection of one equilibrium is conditioned by dynamic factors, related to the history of the interaction of firms. Often the firms do not enter the industry at the same time but will do it sequentially. The leader picks an equilibrium to which the follower adheres. However, even in this case of sequential entry, it preferable to model the game as static, because this will be the situation of the game after the second firm enters.

3 Application to the Portuguese car industry

The role of small country with a labour cost advantage fits well to Portugal with relation to its partners in the European Union. Concerning the industry structure, we may make the simplifying assumption that the production activity in car industry entails the operation of two vertically related firms. A firm produces and sells parts (such as engines, speed transmissions, casting products and so on) to another firm that assembles them and delivers the end product .

|Insert here Figure 2|

This structure is asymmetric and contrasts with the symmetric exchange of inputs between the firms that was assumed in the model presented in section 2. However, if we assume that the selling and the buying firms share the cost of transport of intermediate goods, both have an incentive to select joint locations which is similar to the symmetric structure. The specific structure that defines the car industry also differs from the structure assumed in section 2 in that the parts firm and the assembly firm have different cost parameters. Assembly has higher transport cost and lower fixed costs (economies of scale) than parts production. Furthermore, assembly is more labour-intensive than the manufacturing of parts. The difference in cost parameters can lead the firms to asymmetric locations, although input transactions introduce an incentive for the two firms to cluster.

The situation of the Portuguese car industry until 1980 (see Féria, 1999) was characterized by the existence of several assembly units producing to the local market, based on protectionist measures (import quotas of vehicles) and depending almost completely on imports for the provision of parts. Therefore, the assembly firm had a location of "A and B" type, while the parts producing firm had a location of "A" type. The fact that locations were asymmetric, in spite of the transport cost of intermediate goods, reflects the difference of trade costs (which is emphasised by protection of the car market) and production cost parameters between the two firms.

In 1980, the French manufacturer Renault launched a large investment project that partially changed the location pattern of the industry. Assembly continues to produce for the local market (and to its extension to the south of Spain), again based on protectionist policy, so that its pattern is of "A and B" type. The novelty consists in that the project contains the installation of producing parts firms (namely engines, speed transmissions, and heavy casting) that supply the domestic assembly unit and export to other Renault factories in Europe. Also multinational investment increases the number of domestic parts production firms that export a share of its output. Therefore, the firms that produce components have a new type "B" location pattern. This evolution is explained by the falling trade costs in Europe and by the expansion of the Portuguese car market. Locations of assembly and parts are still non symmetric, but they are partially integrated in the Portuguese space.

The Renault investment lasted until 1995 when the assembly unit was

shut and the producing parts firm was downgraded. After the adhesion of Portugal in 1986, a spur of FDI took place in every sector of activity. In 1991, a joint venture of Ford and Volkswagen performed an investment project of large size. In this case, both assembly and parts production aim the European market, so that both have a "B" type pattern. Locations of the two firms are now symmetric, which can be explained according to several factors. Among them are the further decline of trade costs with the adhesion of Portugal to the European Union and the fast growth of the Portuguese car market given the trend of real convergence of per capita income of Portugal and the European Union. The locational symmetry prevailing now reflects the fact that the amount of input transactions has increased on account of car market growth, creating an incentive for the two firms to choose symmetric locations.

4 Conclusion

The two firm location game with intermediate goods transactions has enabled us to assess the impact of different factors on foreign direct investment in a small country endowed with a labour cost advantage. A relatively high size of the small country and the extent of its cost advantage promote both forms of FDI (horizontal and vertical). The size of the global economy influences positively horizontal investment and has no sensible impact upon vertical investment. Fixed costs at plant level have a symmetric opposite effect to the one exerted by size of global economy: they restrict horizontal investment and favour concentration of production in the large country.

The impact of falling trade costs appears quite the same as was enunciated by the "new economic geography" strand of literature, with a change due to the introduction of input transactions between the firms. If transport cost is very high, the firms will locate a plant in each market giving rise to horizontal investment. If transport cost is very low, vertical investment takes place, with production clustered in the low wage country. If transport cost has an intermediate value, two cases may arise. If intermediate goods exchanges are small with relation to final outputs, production will be located in the large market, near to the majority of customers, . However, if technological interdependence between the firms is important, multiplicity of equilibria arises and its degree increases with the size of input transactions. In the latter case, location equilibrium depends on the history of the game. If firms

choose locations sequentially, the leader can select the prevailing equilibrium among all possible multiple equilibria.

