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MODELLING BARGAINING BEHAVIORS WITHIN BIOTECH CLUSTERS

TOWARDS THE "POWER OF THE WEAK" EMERGENCE ?

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Summary : This contribution brings to light an original artificial life simulation of strategic bargaining behaviors within a biotech cluster. It shows that bargainings involving firms and local institutions lead to an agreement which is not a perfect share but a compromise frequently hiding complex mecanisms of "greedy" strategies and concessions. Indeed, the performance of the cluster is maintained in the time due to the fact of the presence of local institutions which "regulate" the cluster. So they are "power of the weak" carrier.

INTRODUCTION

Since the nineties, researchers in economics and business administration take an active interest in the geographic proximity and in its contribution to competitive advantages and collective performance within local spaces involving clustered firms. Surveys of the literature put in a prominent position the international nature of such an industrial phenomenon and the great importance given to it by regional industrial policies such as in the Silicon Valley in the United States, in the Medicon Valley on the Denmark and Sweden border, or as another example in the Chilean wine clusters (Malmberg and Maskell, 1999 ; Belussi and Arcangeli, 1999 ; Lundvall and Maskell, 2000 ; Waluszewski, 2004; Giuliani and Bell, 2005…). The notion of geographical cluster here concerns more particularly a group of companies and institutions linked by commonalities, complementarities and geographical proximity, characterized by a high degree of specialisation and technological transfer. This active interest in this notion is today so high that the United Nations Industrial Development Organization (UNIDO) even considers clustering as a mondial economic phenomenon. By the way, on a conceptual point of view, these researches open a wide new reflexion on local capacities of innovation and collective performance within such local industrial organizations. In this perspective, this contribution presents an exploratory approach of clusters based on the evolutionary and strategic frameworks.

By the way, if spatial and industrial theoric models, such as industrial districts or learning regions, offer a large analysis of coordination within clusters, they however not really take into account dispute dynamics, such as conflicts of bargaining and power, which can have some impacts on the performance and on the evolution of such local systems. Biotechnology clusters are here highly concerned as they are indeed based on the capacity of firms and local public institutions to solve their conflicting interests to keep on coordinations and collective performance. In this perspective, our purpose in this paper is to examine, on a exploratory and evolutionary heuristic point of view, in which conditions clusters can keep performance on the long run despite the conflictual or opportunist bargaining strategies developed by the agents involved. We more particularly presents an evolutionary model based on exploratory artificial life simulations involving firms and local public institutions which bargain to share a local collective resource using more or less sophisticated and opportunist strategies. As a result, the simulations show that local public institutions are “power of the weak” carrier and play a very important part in the cluster evolution and performance. So this contribution opens a new research way focused on an evolutionary analysis of strategic behaviors within biotech clusters.

I. AN EVOLUTIONARY PERSPECTIVE ON BARGAINING BEHAVIORS WITHIN BIOTECH CLUSTERS

A. BASIC DEFINITION OF INDUSTRY CLUSTERS

Research literature presents a wide variety of cluster definitions. Historically, the cluster analysis finds its source in the Alfred Marshall “industrial atmosphere”, and has been next taken into account in the famous italian researches on industrial districts (citer). According to these conceptual approaches, a cluster is defined as a system of linked firms and institutions that reprensents a robust organisational form characterised by flexibility and based on collective trust facilitating exchanges, apprentissage and emulation. The main characteristic of this collective organization is that it reduces transaction costs and produces positive externalities, both technological and financial. In other respects, clusters are to be put in the same category as “local milieux” (Crevoisier and Maillat, 1991; Camagni, 2003), as « local productive systems » (Garofoli, 1992) or as « new industrial spaces » (Scott, 1988), focused on local collective learning processes and economic regulation. By the way, business administration research, as well as that of economics, largely focuses attention on industrial clusters (Porter, 1998 ; Lorenzoni and Lipparini, 1999 ; Floysand and Jakobsen, 2002 ;…). Wiser for the American experiences, Porter (1998) defines a cluster as « a geographically proximate group of interconnected companies and associated institutions (universities, standard agencies and trade associations) in particular fields, linked by commonalities and complementarities”. So as it is shown by Carbonara (2005), the key features characterizing clusters are namely : the geographical proximity of small and medium sized firms; a dense network of interfirms relationships which both cooperate and compete; a dense network of social relationships, based on face-to-face contacts; the existence of complementary competencies and skills; and a high degree of specialisation and technological transfer.

Moreover, to these key features can be added, on the one hand the existence of trust relations that participate in the system performance, and on the other hand the diversity of local actors involved such as firms and institutions (universities, public research laboratories, business associations, devlopment agencies…). Performance refers here to how actors involved develop and intensify collaborations with mutually beneficial effects (Tambunan, 2005). By the way, the performance of such clusters depends on the ability of the actors involved to coordinate, ie to agree on common rules of conduct without creating locked-in situations.

B. NEGOTIATION AND CONFLICT RESOLUTION AT STAKE WITHIN BIOTECH CLUSTERS

Biotech clusters are developed in many parts of the world and are to be high considered in the european economic policy. The main particularity of these clusters in Europe and in France is that they are companies driven but as well, on a certain point of view, local governments driven. Local governments indeed attempt to create conditions which encourage the formation and growth of clusters, but of course without forgetting clusters are fondamentaly business driven. As an example, local governments participate in the search of public financings, they enhance the image of the cluster and they try to reinforce its attractivity (with start-up development, venture-capital captation, creation of regional incubators, creation of networks between several national or international biotech clusters…).

On a business point of view, biotech companies benefit from sharing knowledge about best practices and reduce costs by jointly sourcing services and suppliers. So biotech clusters are founded on frequent interactions and collaboration between institutions and firms with complementary assets and skills. The latter produce an attraction power that create a pool of skilled labour. Based on local resources mutualisation and on technical competences exchange, a biotech cluster is indeed characterized by a strong connectivity between firms on the one end, and between firms and local institutions, such as public research laboratories and local governments, on the other hand. This strong connectivity between actors leads to the emergence of external economies and "quasi-rents" due to competitive advantages and licence exploitation (Klein, Crawford, Alchian, 1978).

But if literature is mainly focused on cluster successes, only a few works put in a prominent position the question of development curbings and lock-in due to the opportunistic strategies or conflictual relations within the clusters. Conflict is indeed more developed than one could imagine because of the sharing of collective benefits at stake. A previous study (Leroux, 2004) shows that biotech actors are use to be divided by three main types of conflicts :

- Conflicts to share information rents : mutualisation of producting and researching means suppose a mutualisation of information (activity, private financings, business purposes). Some agents sometimes try to play a "free-rider" strategy consisting in capturing these opportunistic rents to the detriment of the others (Cohendet and Llerena, 1999).

- Conflicts for knowledge appropriation : cooperation between firms for knowledge transfer can leads to an unequal capture of knowledge externalities (Cohen and Levinthal, 1990).
- Conflicts to share and capture financings and mutual benefits : if an asset resulting from a cooperation between several firms is highly specific or patent protected, it can be a source of competitive advantage producing a monopoly rent. So some firms could try to capture it to the detriment of the others.

In this perspective, the multipolar relationships within the bioclusters are characterized by a conjunction of these potentially conflictual strategies that are helped by uncertainty, rivalry, and the wide variety of the actors involved. So the resolution of these conflicts is at stake within biotech clusters because it can at every moment leads to relationship ruptures, production lateness or lock-in. Consequently, as a previous work shows it (Leroux, 2004), negotiation and bargaining play a real significant part in the cluster surviving, as a process of compatibility construction. By the way, if firms and institutions bargain for resources and rents sharing, they try at the same time to instrumentalise power relations using different and opportunistic collusive means. So the cluster performance and surviving on the long run will depend on the capacity of such agents to find agreements beyond their conflicting interests.

So on a theorical point of view, the cluster notion has to be defined not as a structure but as a complex system taking into account the dynamic and evolutionary coordination processes involved. Surviving of such clusters depends on the strategic behaviors of firms and institutions characterized on the long run by different purposes, temporalities and needs. In this perspective, our purpose is to investigate this subject that is not recurrent within the literature. The latter is indeed focused on cognitive approaches about technological transfer but not on evolutionary strategic behaviors that can call into question the cluster performance. In this perspective, we offer a new research way that consists in modelling strategic evolutionary behaviors taking into account exchanges and communication between agents. So an artificial life simulation is an original tool to investigate behavioral dynamics within clusters.

C. TOWARDS AN EVOLUTIONARY SIMULATION OF BARGAINING BEHAVIORS WITHIN BIOTECH CLUSTERS

Simulations are part of the works carried out in the field of Artificial Life, which substitutes the problematic of the emergence of collective regularity in a complex environment with the traditional problematic of static equilibrium. So simulations are considered as a right tool to model strategic behaviors within clusters, defined within this framework as complex evolutionary systems involving heterogeneous agents. They indeed contribute to introduce « variability » of behaviors on one hand, and they bring to light emergence of « newness » within these complex systems in evolution on the other hand (Arthur, Durlauf, Lane, 1997).

Consequently, Artificial Life can contribute to better understanding clusters dynamics because it takes into account complexity of behaviors when agents are numerous and heterogeneous. More precisely, this is a way to grasp which behavioral characteristics are fundamental or recurrent, and among these latter which can be perceptible at a global level as an "emergence regularity". So it becomes possible to catch emergence of isolable behavioral regularities stemed from interaction between firms and local institutions on one part, and from complex contextual and individual reasonings on the other part : appropriation strategies, capability to observe strategies of the others, capabilities to evaluate collective benefits. By the way, contrary to the approaches centered on static equilibrum, data-processing modelling of biotech clusters allows the analysis of behavioral dynamics and phases.

On an epistemic point of view, this is an institutionalist approach based on an hayekian perception of social interaction. This epistemic posture rests on the darwinian natural selection and emphasizes evolutionary learning processes. On a theorical point of view, this approach is affiliated to the cognitive economics (Simon, 1955; Walliser, 2000), based on the following precepts : 1) *variability*, that corresponds to the endogeneous capability of the system to produce new directions depending on behavioral mutations of the agents involved ; 2) *path dependency* that results from learning effects and auto-reinforcement mecanisms leading to the irreversibility of the cluster evolutionary dynamics; 3) *inductive learning*, according to which agents are individually involved in a cognitive process of problems solving. They learn and adapt themselves with experience in a complex evolving system; 4) *situated rationality* inspired from Simon (1955) work and taken up by Walliser (2000), concerning a rationality that is constructed throught interaction and that involves rationally adaptative agents.

And on a methodological point of view, simulations are taken up in a purely exploratory perspective. The objective is to produce artifacts for heuristic purpose and to call into question the classical assumption of the representative agent (Marney and Tarber, 2000). This approach so consists in investigating a metaphoric world to make emerge new empirical and theorical questionnings and avenues of research.

II. THE MODEL

A. INTERACTION WITHIN THE BIOTECH CLUSTERS AND "STATE OF THE WORLD"

Starting from the empirical established facts applied to biotech clusters, this model consists in Artificial Life simulations of local bargaining games involving heterogeous agents. More precisely, these are simulations of bargaining behaviors involving firms and local public institutions (local governments), which bargain to share a collective resource, such as a quasi-rent, represented in the model by a pie. By the way, this is a Nash game under ultimatum inspired from the Ellingsen (1997) bargaining evolutionary game : when the two transactors involved want both to appropriate an over-large part of the pie, using opportunistic means, the negotiation fails. Two kinds of transactors take place in the model, as a state of the world :

- firms are modeled as "obstinate agents" whose demands are independent of those of the adversaries. As they participate in the cluster performance they want to appropriate the part of the pie that they fixed themselves depending on their profitability objectives. Some of them expect for a large part (more than 50 %) whereas the others expect for a less important part (less than 50 %). The part expected depends as well on the more or less powerful and opportunistic behaviors adopted by these firms.
- local public institutions (local communities) are modeled as "sophisticated agents" which adapt their demand to that hoped for of their adversaries rather than gain nothing. As they answer for the "general interest", they adapt themselves to the firms expectations. The stake is here to fix firms in the cluster, to avoid relocations, to impulse research innovation links, new employments and territorial performance. So they are under firms' ultimatum because the latter sometimes make relocation or employment blackmails to capt public financings or to obtain more advantages. When two local public institutions bargain together, they share the pie in a 50 /50

proportion in respect to the “general interest” and to their common stake : local development and performance.

The originality of this model is due to the introduction of a “relationship proximity” linking some agents in this artificial world. So if firms and institutions can bargain with every agent within the cluster, they however exchange information on the pie size only with partners that they have noted they had adopted the same strategy as them during the bargaining phase. Consequently, if certain agents are not able to recognize ex-ante the strategy of their adversary, they are nevertheless able to know it at the end of the bargaining process. So depending on the bargaining process and pay-off, they know if they can trust and exchange information with their partner.

Starting from this model structure, the purpose is here to test the outcomes of bargainings under different situations. In this perspective, we develop three simulations based on a genetic algorithm (Goldberg, 1989). The simulation number one (S1) models the behaviors of firms and institutions when the pie size is known. The simulation number two (S2) models the behaviors of theses agents when the pie size is unknown, introducing uncertainty in the game. And the third simulation (S3) models their behaviors when the pie size varies depending on the bargainers’ behavior. So will the bargainings between firms and local public institutions lead to a perfect share ? Will the results change if the pie size is unknown or if the pie size evolves and depends on the bargaining behaviors of the transactors involved ? Which is the part played by local public institutions in the game ? And how does the cluster performance evolve according to the bargaining behaviors of the agents involved ?

The main interest of these simulations is that they are part of a cognitive approach centered on perception/ reasoning/ decision-making (Haton and Haton, 1993) Perception refers to the mechanisms used to acquire information which will give the agents a specific representation of the environment at a given time. Reasoning refers to learning mechanisms which enable individual behaviors to be adjusted depending on the state of the environment, i.e. depending on the information received. Finally, decision-making shows the outcome of reasoning, i.e. the deliberate choice of an action. It is a question of using a heuristic research process so as to solve a specified problem, the simulation giving agents the ability to explore and assess possible actions within a changing environment. The simulation is technically made on the basis of implementing evolution operators, such as crossover and mutation, which make it possible for aggregate behaviors said to be "intelligent" to emerge.

B. DEMAND DETERMINATION

1. Firms demand

The obstinate firm's demand d_i is broken out into two components : the size of the pie expected for and the portion demanded. Thus :

d_i = expected size of the pie (teg) * demanded portion (i)

with

T : the real size of the pie

$teg \in [0,TG]$, minimum value and maximum value of teg

$i \in I \subset [0,1]$, I set of the portions demanded

of which

$d_i \in D \subset [0,TG]$, D D finite set of possible demands.

The strategy d_i with $i = 0.5$ is called "fair strategy". Any strategy for which $i > 0.5$ is called "greedy strategy". And the other strategies for which $i < 0.5$ are called modest strategies.

	modest	fair	greedy	
0	————————	0.5	————————	1

2. Institutions demand

Institutions, whose strategies are called r, are supposed to identify the adversary's strategy and adapt their demand to the demand expected for of the adversary. Consequently, when an institution bargains with a firm whose demand is d_i, it demands :

$$r = teg_r - d_i$$

Nevertheless, institutions can also be put into a situation of failure if they overestimate the size of the pie. So the set of possible strategies is $S = D \cup \{r\}$, with d_i the obstinate demand and r the sophisticate demand.

C. PAY-OFF FUNCTION

If firm i asks for d_i and firm j asks for d_j, then firm i receives the following pay-off :

$$\Pi_{ij} = \begin{cases} d_i \text{ si } d_i + d_j \leq T \\ 0 \text{ if not} \end{cases}$$

If the total of d_i and d_j is greater than the real size of the pie T, then the bargaining has failed and neither firm obtains any gain. The surpluses are not redistributed and are considered as lost. By the way, an institution that meets a firm thus obtains :

$$\Pi_{ri} = teg_r - d_i \text{ si } teg_r \leq T \text{ et } d_i \leq T$$

And when two institutions meet, they obtain :

$$\Pi_{r1r2} = \frac{teg_{r1}}{2} \text{ si } \frac{teg_{r1} + teg_{r2}}{2} \leq T$$

So the following pay-off matrix is obtained:

Table 1. The pay-off matrix

	Obstiné d_i	Sophistiqué r_1
Obstiné d_j	d_i d_j	$teg_{r1}-d_j$ d_j
Sophistiqué $r2$	d_i $teg_{r2}-d_i$	$teg_{r1}/2$ $teg_{r2}/2$

D. SIMULATIONS

1. Implementation of the genetic algorithm

Simulations are based on a genetic algorithm supported by a darwinian optimizing fonction (Holland, 1975). Each agent, firm or institution, is determined by its “genotype” broken out into two components : its strategy and the expected for size of the pie. The whole population consists of 1000 agents and the initial size of the pie is equal to 1. The obstinate population (the firms involved) is divided into seven profiles which correspond to seven discreet intervals between [0,100]. Each profile has been arbitrarily fixed and corresponds to a portion demanded.

Table 2. The seven obstinate profiles

Obs 7	Firms whose demand is 7 %	Modest
Obs 21	Firms whose demand is 21 %	
Obs 35	Firms whose demand is 35 %	
Obs 50	Firms whose demand is 50 %	Fair
Obs 64	Firms whose demand is 64 %	Greedy
Obs 78	Firms whose demand is 78 %	
Obs 92	Firms whose demand is 92 %	

Each simulation is held according to the following steps : 1) *Initialisation* : randomly or deliberative choice of strategies; 2) *Notation* : bargaining process and notation, ie assessment of each agent in function of the gains he can generate; 3) *Selection* : process through which agents are chosen to be replicated, the most favored being those with the highest level of notation; 4) *Crossover* : crossover and reproduction of the most successful agents; 5) *Mutation* : randomly deterioration of one or several genetic characters of an agent; 6) Return to 1.

By the way, this model is based on the following parameters : the initial size of the pie is 1; the pie can vary according to the interval [0,1 ; 2,0]; the number of agents within the population is 1000; the mutation rate is 10 %; the crossover rate is 50 %; the initial distribution of the different populations involved (Obs and Soph) at the start of the game is 12,5 %. In a cluster, agents don't systematically bargain with the whole population, but only with some agents when necessary. Consequently, this constraint has been introduced in the model : at each bargaining an agent bargains with 10 % of the whole population. Each agent is next assessed in function of the gains he can generate. As to the simulations S1, S2 and S3, they have been carried out 1000 times.

2. Relationship proximity

A modelling of what we call "relational proximity" is introduced in the crossover process. If firms and institutions are paired off and bargain with every type of adversary (notation step), they next nevertheless don't exchange information with a partner whom they have observed adopting a different strategy during the bargaining (crossover step). So it consists in an endogeneous creation of relationship proximity which links agents in a common mutual selfprotection strategy : selective exchange of information on the pie size between agents that have the same strategic approach of exchange.

3. Simulation S1 : the size of the pie is known

In this first simulation, companies and institutions bargain as they perfectly know the size of the quasi-rent, affiliated to the pie, from the start. The size of the pie is T=1 and doesn't change during the bargainings. Let's remind here that firms are not concessionary and don't adapt themselves to the strategy of their adversary. On the contrary, institutions are concessionary. In this perspective, how will their behaviors evolve ? Will the agents involved adopt a perfect share of the pie ? Or will they try to capture the pie to the detriment of the others ? Will do emerge new conflicting or powering behaviors ?

Resorting to a simulation allows us to observe step by step the strategies adopted by the agents involved and the eventual trending changes on 500 periods. At the start of the game, the different populations are equally divided into 8 subpopulations of firms "the obstinated" (Obs 7, …, 92) and institutions "the sophisticated" (Soph) such as in the Ellingsen model. In this way, no population is over-determining. On a technical point of view, the evolutionary algorithm is not entirely used – no crossover – due to the fact that the pie size is known.

4. Simulation S2 : the size of the pie is unknown

In this second simulation, uncertainty is introduced into the bargaining game. The pie size is not known and the agents have to try to estimate it. The main interest of a such simulation is that no agent has a perfect lisibility of the collective surplus, and uncertainty is high. So will they reduce their ambition on the pie sharing ? Will they modulate this ambition according first to their evaluation of profits and second to the errors made during these evaluations ? Will conflict emerge and with which acuity ? Thus this simulation allows on one hand to estimate the global capacity of the cluster to "survive" through the time, and on the other hand to analyse which strategies are to be the most recurring.

The size of the pie is fixed at T=1. Firms and institutions are here endowed with an endogeneous capacity to modify their respective demands d. More precisely, they estimate the size of the pie thanks to a learning process of teg, based on the use of evolutionary operators such as crossover and mutation. Each agent is indeed endowed with an evaluation capacity of what he expects for to be the size of the pie (teg). Consequently, each new evaluation leads to a change of the demand d.

In addition, this exploration capacity relates to the potential values of the pie size, not only around the `teg` values (local research), but as well around what we call "unknown zones" (global research). The agents involved are indeed lead to estimate with the most significant precision what they think to be the real size of the pie.

Nevertheless, they can be led to overestimate or to underestimate the size of the pie during the evaluation process. So the "winners" will be those who succeeded with estimating the size of the pie as soon as possible without making errors, and who exchanged information with the most successful agents.

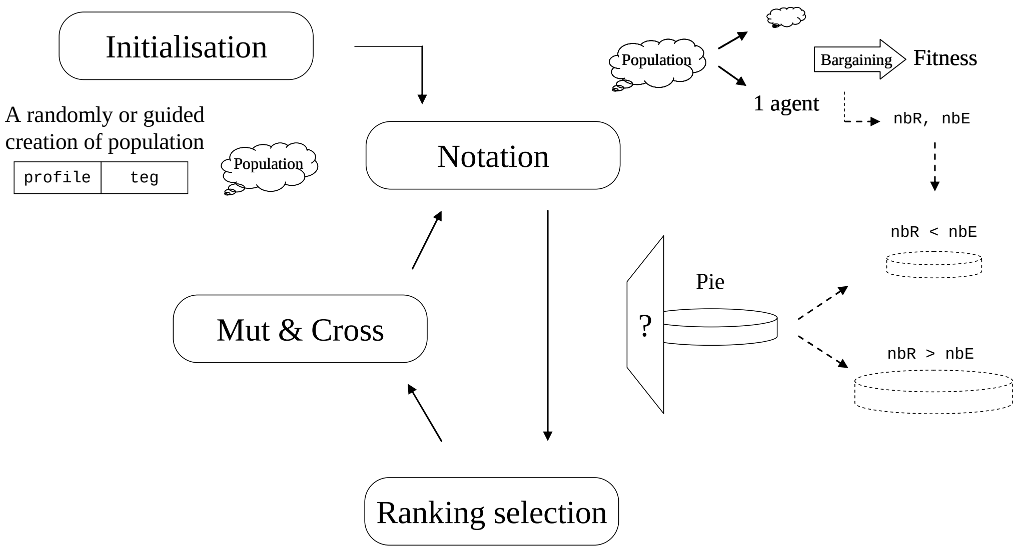
5. Simulation S3 : the size of the pie varies depending on agents' behavior

As we have evoked it previously, clusters are basically conditioned by the capacity of the actors involved to lead to acceptable compromise and to solve their conflicting interests. Each negotiation has indeed a cost : as an example the cost generated by the time spent to negotiate (Ellingsen, 1997); the cost generated by the time spent to estimate the pie size or to observe the strategies adopted by the adversaries; or as well the cost due to the emergence of irreducible conflicts if too many agents choose to exerce a greedy strategy. In a situation characterized by uncertainty on the pie size, these behaviors that can be "opportunistic" qualified, are likely to call considerably in question the viability of the cluster.

In this perspective, the simulation S3 takes into account the impact of bargaining behaviors on the pie size. The more firms and institutions are brought to choose behaviors leading to the failure of the negotiations, the greater the negative impact on the global performance of the cluster and thus on its viability in time (the size of the pie decreases). A contrario, the more the agents are led to choose behaviors supporting the success of negotiations (as concessions, or fair vs modest strategies), the more positive the impact on the global performance of the cluster (the size of the pie increases). In this way, which will be the behaviors mainly adopted by the firms and the institutions ? Which will be the impacts about it on the performance of the cluster ? How will be organized the powership relations between agents ?

Technically, a parameter of influence `k` is here affected with the real size `T` of the pie. As the figure shows it below, if at the preceding step `(n-1)` the number of successful bargainings is higher than the number of the failures, then the size of the pie increases by `0.01`. In the opposite case, it decreases by `0.01`. The choice of this parameter `k=0.01` is arbitrary and fixed at a low level. Indeed, it has vocation to illustrate that the failure of bargainings influences the cluster performance but in a nonradical way, as opposed to what could induce a strong economic crisis or the closing of a donor-of orders company. In these last two cases, the performance of the cluster can be radically destroyed, which is not our case here.

Figure 1. Algorithm process for S3[1]



III. RESULTS

A. SIMULATION S1

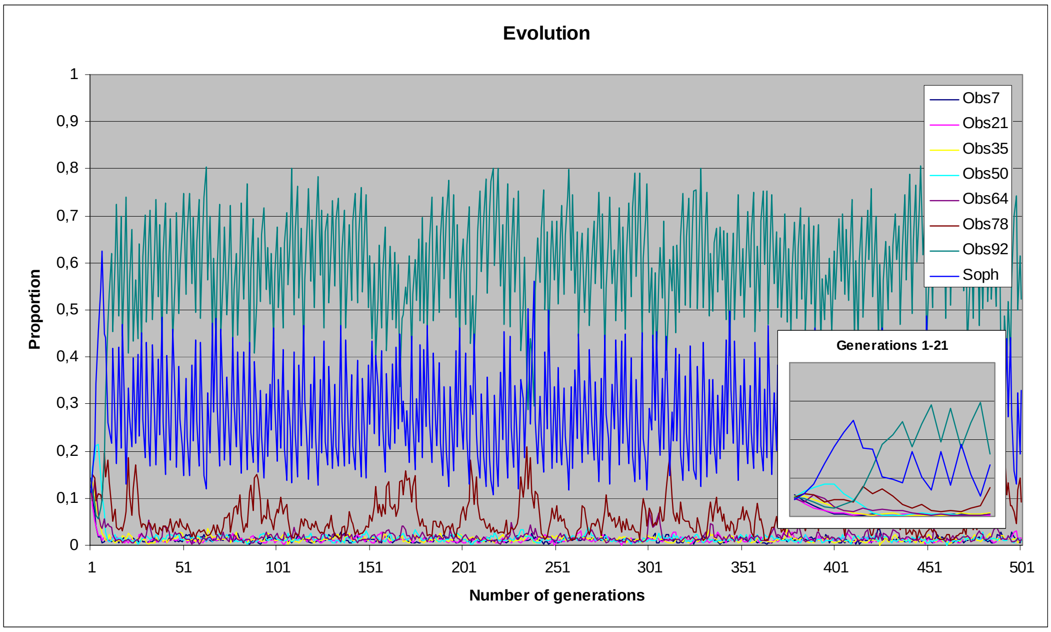
This first group of simulations (S1) consists in testing the evolution of bargaining behaviors when the size of the pie is known and doesn't change. The simulations show that bargaining behaviors evolve in two distinct phases. First, local institutions making concessions are supreme to the other transactors during the first tweenty generations. During these periods, bargainings lead mainly to an equal share of the pie (50/50). Second, this supremacy of local institutions which make concessions then allows the emergence of the greedest firms, which demand is 92 % of the pie, and a low proportion of firms which demand is 78 % of the pie.

It is important to note that bargaining is in the medium and long terms stabilized around a majority of greedy firms whose existence is maintained due to the presence of local institutions playing concessions. So without uncertainty on the pie size, the greedest firms take advantage due to the redistributive part of local institutions. We can here conclude that

[1] The « ranking selection » consists at first in classifying the agents by decroissant order according to their capacity to generate profits. Thus, the most powerful agent has a note equal to 1000 and the least powerful has a note equal to 1. Then, a random pulling is next carried out.

institutions play indirectly, indeed non deliberately, a regulator role : as making concessions they contribute to allow the greedest firms to capt quasi-rents to the detriment of the modest and fair firms. So they are "power of the weak" carrier in that sense that the greedest firms are maintained due to their presence in the game. Without institutions making concessions, the greedest firms couldn't take advantage of the situation.

Figure 4. Simulation S1



B. SIMULATION S2

The second group of simulations (S2) consists in testing the evolution of bargaining behaviors when the size of the pie is unknown, giving rise to uncertainty. So the possibility of failure is stronger. After a thousand tests, the results show the existence of a plurality of possible outcomes :

- In 46,20 % of cases, the bargaining is stabilized around the greedest firms, which demand is 92 %, and the local institutions. Their existence in the game is maintained due to the presence of these local institutions, such as in S1.
- In 29,6 % of cases, the bargaining is stabilized around firms, which demand is weither 78 % or 64 %, and the local institutions.
- In 22,40 % of cases, the bargaining is stabilized around the fair firms, which demand is 50 % of the pie, and the local institutions.

- In 1 % of cases, the bargaining is stabilized around the modest firms which demand less than 35 % of the pie, and the fair firms. In these very rare cases, local public institutions are going missing.
- The last 0,8 % concern errors or accidents of the evolutionary process that can sometimes occur.

So when the pie size is unknown, results can be very different and depend on the capacity of agents involved to find quickly the right size of the pie and to appropriate it. In the most recurring cases, such as in the figure n° 5 below, the greedest firms find it rapidly benefiting from a very large presence of local institutions during the first fourty periods or generations. This very large presence of institutions is due to the pie size researching process : concessions facilitate right evaluations, such as modest and fair firms whose low demands contribute to avoid failure. The other cases contribute to put in a prominent position emergence of prudent strategies consisting in revisiting demands downwards. Concessions appear en masse at the start of the period and then give way to more prudent obstinate strategies once the size of the pie is approximately estimated. So when the pie size is unknown, the regulator part of institution is very high. By the way, in only 1 % of cases modest firms can survive without local institutions because they themselves play a redistributive part.

So we conclude that if the pie size is unknown the cluster can survive if there are enough local institutions to provide the pie redistribution or if the firms adopt a very modest behavior. So here as well, institutions and modest firms are “power of the weak” carrier in that sense that the greedest firms are maintained due to their presence in the game. Without institutions making concessions or without very modest firms, the greedest firms couldn’t take advantage of the situation.

Figure 5. Simulation S2

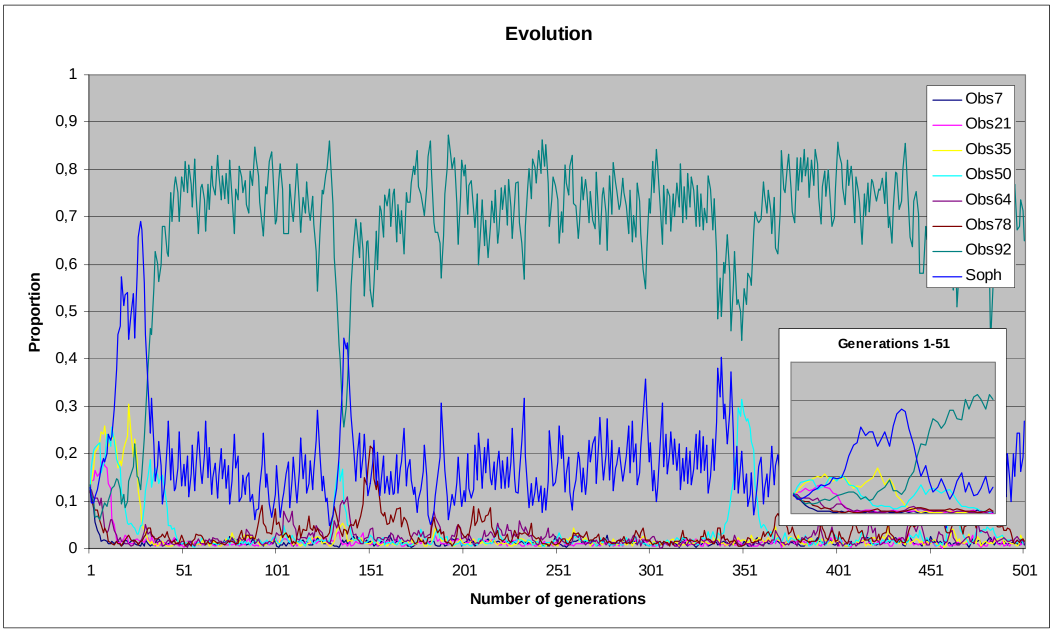
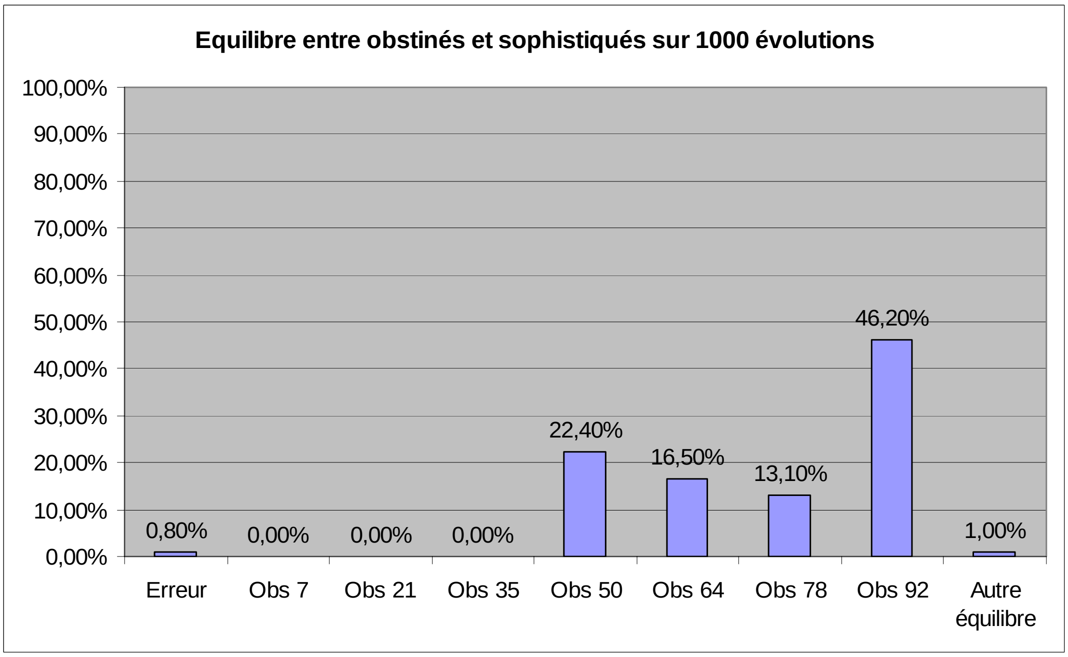


Figure 6. Average results on 1000 generations

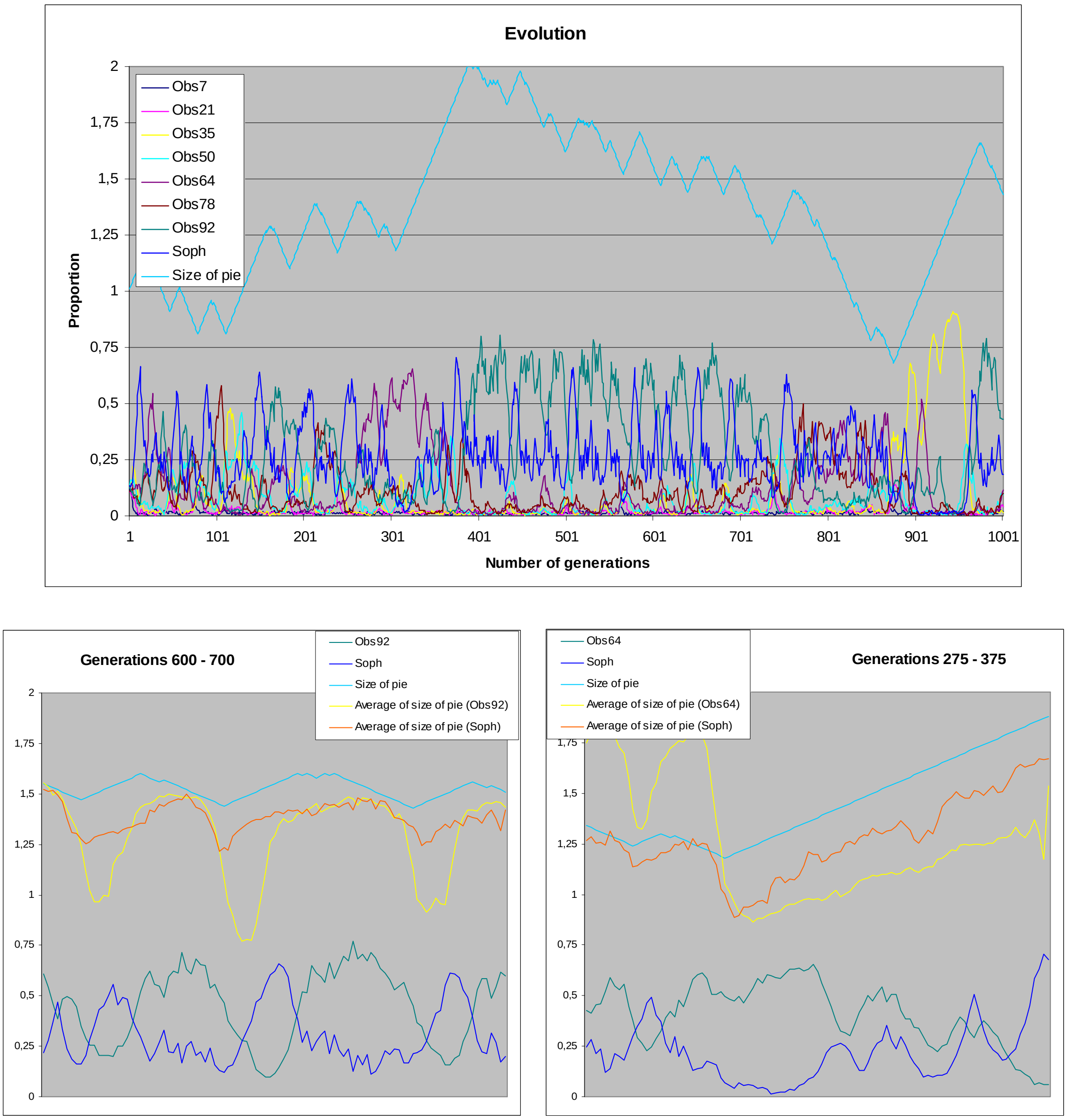


C. SIMULATION S3

The third group of simulations (S3) consists in testing the evolution of bargaining behaviors when the size of the pie varies depending on previous bargaining behaviors. In other term, we test the impact of bargaining behaviors on the cluster performance, which is represented here by the pie size. As explained previously, the pie increases (decreases) by 0,01 if the number of successes is higher (lower) than the number of failures in each period.

The results show that agents adapt their behavior according to the maintain of the pie size. As the game is not stabilized, one thousand periods are represented here. They put in a prominent position that firms are led to exploit the bargaining process according to their evaluation of the pie size, its evolution, and the more or less important presence of institutions and modest/fair firms. Thus, once the pie has reached a size near the maximum threshold expected, the move from fair/modest strategy to the greedest strategy can be successively observed. As an example, the periods [275; 375] are caraterized by a strong presence of the very modest firms which demand is 21 %. During this period, modest behaviors contribute largely to make the pie growing towards the maximum threshold. Once the pie has reached this size, we can observe the move from the modest 21 % strategy to the greedest 92 % strategy. And this can be possible due to the presence of the institutions which appear to play their regulator part : reducing conflict between the greedest agents so as to avoid any radical reduction of the collective performance. So when the cluster is threatened due to the too important presence of greedy behaviors, which can considerably alter the global performance, local public institutions appear and play a regulator part allowing the pie growth. By the way, the cluster performance is maintained due principally to institutions, and in some cases to modest firms. Here as well, they are “power of the weak” carrier.

Figure 7. Simulation S3 and zooms



IV. DISCUSSION

This model thus brings to light a first reflexion on dynamics and phases of behaviors within a biotech cluster characterized by a strong presence of local institutions. In this way, the evolutionary approach contributes to put in a prominent position that bargainings do not systematically lead to a perfect division of the pie (50/50). The simulations show that agents collectively modulate their behavior through time according to various parameters: the profits withdrawn during the bargainings; the effects of their own behavior on the global performance of the cluster; the uncertainty; their capacity to observe their partners' strategies and to make concession; and the existence of relational proximity ie the choice to exchange or not to exchange information according to the previous negotiation process. Whereas many models of clustering are focused on positive coordinations, the way is here opened on the dynamic modelling of strategic behaviors within complex environments. So the assumption of agents' homogeneity is replaced by the assumption of agents' heterogeneity along with different relationships and strategies of appropriation.

By the way, this model leads to substitute the assumption of « situated rationality » for the assumption of « limited rationality » (Simon, 1955 ; Walliser, 2000). This is a significant advance to understand the way that behaviors evoluate through the time. The behaviors of such heterogeneous agents indeed differ from those of the optimization approach developed by the othodoxe theory, that refers to the "homo-oeconomicus" principe. Here, this model takes into consideration the environmental factors and is able not only to evaluate them but as well to adapt itself to them. This adaptation more particularly depends on the agents' representation of the environment evolution. So in this case, rationality is not fixed ex-ante but it is an outcome of collective action.

Another contribution of this model is to bring to light the evolution of power relationships, more particularly the « power of the weak » carried by institutions. It makes possible to observe step by step how the agents "instrumentalise" their power relationships in a complex environment. If most previous researches on clusters develop analysis of knowledge transfer within rivalry situations, they however don't develop analysis of conflicts due to the sharing of benefits on one hand, and to the different strategies adopted by the agents involves on the other hand. So this model calls into question that "rivalry-cooperation" systematically produces emulation. It can also leading to conflicts that agents have to solve to keep collective performance.

Artificial life simulations indeed contribute to correct these inconsistances and put in a prominent position the regulating part of institutions, that are "power of the weak" carrier. So, if institutions regulate the system when the latter is threatened, they however indirectly contribute to the emergence of the greedest strategies. So this model makes emerge one of the main ambiguities of coordination within biotech clusters : on one part, they are supported by local governments because of the uncertainty depending on the firms' behaviors (in situations characterized by relocalisation blackmails; closing firms blackmails…) and on the environment evolution. And on a another part, supporting firms can in some cases contribute to the emergence of the greedest strategies and to the ousting of the less opportunist firms.

And finally, these simulations show that the cluster' performance, that is here represented by the pie size, is not fixed ex-ante but evoluates depending on the behaviors and the strategic choices made by the agents involved. At each moment, some "accidents" of the system evolution, viewed as artifacts, can considerably affect the composition of the cluster. Consequently, this model offers a first attempt to formalize the notion of performance. Admittedly it needs to go deeper into the modelling reflexion. By the way, this is a first avenue of research that opens a way to the analysis of the cluster' conditions of perenniality. For the first time, a bond is directly established between behavioral considerations and their impact on the cluster performance.

On an exploratory point of view, such a model with a heuristic aiming opens new theoretic and empirical research ways. On a theoric point of view, it can lead to a reflexion focused on conflicting and power analysis within clusters, according to an evolutionary approach. Beyond the "rivalry-cooperation" relationships within clusters, how do the behavioral rules emerge and evoluate through time ? Do they produce an impact on the cluster performance on one part, and on the cluster surviving on the other part ? So these questionnings suppose the cluster not to be analysed according to a structuralist perspective. It needs to be analysed according to an evolutionary and processual perspective that can be characterized by different and numerous contingencies. On an empirical point of view, it seems to be interesting to develop analysis of concrete cases focused on conficts at stake within biotech clusters such as : the nature of conflict; the different solving processes adopted by the local actors involved and depending on environmental constraints (market, legal regulation…); and finally the impacts on the system evolution. In addition, if literature takes into account firms' strategies, it doesn't really develop reflexions about the part played par local governments within biotech clusters. However it is very significant especially within biotech clusters that are largely supported by local institutions and public financings. Here, an empirical research avenue is opened, that can be, as an example, focused on the ambivalences of the local governments' part in the governance of such clusters.

But if these heuritic simulations lead to new research matter, they however include methodological limits. As a first limit, the model develops only two kinds of agents, firms on one hand and institutions on the other hand. So it needs to be enlarged, taking into account a greater diversity of agents (research laboratories, development agencies,…), a greater diversity of exchanges (sellers-suppliers, …). Second, such a model is limited to relationships developed within the cluster. So it is important to take into account a more complex environment including the embedness of the actors involved in complex social relations outside the cluster (relations with donors-of orders; with shareholders; european policies…). The questionning is here focused on the various levels of decision and their impact on the cluster performance and surviving. And the third limit of the model is that it doesn't introduce proximity as a distance, but as a relational and communicative one. In this perspective, our purpose is now to introduce geographical distance. Consequently, new computing tools such as MAS (MultiAgents Systems) can contribute to reinforce the mecanisms of inductive reasoning, while introducing geographic proximity parameters. MAS can be good tools to investigate complex phenomenons, such as lock-in and intrinsic vulnerability of biotech clusters.

V. CONCLUSION

As a result, the three simulations show that bargainings between firms and local institutions within the biotech cluster lead to an agreement which is not a perfect share but a compromise frequently hiding complex mecanisms of more or less greedy strategies and concessions. Indeed, the performance of the cluster is maintained in the time due to the fact of the presence of local institutions, and sometimes very modest firms, which play a distributive part and which "regulate" the cluster. So they are "power of the weak" carrier. In this perspective these results bring to the fore the question of evolutionnary flexibility, dynamics of phases and power behaviors within biotech clusters. In this way, this model can contributes to open new researches focused on complex economic dynamics, collective performance and ambivalent power strategies according to the spatial industrial framework.

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