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Strategic location behaviour: Temporal and spatial proximity in situation of agglomeration effects

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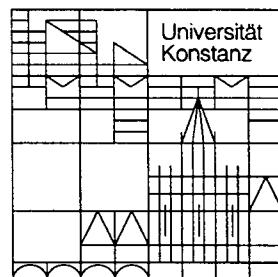
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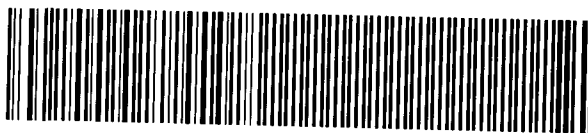
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STRATEGIC LOCATION BEHAVIOUR: TEMPORAL AND SPATIAL PROXIMITY IN SITUATION OF AGGLOMERATION EFFECTS

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Abstract: We address the question of competition within the location choices of firms. In a framework of agglomeration effects, both spatial and temporal dimensions of the firms' decisions are studied. We show that the competition consequences of preemptive move and optimal time of entry can interfere with the geographical decisions. Our results contrast with those of agglomeration economics models which generally provide extreme results of mono-location. The Stackelberg equilibria described here tend to demonstrate that the relation between competition strength and spatial differentiation remains pertinent in a context of agglomeration economies.

JEL classification : F21

Keywords : location theory, agglomeration effects, strategic investment

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Stylised facts

In a framework of accelerated foreign direct investments (FDI) flows which become increasingly mobile, the competition between host countries is more and more intense and many countries try to strengthen their attractiveness by investment incentives. These measures give rise to conflicts with important employment issues at stake. This has been particularly well illustrated in the recent affair of the aids given to Volkswagen by the lander of Saxe and opposed by the European Commission. The re-location of plants by Hoover and JVC from France to Scotland justified by wages differentials and financial grants are also instructive on this ground.

In the current European context of weak economic growth, the location strategies take an important dimension both for firms and potential host countries. These strategies often leads to a spatial clustering of firms with two characteristics : The multinational firms tend to imitate the location pattern of the local firms as well as the choices of previously settled foreign firms. This behaviour gives ground to some agglomeration effect hypotheses in the location decision process.

Recent empirical studies on Japanese FDI in the United States (Head, Ries Swenson, 1994a) or in Europe (Han, 1994; Mayer and Mucchielli, 1996) reveal strong agglomeration effects in the strategic location behaviour of firms. This clustering is not limited to spatial choices, as the FDIs also seem to concentrate in time, as shown by the timing pattern of Japanese investments in Europe. Our approach allows for these two, spatial and temporal, dimensions of agglomeration. The purpose is to study decisions resulting in both spatial and temporal proximity in a context of sectoral agglomeration effects.

There are two main types of analytical approaches to the agglomeration effect. One way is to determine the mechanisms of clustering : if investments concentrate, there must be a positive externality justifying the apparent similarity of these decentralised decisions. Many models deal with the study of the precise determinants which make up the agglomeration economies¹, such as these of Krugman(1991) and of David and Rosenbloom (1990).

¹ Fujita and Thisse (1995) articulate their survey of the agglomeration determinants around three points : externalities under perfect competition, increasing returns and spatial competition under strategic interaction.

Clustering may also result of a search of information on the part of firms, an information revealed by previous decisions of other firms. It has to do with the idea of the signal of the site attractiveness². Indeed if all firms belonging to the same sector have to take their decisions on common objective criteria, the presence of firms on a site reveals the attractiveness characteristics that underlie decision making. This type of approach is explicit in most empirical work (Head, Ries and Swenson, 1994 for example) but all models that not specify the agglomeration effect can implicitly follow this approach (Arthur, 1990 and Rauch, 1993).

However, if some level of clustering in individual decisions is observed, the most usual prediction of the models with agglomeration economies (i.e total concentration of economic activity) is not verified. We argue, in line with the "traditional" strategic location theory, that the competition issues can be an important counterforce and therefore can lead to less extreme outcomes more likely to match with reality. This paper studies what clustering implies in terms of competition. The centrifugal force of competition is opposed to the centripetal force of the agglomeration effects : the isolating tendency of firms aimed at softening competition counter-balances the agglomeration effect which pushes towards concentration. The main finding of the model developed in this article lies in the trade-off between competition intensity and agglomeration effects. It allows to explain, in a single framework where firms act strategically, both situations of spatial and temporal agglomeration and situations where firms differentiate in their site and timing of location.

The remaining of the paper is as follows : the first section deals with the theoretical background of location theory and agglomeration economics. In the second section, we expose a model determining optimal dates of entry of competing firms on a foreign market. The geographical choice is introduced in the third section and the last section consists of a parametric analysis of the game studying location patterns depending on the degree of competition on the initial market.

² The availability of information is very important in the location choice, particularly when one deals with international location. Incomplete or asymmetric information concerning the different sites in competition can generate many agglomeration forces. A government can signal a high attractiveness through its promotion efforts (Bond et Samuelson, 1986). The bankers' behavior can lead to imitation strategies from the investors (De Coster and Strange, 1993).

1. THEORETICAL BACKGROUND

Within the traditional framework of location strategies, spatial clustering or differentiation may result from strategic firm behaviours³. In a Hotelling-type two period location/price game, the location decision has two opposite effects. The spatial proximity has a direct positive impact as it increases the demand faced by each competitor. It has also an indirect negative impact on the competition toughness, as geographic concentration leads to a price war. It has been demonstrated that, when the consequences of the first period location choice are taken into account, firms locate so as to soften competition which means that they avoid spatial proximity (Tirole, 1988; Forges and Thisse, 1993). The indirect effect always dominates the direct one and the location equilibrium results in a maximal differentiation. For this reason, this approach doesn't seem relevant in the analysis of agglomeration phenomena.

The introduction of increasing returns in the geographical choice allows for a geographical clustering to emerge. However, location models with agglomeration effects have two disadvantages : they present the opposed (but not less extreme) result of mono-location and the precise determination of this mono-location depends on an "historical accident". In this case, the outcome depends fundamentally on the initial conditions. In Arthur's models (1990,1994) some firms belonging to the same sector have a benefits function depending on a geographical benefit (in absence of other firms) and on an agglomeration benefit (a positive function of the number of previously settled firms). Without economies of agglomeration, the companies' geographical preference is the only one to be taken into account and the location of companies is predictable : it depends on the distribution of relative "tastes" of companies. With unlimited economies of agglomeration, a location monopolises all firms. The precise solution depends on :

- The relative attractiveness of sites: the site that offers a bundle of characteristics nearest to the requirements of the firms has the highest relative attractiveness. This can be related to the literature about horizontal product differentiation (Gabszewicz and Thisse, 1992), with a lancasterian problem of variety of tastes among companies. The site that succeeds in satisfying the demands of the *first companies* is sure to obtain the whole sector.
- The entry order of companies: the preference of the first companies is predominant in the determination of the equilibrium. This historical accident is the main indeterminacy of the model whereas we will see that this order can be determined by the strategic behaviour.

³ See noticeably Gabszewicz and Thisse (1992) and Fujita and Thisse (1995) for an interpretation of strategic location in terms of spatial differentiation between firms competing in price.

A third drawback is underlined by Arthur (1994) : this type of approach is not strategic since firms only arbitrate between their tastes and the choices of other firms. The entry order is predominant but firms act mechanically when their turn comes, whereas the sequence of entry precisely poses a strategic problem :

Suppose, for example, that agglomeration effects result from an infrastructure spending, undertaken by the pioneers which benefit freely to all later entrants. It seems intuitive in such a framework that each company will attempt to enter on the new market once the infrastructure spending has been undertaken by the first movers. Rauch (1993) analyses this type of strategic problem. In his model, the first mover is disadvantaged in undergoing the high costs of a "virgin" site and has to wait next periods to benefit from agglomeration effects⁴. From then on, the wait and see attitude is the dominant strategy if all firms are symmetrical, and the solution of the game is that all firms remain in the old location. This situation forms a strongly sub-optimal Nash equilibrium and it seems intuitive that the equilibrium will be more efficient when one of the two firms will accept the first costs of location against some sort of advantage. It implies that firms would be able to arbitrate between the benefits of waiting, led by agglomeration effects, and a form of waiting cost in the determination of their entry rank.

Rao and Rutenberg (1979) construct a model with such a waiting cost. They determine the entry sequences when firms have to select a rank and an optimal date of entry in a growing market to which they export. Firms wait to enter because there is a fixed (private) cost to location and the foreign market is in growth ; therefore their interest is to spread their fixed costs on the greatest possible sale volume. There is also a waiting cost because if a firm preempts the market, it will increase its market share on the foreign country until the other firm joins it.

In the following model we introduce this preemption premium of Rao and Rutenberg (1979) in a game similar to Rauch's (1993) one. This enables us to determine endogenously the sequence of firms' entry.

⁴ Just like a telecommunication network user wishes to wait for the network to be big enough (Curien and Gensollen, 1992; Economides, 1996), firms may wish to delay entry.

2 THE MODEL OF OPTIMAL RELOCATION TIMING

2.1 Assumptions

The model consists of two asymmetric firms, two alternative host countries as relocation destinations. These two countries exhibit different levels of attractiveness. This Stackelberg game is first studied with a single host country in order to focus on the temporal choice of the firms.

The two firms are in a home country at the beginning of the game and have to select here an optimal entry date in a more attractive foreign country⁵. Strategic variables are t_X , entry date of firm X and t_Y , entry date of firm Y.

The sector to which firms belong is characterised by agglomeration effects such that the productivity of a site depends positively on the number of firms ($n=0, 1$ or 2 ; $n^*=0, 1$ or 2) located in this site at the previous period. We suppose⁶ a global duopoly profit $\Pi(n)$ in the domestic region and $\Pi^*(n^*)$ in the other region with:

$$\Pi(0) < \Pi(1) < \Pi(2) \text{ and } \Pi^*(0) < \Pi^*(1) < \Pi^*(2).$$

In order to simplify, we will make the simple assumption that the monopoly global profit is higher than the duopoly global profit:

$$\Pi_m(n) > \Pi(n) \text{ and } \Pi^*_m(n^*) > \Pi^*(n^*)$$

Firm Y and X will respectively have a share λ_Y and λ_X ($\lambda_Y + \lambda_X = 1$) of the total profit $\Pi(n)$ at home and $\Pi^*(n^*)$ abroad. A firm, by moving first, preempts the host country's market and captures a part of its rival's market share. Hence we define a α ($0 < \alpha < 1$) that represents the capture coefficient, this capture being definitive. If firm Y chooses to move alone at the period t , and firm X follows at period t_X , we have the following profits for each period.

⁵ We will use indifferently the terms country, region or site to specify locations.

⁶ Our purpose is not to solve an equilibrium in quantity that would precisely allow us to obtain the global profit. To do so, it would be necessary to specify the function of profit and thus to specify the agglomeration effect thanks to a fixed cost that could be, for example, shared between firms.

Table 1 : Profits for each period

Firm Y	Period	Firm X
$\Pi_m^*(0)$	t	$\Pi_m(2)$
$\Pi_m^*(1)$	↓	
$1 - (\alpha^{(t_x-t)} \lambda_x) \Pi^*(1)$	t_x	$\alpha^{(t_x-t)} \lambda_x \Pi^*(1)$
$1 - (\alpha^{(t_x-t)} \lambda_x) \Pi^*(2)$	↓	$\alpha^{(t_x-t)} \lambda_x \Pi^*(2)$
	∞	

The market of the host country grows with time. A coefficient γ will make the total profit of the country of destination increase with time, following the form: $\gamma^{(t_x-t)} \Pi^*(n^*)$

Firms maximise a flow of discounted net profit⁷, which means that they consider location profit on foreign market as compared to a reference situation; For the case of firm Y preempting at period t: $\Pi_m^*(0) - \lambda_Y \Pi(2)$

2.2 Sequence of entry equilibrium

As can be seen in table 1, the profit function will be very different depending on the rank of entry of the firm. Hence, it is difficult to determine optimal dates of entry in a simultaneous game. As both firms can't be first entrants or second entrants at the same time, the own shape of the profit function will be conditional on the observation of an earlier entry of the competitor.

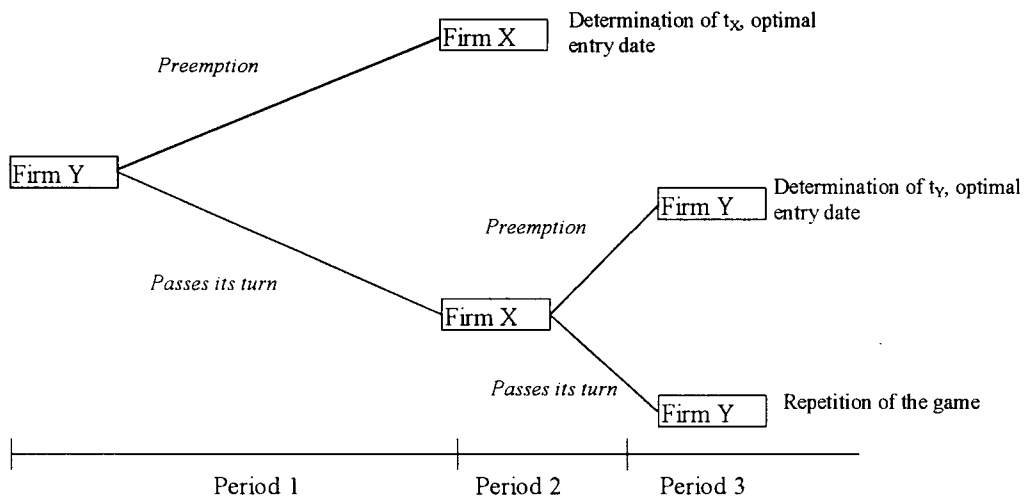
This type of problem can be resolved by using a sequential game, a Stackelberg equilibrium. We will assume that firms have a game order so that they have to take their entry decision after having observed if the other firm has already entered. Here the big firm (Y) is solicited first, at time t, because of the agglomeration effect it may generate (Scott, 1992; Black and Hoyt 1989), the problem of the small firm (X) will be then to react optimally to the leader firm's action.

⁷ . The advantage of this formulation, inspired by Rauch (1993), is that it simplifies the determination of equilibrium because the situation where nobody moves, brings zero net profits and therefore will be chosen only when the other strategies bring negative profits.

Firm Y is the Stackelberg leader as its position of first player gives it the choice between two alternatives : preempting the host country or waiting for firm X to enter first and by this way passing its turn.

Firm Y is the Stackelberg leader as its position of first player gives it the choice between two alternatives : preempting the host country or waiting for firm X to enter first and by this way passing its turn. At period t , firm Y, faces the following problem :

Figure 1: Decision tree with a single host country



There are three possible outcomes to the game that the Stackelberg leader will evaluate in order to take his decision. The firms being in complete (no uncertainty) and perfect (sequential game) information, the equilibrium of the game is determined by backward induction (Rasmusen, 1989). Starting from the end of the tree, the leader resolves the subgame of firm X at the second period by comparing profits of the two alternatives. Once this decision is known, the game is reduced to a comparison between preempting and passing its turn and the equilibrium is subgame perfect. More precisely, firm Y analyses the two following alternatives :

A) If firm Y decides to enter at date t , firm X will have to determine an optimal entry date in response to the behaviour of the leader. It has to maximise its total discounted benefit made up of three terms:

A first term represents the net gain for a monopoly on the market of origin, this gain increases as the firm delays its entry and tends to a finite value. As long as it does not follow the pioneer, firm X is in monopoly on the country of origin.

$$\Phi_M = \sum_{k=t}^{t_X-1} \frac{\Pi_m(2) - \lambda_X \Pi(2)}{(1+i)^k} \quad (1)$$

Two additional terms represent the net gains to rejoin firm Y on the foreign market. When it decides to enter the foreign country at t_X , firm X has lost a part of its market share. From $t_X + 1$ onwards it keeps the same market share (third term). This gain declines as firm X (second term) delays its entry and tends to 0, since it will be able to play a decreasingly important role on the market:

$$\Phi_D = \frac{\alpha \gamma^{(t_X-t)} \lambda_X \Pi^*(1) - \lambda_X \Pi(2)}{(1+i)^{t_X}} + \sum_{k=t_X+1}^{\infty} \frac{\alpha^{(t_X-t)} \lambda_X \gamma^{(k-t)} \Pi^*(2) - \lambda_X \Pi(2)}{(1+i)^k} \quad (2)$$

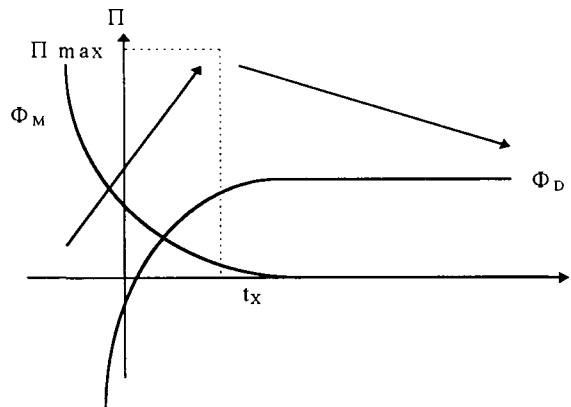
Therefore firm X chooses an optimal entry date t_X such as:

$$\tilde{\Pi}_1^X = \max_{t_X} \left[\sum_{k=t}^{t_X-1} \frac{\Pi_m(2) - \lambda_X \Pi(2)}{(1+i)^k} + \frac{\alpha \gamma^{(t_X-t)} \lambda_X \Pi^*(1) - \lambda_X \Pi(2)}{(1+i)^{t_X}} + \sum_{k=t_X+1}^{\infty} \frac{\alpha^{(t_X-t)} \lambda_X \gamma^{(k-t)} \Pi^*(2) - \lambda_X \Pi(2)}{(1+i)^k} \right] \quad (3)$$

A maximum of the sum of the two effects exists if the first effect is stronger than the second during the first periods and the opposite in subsequent periods.

Both effects can be schematised according to figure 2 :

Figure 2 : optimal entry date of the follower



The sum of both effects reaches a maximum in this type of configuration. For that purpose, the erosion coefficient of the foreign market must not be too strong, otherwise the curve decreases evenly. In this case firm X makes a maximum profit by entering immediately. But it must not be too weak, otherwise the optimal entry date tends to be infinite which means that the firm do not move.

When firm X determines an optimal entry date t_x , the profit of firm Y is :

$$\tilde{\Pi}_t^Y = \begin{cases} \frac{\Pi_m^*(0) - \lambda_Y \Pi(2)}{(1+i)^t} & \text{in } t \\ + \sum_{k=t+1}^{t_x-1} \frac{\gamma^k \Pi_m^*(1) - \lambda_Y \Pi(2)}{(1+i)^k} & \text{from } t+1 \text{ to } t_x-1 \\ + \frac{[1 - (\alpha^{(t_x-1)} \lambda_X)] \gamma^{(t_x-1)} \Pi^*(1) - \lambda_Y \Pi(2)}{(1+i)^{t_x}} & \text{in } t_x \\ + \sum_{k=t_x+1}^{\infty} \frac{[1 - (\alpha^{(t_x-1)} \lambda_X)] \gamma^{(k-t)} \Pi^*(2) - \lambda_Y \Pi(2)}{(1+i)^k} & \text{from } t_x+1 \text{ onwards} \end{cases} \quad (4)$$

Firm Y will, when it invests, be in monopoly in the destination country : in the first term no firm had been in this country before, the second term takes into account its own presence during the following periods. At the period of investment of firm X, firms share profit, the pioneer succeeding in capturing a part of the market share of the follower (third term). From then on, the same sharing rule is applied, the total benefit being increased as the second firm has located.

B) If firm Y decides not to enter in t , firm X will then have the choice between entering and waiting during the next period $t+1$. The flows of profits, similarly to the preceding solution, are:

If it decides to enter:

$$\tilde{\Pi}_{t+1}^X = \begin{cases} \frac{\Pi_m^*(0) - \lambda_X \Pi(2)}{(1+i)^{t-1}} \\ + \sum_{k=t+2}^{t_Y-1} \frac{\gamma^k \Pi_m^*(1) - \lambda_X \Pi(2)}{(1+i)^k} \\ + \frac{[1 - (\alpha^{(t_Y-t-1)} \lambda_Y)] \gamma^{(t_Y-t-1)} \Pi^*(1) - \lambda_X \Pi(2)}{(1+i)^{t_Y}} \\ + \sum_{k=t_Y+1}^{\infty} \frac{[1 - (\alpha^{(t_Y-t-1)} \lambda_Y)] \gamma^{(k-t)} \Pi^*(2) - \lambda_X \Pi(2)}{(1+i)^k} \end{cases} \quad (5)$$

and the firm Y will then have to determine an optimal response:

$$\tilde{\Pi}_{t+1}^Y = \max_{t_Y} \left[\sum_{k=t+1}^{t_Y-1} \frac{\Pi_m(2) - \lambda_Y \Pi(2)}{(1+i)^k} + \frac{\alpha \gamma^{(t_Y-t-1)} \lambda_Y \Pi^*(1) - \lambda_Y \Pi(2)}{(1+i)^{t_Y}} + \sum_{k=t_Y+1}^{\infty} \frac{\alpha^{(t_Y-t-1)} \lambda_Y \gamma^{(k-t-1)} \Pi^*(2) - \lambda_Y \Pi(2)}{(1+i)^k} \right] \quad (6)$$

If firm X decides to wait, the game is repeated at the next period. Here, contrary to the Rao and Rutenberg (1979) game, firms make no net profit compared to the reference situation if they remain both in the location of origin. If firm X decides to pass its turn at period $t+1$, it will have to determine an optimal response at $t+2$. As this optimal response will be made exactly in the same conditions as in the first period, the discounted profit flow will therefore be inevitably smaller than for the first period optimal response, the firm X therefore decides to enter if firm Y has not entered or chooses not to enter at all.

2.3 Parametric analysis of the sequence of entry

In table 2, the Stackelberg leader, firm Y, chooses the more profitable strategy between $\tilde{\Pi}_t^Y$ and $\tilde{\Pi}_{t+1}^Y$.

Table 2: Equilibrium computation in the one host country game

Firm X, period $t+1$	Preemption	Optimal Reaction
Firm Y, period t		
Optimal Reaction	$\tilde{\Pi}_{t+1}^X$ Profit for firm X pioneer in $t+1$ $\tilde{\Pi}_{t+1}^Y$ Profit for firm Y from its best response	Impossible
Preemption	Impossible	$\tilde{\Pi}_t^X$ Profit for firm X from its best response $\tilde{\Pi}_t^Y$ Profit for firm Y pioneer in t

Each profit flow is computed for values of t_X and t_Y satisfying the first order condition of profit maximisation. The equilibrium of the game can be computed this way for different values of the parameters. A particularly interesting relation is the influence of the degree of rivalry on the timing of entry decision. Two parameters measure the degree of rivalry in the model : the gap between the two market shares and the capture coefficient. We study this relation in a parametric analysis of the game with the following values for the parameters:

Home country profit : $\Pi(2) = 400$ Host country erosion coefficient $\gamma = 1.05$
 Interest rate : $i=0.1$ Firm X market share : λ_x between 0.3 and 0.45
 Structure of host country profit: $\Pi^*(0) = 150$ Capture coefficient: α between 0.980 and 0.999
 $\Pi^*(1) = 300$
 $\Pi^*(2) = 500$
 Monopoly profits are increased by 4%

Table 3: Parametric analysis of the optimal entry date

	λ_x	α	Firm X		Firm Y	
			profit	date	profit	date
Growing degree of competition	0,45	0,980	4142	12	5620	1
		0,985	4306	13	5542	1
		0,990	4484	14	5434	1
		0,995	4679	14	5299	1
		0,999	4893	16	5137	1
	0,4	0,980	4050	15	5559	1
		0,985	4207	15	5391	1
		0,990	4376	16	5211	1
		0,995	6270	2	5017	9
		0,999	6253	2	5212	11
	0,35	0,980	4009	18	5559	1
		0,985	4150	18	5310	1
		0,990	6715	2	5132	6
		0,995	6777	2	5272	7
		0,999	6779	2	5455	9
	0,3	0,980	4014	22	5608	1
		0,985	7111	2	5401	2
		0,990	7269	2	5444	4
		0,995	7339	2	5554	6
		0,999	7349	2	5718	8

We can see in table 3 two characteristics of the temporal choice. For low levels of competition, the Stackelberg leader lets the small firm preempt. However, firm Y will respond optimally (enter the host country) more and more early as the degree of competition gets tougher. The leader wants to benefit from the agglomeration effect by delaying its entry, but he also wants to secure its market share. For high levels of competition, the losses associated with a late entry are high and preempting the market becomes a better solution.

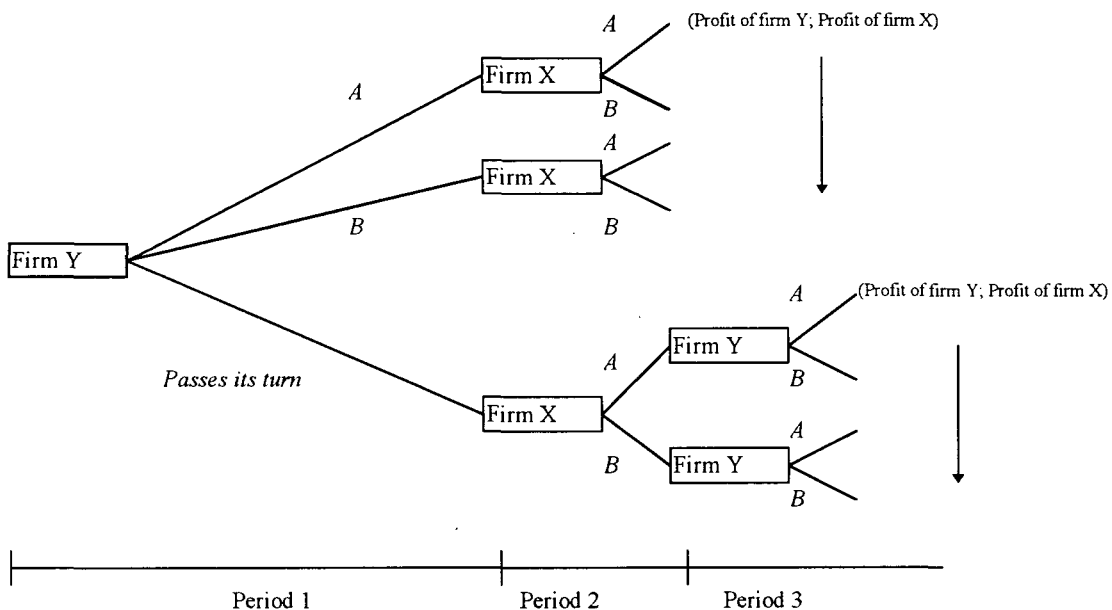
The date of investment decision is here a strategic variable which can be used in order to soften the degree of competition. The reduction of the entry lag with growing degree of competition confirms the result of Rao and Rutenberg (1979). This can be related with the use of spatial proximity in a strategic framework. While firms differentiate spatially so as to soften competition, they must concentrate temporally to achieve the same objective. The next section allows to study the articulation of both strategic variables.

3. OPTIMAL LOCATION AND ENTRY SEQUENCE.

Assume that there are now two foreign alternative sites for the investors, country A and country B. Each firm will have the choice between following and not following the pioneer firm in its spatial choice. The trade-off between gains and costs of the wait and see attitude that determines the entry sequence is coupled with a trade-off between agglomeration economies and monopoly power. A firm can prefer to locate on a less-developed territory on which monopoly power can counterbalance a lower strength of agglomeration effects.

The game with two countries is represented in figure 3 :

Figure 3: Decision tree with two alternative countries



The solving method for this game remains the backward induction. At each final branch of the decision tree, a firm maximises its profit by determining an optimal date of entry on each of the two sites. It fixes then by simple comparison its geographical choice. Once these decisions are known, firm Y solves every subgame from the end to the beginning of the tree. The decision of the leader then reduces to three alternatives : Preempting in country A, preempting in country B and passing its turn.

In this case, the strategies are far more sophisticated than in the game with a single foreign country. When a firm ascertains that its competitor has preempted at one of the two sites, it has the

choice between two strategies: to respond optimally (in term of entry date) in the same country or to respond optimally by settling in the other country on which it will be in monopoly.

Replacing the Π^* by Π^A and Π^B representing profits of firms at sites A and B, we can compute the flows of discounted profit in the case where firm Y has preempted at time t. The firm X selects then both the country and the period of entry. We define a profit function conditional on the spatial choice of the other firm : $\bar{\Pi}_t^X$ (firm X location | firm Y location).

$\bar{\Pi}_t^X(A|B)$ represents the profits for firm X from locating in country A considering the fact that firm Y has preempted country B at period t. The follower has to choose between this profit flow and $\bar{\Pi}_t^X(B|B)$, the profit from imitating the leader in its spatial choice. Firm X therefore chooses between these two alternatives :

$$\bar{\Pi}_t^X(B|B) = \max_{t_x^B} \left[\sum_{k=t}^{t_x^B-1} \frac{\Pi_m(2) - \lambda_X \Pi(2)}{(1+i)^k} + \frac{\alpha \gamma^{(t_x^B-t)} \lambda_X \Pi^B(1) - \lambda_X \Pi(2)}{(1+i)^{t_x^B}} + \sum_{k=t_x^B+1}^{\infty} \frac{\alpha^{(t_x^B-t)} \lambda_X \gamma^{(k-t)} \Pi^B(2) - \lambda_X \Pi(2)}{(1+i)^k} \right] \quad (7)$$

$$\bar{\Pi}_t^X(A|B) = \max_{t_x^A} \left[\sum_{k=t}^{t_x^A-1} \frac{\Pi_m(2) - \lambda_X \Pi(2)}{(1+i)^k} + \frac{\gamma^{(t_x^A-t)} \Pi_m^A(0) - \lambda_X \Pi(2)}{(1+i)^{t_x^A}} + \sum_{k=t_x^A+1}^{\infty} \frac{\gamma^{(k-t)} \Pi_m^A(1) - \lambda_X \Pi(2)}{(1+i)^k} \right] \quad (8)$$

Depending on which country is selected by the follower, the leader clearly sees its profits change. It must anticipate both when the second firm will invest and on what territory it will do so. In this case, firm Y preempts in B and equation (9) represents its profits when the firm X chooses the same country, whereas equation (10) represents its profits when firm X chooses country A.

$$\bar{\Pi}_t^Y(B|B) = \frac{\Pi_m^B(0) - \lambda_Y \Pi(2)}{(1+i)^t} + \sum_{k=t+1}^{t_x^B-1} \frac{\gamma^{(k-t)} \Pi_m^B(1) - \lambda_Y \Pi(2)}{(1+i)^k} + \frac{[1 - (\alpha^{(t_x^B-t)} \lambda_X)] \gamma^{(t_x^B-t)} \Pi^B(1) - \lambda_Y \Pi(2)}{(1+i)^{t_x^B}} + \sum_{k=t_x^B+1}^{\infty} \frac{[1 - (\alpha^{(t_x^B-t)} \lambda_X)] \gamma^{(k-t)} \Pi^B(2) - \lambda_Y \Pi(2)}{(1+i)^k} \quad (9)$$

$$\bar{\Pi}_t^Y(A|B) = \frac{\Pi_m^B(0) - \lambda_Y \Pi(2)}{(1+i)^t} + \sum_{k=t+1}^{\infty} \frac{\gamma^{(k-t)} \Pi_m^B(1) - \lambda_Y \Pi(2)}{(1+i)^k} \quad (10)$$

- Equations (7) and (9) are similar to those (equations (3) and (4)) of the case where it existed a single foreign country. Equations (8) and (10) define a situation where firms share markets, firm Y being in situation of monopoly in country B and firm X in country A. By comparing (7) and (8), the Stackelberg leader knows what will be the behaviour of the follower if it preempts in country B. Similarly, it knows the profit of preempting in country A, it can therefore select the country that provides the greatest profit considering the behaviour of the other firm.

- As in the case where there is a single foreign country, the leader can also choose not to preempt, *i.e.* to let firm X preempt on the territory of its choice. It will be able then, symmetrically to the situation that we have just seen, to react optimally to this preemption both in date and location terms.

4. PARAMETRIC ANALYSIS

A parametric analysis has been conducted with the same methodology as in the one host country game. Table 4 presents the profits yielded by each situation. The equilibrium of the game is computed by backward induction as seen in figure 3 above.

Table 4: Strategies with two alternative sites

		Country A		Country B		
Firm X's decision at the period t+1		Preemption	Optimal Reaction	Preemption	Optimal Reaction	
Firm Y's decision at the period t						
Optimal Reaction		$\bar{\Pi}_{t+1}^X(A A)$	Impossible	$\bar{\Pi}_{t+1}^X(B B)$	Impossible	Follower chooses same country
		$\bar{\Pi}_{t+1}^Y(A,A)$		$\bar{\Pi}_{t+1}^Y(B B)$		
Preemption		Impossible	$\bar{\Pi}_t^X(A A)$	Impossible	$\bar{\Pi}_t^X(B B)$	
			$\bar{\Pi}_t^Y(A A)$		$\bar{\Pi}_t^Y(B B)$	
Optimal Reaction in the other country		$\bar{\Pi}_{t+1}^X(A B)$	$\bar{\Pi}_t^X(B A)$	$\bar{\Pi}_{t+1}^X(B A)$	$\bar{\Pi}_t^X(A B)$	Follower chooses other country
		$\bar{\Pi}_{t+1}^Y(A B)$	$\bar{\Pi}_t^Y(B A)$	$\bar{\Pi}_{t+1}^Y(B A)$	$\bar{\Pi}_t^Y(A B)$	

Despite the apparent complexity of the decision process, the equilibrium is determined by the leader of the game who, eventually, has only 3 outcomes to compare: Profits of preemption on each of the two markets and the sole solution of the game if it enters in second position. Indeed in the second period, leader and follower are reversed and firm X that determines the equilibrium by taking the maximising behaviour of firm Y in period 3 as given.

So as to see what are the outcomes of this game and to what type of equilibrium one is led, we took a numerical example in which two firms have to select between two sites with different agglomeration economies, the country A being disfavoured at the start of the game.

A particularly interesting point will be to look at the outcomes in terms of firms' distribution as compared to the usual results of mono-location : will a site favoured by the initial conditions be able to lock-in the location process, and will the competitive stakes ensure a more even distribution of firms? In Table 5, we have computed a specific outcome where country A is disadvantaged for the first investor but is more attractive than country B if both firms choose it.

Table 5: Computation of a specific outcome

Market share Firm X	40%	α	0,980
Market share Firm Y	60%	γ	1,050

$\Pi(2)$	$\Pi^*(0)$	Country A	Country B
i	400	150	200
	10%	200	300
		550	500

Monopoly profits : +20%

OPTIMAL TIMING

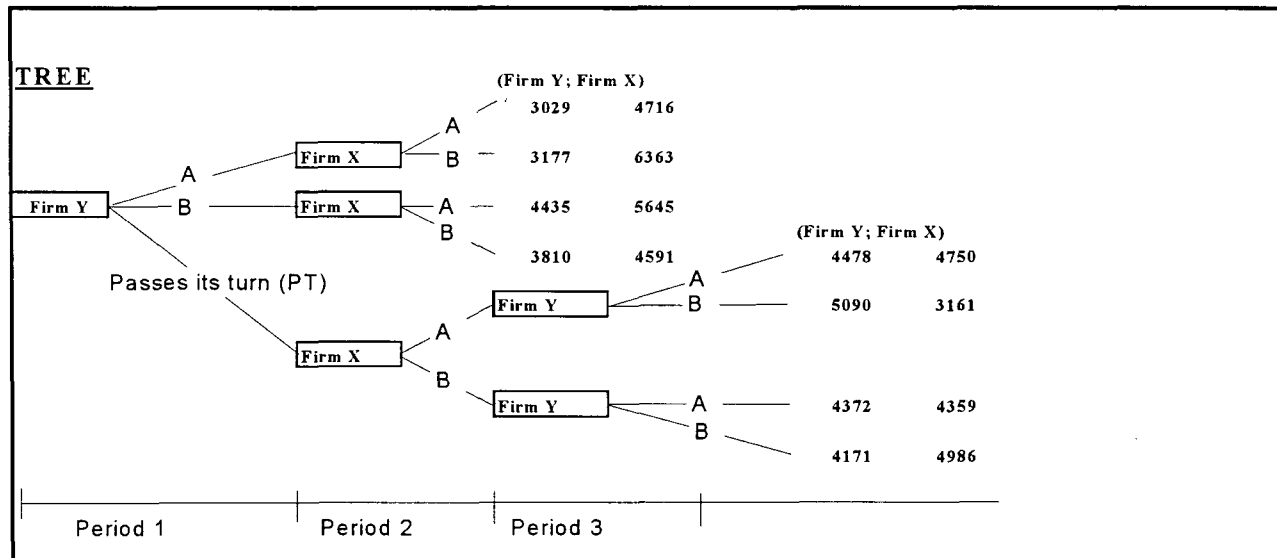
Firm	Preempts in period	COUNTRY A		COUNTRY B	
Y	1	T_x^A	22	T_x^B	11
X	2	T_x^A	12	T_y^B	11

		COUNTRY B	
		T_x^B	24
		T_x^A	15
		T_y^B	14
		T_x^A	15

MATRIX

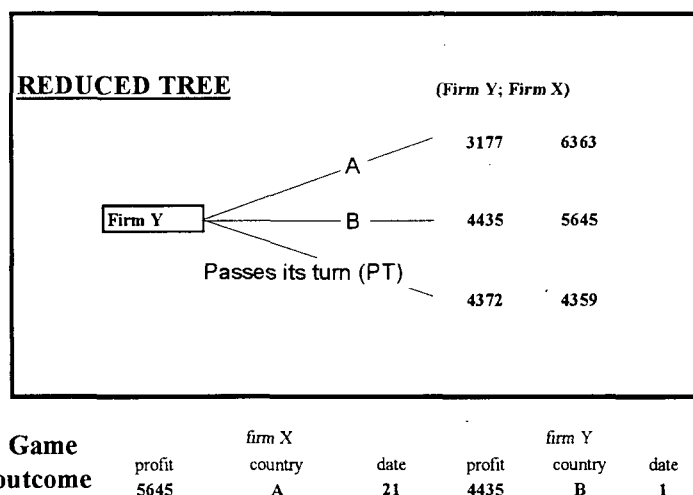
		Firm X			
		COUNTRY A		COUNTRY B	
		Preemption	Optimal reaction	Preemption	Optimal reaction
Firm Y	Optimal reaction	4750		4986	
	Preemption	4478	4716	4171	4591
	Optimal reaction in the other country	3161	6363	4359	5645
		5090	3177	4372	4435

TREE



We can then, by backward induction, determine the reduced decision tree of firm Y consisting of the three alternatives.

Table 6: Reduced decision tree



The game ends up with one firm locating in each country. The initial conditions are not as important as in Arthur's game (1989). The competition effect counterbalances the agglomeration effect in the sense that the late entrant prefers to be in monopoly in the disadvantaged country rather than sharing the market B.

An important feature of this model is that the leader is unable to reach its first-best outcome. Looking at the decision tree in terms of trajectories in table 5, the best outcome for the leader would be PT - A - B. But by letting firm X preempt, the outcome will turn out to be PT - B - A. The firm Y is therefore obliged to preempt, and the outcome is B-A.

We conducted, in table 7, a parametric analysis of the two alternative countries model. As in table 3, the outcomes are computed in a decreasing degree of competition. Three cases are studied with different settings of relative attractiveness between the two competing sites. The parameters take the following values :

Home country profit :	$\Pi(2) = 400$	Host country erosion coefficient:	$\gamma = 1.05$
Interest rate :	$i=0.1$	Firm X market share :	λ_X between 0.30 and 0.45
Structure of host country profit:	See the 2 cases in table 4	Capture coefficient:	α between 0.980 and 0.999
Monopoly profits are increased by 20%			

Table 7 gives the result of 2 simulations conducted with the same methodology as in section 2. Case 1 takes an Arthur-type setting where one of the sites (country B) is advantaged by initial conditions but disadvantaged if the two firms choose it. In case 2, the preemption premium on country A is increased.

Reintroducing competition brings various outcomes. In case 1, the country B is chosen by both firms in most of the situations. It partly confirms the usual results of models with agglomeration economies, such as Arthur (1990). The initial conditions are important and former location choices undoubtedly provide an advantage for a country willing to attract more investments. Even if it has the higher attractiveness in the end, a site might never start to attract firms due to an initial disadvantage. Despite agglomeration economies, the traditional relation between competition strength and spatial differentiation can be found in our model. Case 1 illustrates this point, as the favoured site gets the two firms only if the competition conditions are not too hard. A location model dealing with economies of agglomeration does not necessarily rely on the initial conditions once strategic matters are taken into account. The intensity of competition can remain a strong centrifugal force between firms within this framework.

Table 7: Parametric analysis of the game

α 0,980
 γ 1,050

CASE 1

CASE 2

$\Pi(0)$
 $\Pi(1)$
 $\Pi(2)$

Country A	Country B
150	200
200	300
550	500

Country A	Country B
150	200
250	250
450	500

Monopoly profits : +20%

Market share firm X	α
0,45	0,980
	0,985
	0,990
	0,995
	0,999
0,4	0,980
	0,985
	0,990
	0,995
	0,999
0,35	0,980
	0,985
	0,990
	0,995
	0,999
0,3	0,980
	0,985
	0,990
	0,995
	0,999

Firm X			Firm Y		
profit	country	date	profit	country	date
4828	A	20	4685	B	1
4828	A	20	4685	B	1
4828	A	20	4685	B	1
4828	A	20	4685	B	1
4828	A	20	4685	B	1
5078	A	20	4435	B	1
5078	A	20	4435	B	1
5078	A	20	4435	B	1
5078	A	20	4435	B	1
5078	A	20	4435	B	1
5328	A	20	4185	B	1
5328	A	20	4185	B	1
5328	A	20	4185	B	1
5426	B	2	4218	B	12
5342	B	2	4423	B	13
5578	A	20	3935	B	1
5997	B	2	3953	B	8
5970	B	2	4111	B	9
5917	B	2	4292	B	11
5844	B	2	4496	B	12

Firm X			Firm Y		
profit	country	date	profit	country	date
3439	B	2	4600	A	15
3439	B	2	4600	A	15
3439	B	2	4600	A	15
3439	B	2	4600	A	15
4112	B	2	4605	B	15
3211	B	2	4372	A	15
3211	B	2	4372	A	15
3211	B	2	4372	A	15
4799	B	2	4478	B	12
4653	B	2	4683	B	13
2984	B	2	4145	A	15
5608	B	2	4250	B	8
5509	B	2	4404	B	9
5386	B	2	4584	B	10
5244	B	2	4787	B	12
6352	B	2	4355	B	3
6278	B	2	4431	B	5
6166	B	2	4558	B	7
6034	B	2	4721	B	9
5886	B	2	4916	B	10

On the contrary, temporal proximity seems to increase with the intensity of competition. In case 1, when both firms choose to locate in country B (the more attractive), the later entrant advances its entry with the erosion factor. When the premium for the pioneer gets bigger, the second entrant must shorten its time lag so as to keep enough market share on this market. It seems therefore that there is a relation between the two dimensions of proximity: The late entrant chooses the same country up to a certain point of competition when the date of entry is too weak a variable to compensate for the market share loss. This is particularly clear in case 2, where firm y chooses the same country as firm X up to a certain level of competition intensity when it is forced to differentiate spatially from its competitor.

The competition conditions also determine the preemption choice. Two effects can be seen in case 1 : The leader chooses to preempt when the risk of losing market share is important and when his advance is small. It means that a dominant firm can be forced to be a pioneer by the competitive game. It also means that the leader can accept to be preempted if he has a big advance to share. Considering the spatial choice of the leader, we notice in case 1 that he always chooses the more attractive country in terms of monopoly situation. In a case where a firm has to choose its location first, it may not (as we saw previously) be able to make an optimal profit, but it may keep an advantage on the second player.

Even in a context of agglomeration economies, a site with few historical advantages might be chosen because of monopoly elements. Comparing cases 1 and 2 show that the monopoly profits are at least as important as the initial advantage of the site. Although it is initially disadvantaged in case 1, country A is chosen by one of the two firms because the monopoly rents earned from isolation more than compensate the agglomeration effect in situations of high competition. Case 2 shows that even if a country is initially and finally disadvantaged, it can succeed in attracting firms due to an equivalent level of monopoly profits in the two countries.

We found, with this model, a relation between spatial proximity in the behaviour of firms and the degree of competition. In situation of agglomeration effects, firms will concentrate geographically for low levels of rivalry. When this rivalry increases, firms might still choose the same country but they will reduce their lag of entry. At high levels of competition, firms will differentiate spatially.

Conclusion

We have provided a framework where the location choice of firms can be seen as two main strategic decisions: Firms must determine the geographical destination as well as the timing of their investment. An agglomeration effect within a competitive industry generates many opposite forces. In terms of entry date, firms face a trade-off between a preemption premium and the costs of being an early entrant. In terms of country choice, concentration generates agglomeration economies but spatial differentiation leads to monopoly rents.

The choice of a new location strongly affects the competitive game between firms. Especially in the case of international investment where the relevant information about the destination country is far more uncertain. We found a tendency strong of firms to secure the competition conditions of the origin market. Agglomeration effects offer the opportunity of a mutually beneficial delaying of entry but, as the competition gets tougher, firms tend to concentrate temporally and differentiate spatially.

In the trade-off between agglomeration effects and competitive stakes, shortening the time entry lag can maintain a geographical concentration. From a certain point of competition onwards, the spatial differentiation rule applies. This conclusion leaves room for effective attractiveness policies from governments competing for firms which will be the object of a future investigation.

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