References

Féria, Luis P., "O sonho automóvel", *Economia Pura*, Ano II, n°16,1999, pages 94-87.

Fujita, M., "location of firms with input transactions", *Environment and Planning A*, 1981, vol.13, pages 1401-1414.

Fujita, M., P. Krugman and A. Venables, *The Spatial Economy-Cities, Regions and International Trade*, Cambridge Mass. and London, MIT Press, 1999.

Gao, Ting, "Economic geography and the department of vertical multinational production", *Journal of International Economics*, vol. 48, 1999, pages 301-320.

Helpman, E., "A simple theory of international trade with multinational corporations", *Journal of Political Economy*, vol.92, 1984, pages 451-472.

Krugman, Paul and Maurice Obstfeld, *International Economics: Theory and Policy*, Harper Collins, 1994.

Markusen, James R. and Anthony J. Venables, "Multinational firms and the new trade theory", *Journal of International Economics*, vol.46, 1998, pages 183-203.

Pontes, Jose P., "Locational Aspects of Foreign Direct Investment in Portugal", Center for the Study of Complex Economic Systems, Institute of Economic Research, Kyoto University, Discussion Paper No A-82, November 1999.

Several authors, "Le commerce et l'investissement étranger direct", *Problemes Economiques*, n°2512, 19 Mars,1997, pages 25-32.

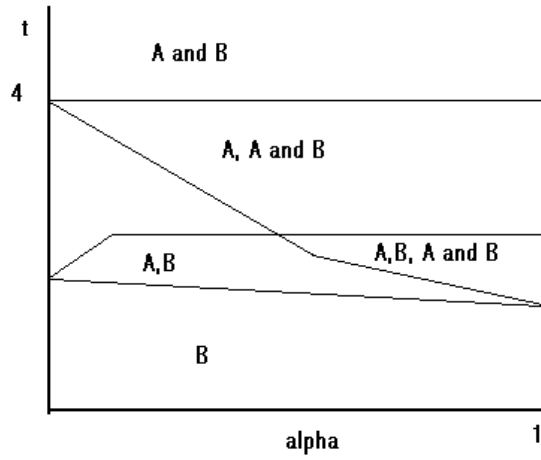


Figure 1: Multiplicity of equilibria in (α, t) space

Figure 1:

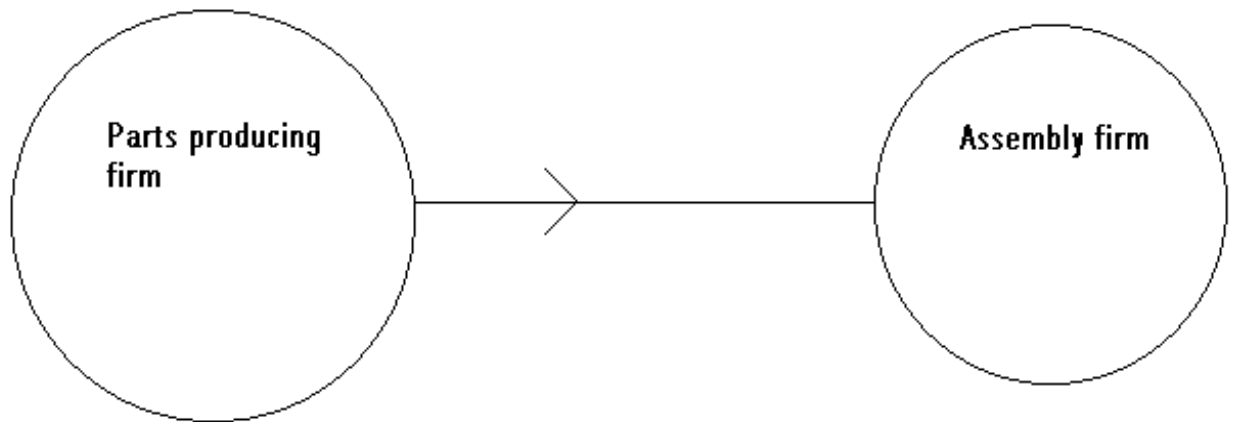


Figure 2: Structure of the car industry

Figure 2: