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Abstract

I propose an interpretation of business dynamics in terms of the spatial co-localization of firms in a circumscribed area in order to form clusters of various types. I interpret clustering by adopting the methodology of combinatory systems: that is, systems formed by collectivities of agents that, by combining their micro behaviour, give rise to a macro behaviour and a macro effect that refers to the collectivity considered as a whole. Due to the presence of an internal feedback the macro behaviours direct or condition the subsequent micro behaviours, even though they derive from these.
There are two business dynamics that lead to the formation of clusters: the exogenous dynamics, where the outside entrepreneurs locate their firms in a given area, and the endogenous dynamics, where there are new entrepreneurs generated from within a preexisting cluster.
The firm is considered as an intelligent cognitive system that evaluates its own fitness on the basis of a system of performance indicators; it estimates the effective or potential fitness for various possible areas of intervention and on the basis of the fitness levels assigns an index of attractiveness to the area.
We maintain that if an area has advantages in terms of fitness, then clusters will form there as a result of the co-localizations of firms that assign these areas a high attractiveness index.
If the attractiveness landscapes appears flat, because no element stands out from the other areas to favor fitness, then if by chance an initial core of firms co-localize in the area, and their presence produces economic advantages in terms of economic efficiency or profitability with respect to other areas, these acquire the force of attraction and a combinatory system forms that by necessity increases the cluster. This process lasts as long as recombining factors maintain or increase the perceived advantages.
We also present the idea that if a cluster has fitness advantages for new firms, then usually new entrepreneurs are formed within it and the cluster widens due to the endogenous genesis of new firms.

Keywords:co-localization, cluster, bah, endogenous development, exogenous development, entrepreneurship.

1 – Objectives of this study

We shall consider two of the various possibilities for analysing the complex topic of business dynamics:

a) The *spatial dynamics* of firms and entrepreneurs; that is, the aspect of the *localization* of the firms in a given area or territory, or even – in equivalent though general terms – the dynamics regarding the formation of *clusters* of firms or productive activities;

b) The dynamics regarding the *density of firms* and entrepreneurs over a given territory; that is, the aspect regarding the *genesis* of new firms in a territorial context where there is already a cluster of entrepreneurs and productive activities

Both cases involve examining how different firms and entrepreneurs co-localize in a given area; nevertheless the two cases differ in that, in the first, the *co-localization* takes the form of the aggregation of units coming from other areas external to the one observed. We shall call this phenomenon *exogenous co-localization*. In case b) the co-localization depends on the genesis of new entrepreneurial initiatives, entrepreneurs or firms within the area in question. This phenomenon will be called *endogenous co-localization*.

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2 – First basic assumption: the firm as an agent characterized by fitness

Despite the differing points of view from which the firm can be considered, for the purposes of a study on entrepreneurial dynamics I believe it is appropriate to introduce the basic thesis that considers the firm as a *rational cognitive economic agent*.

The firm, as a business oriented organization, can be conceived as an autonomous *economic agent*, even given the variety of businesses carried out and the multiplicity of components that make up its organization.

We can thus also consider a *collectivity* of firms, whether or not these have similar or different structures, size, businesses and production, as a population of agents constituting a complex system (Allen, 1996; Axelrod, 1997; Goldspink, 2000; Holland, 1995; Mella, 2002b, 2003; Mitleton & Kelly, 1997).

It is a *cognitive and viable agent* (Beer, 1979, 1981) in that we must assume that the firm-economic agent carries out a cognitive activity aimed at giving significance to the environmental stimuli, translating these into information that is structured in knowledge (de Geus, 1988, 1997), producing a *reactive* and *proactive* behaviour aimed at reproducing the economic processes in a lasting way, thereby adapting itself to changes in its environment while maintaining its identity in a long-lasting autopoietic process . (Maturana & Varela, 1980; Mingers, 1994; Uribe, 1981; Varela, 1981).

It is a *rational agent* in that the cognitive activity is aimed at maximizing its *fitness*, indicated by a system of performance measures – analytical (businesses and the various cycles of the economic processes) as well as synthetic (entire firm) – which express the entrepreneur's ability to maintain or improve the autopoiesis of the system-economic agent in a given area and over a definite interval of time.

3 – Second basic assumption: the firm as a transformer system

To fully understand which performance indicators most effectively express the fitness of the firm we must agree on the minimum characteristics of survival.

If we define a *capitalitstic firm* as an autonomous permanent *business* and *profit–oriented* organization (Williamson, 1993) we can interpret *capitalistic firms, at a micro level, as operating systems for efficient transformation that carry out five parallel transformations* (Mella, 2002a; 2014):

a) a *productive* transformation of factors into production; this is, a transformation of utility, governed by productivity and quality;

b) an *economic* transformation of costs and revenues into operating income; this is a transformation of value, governed by production costs and selling prices, and therefore by the market;

c) a *financial* transformation of risks, which transforms capital into returns and guarantees the maintenance of its financial integrity;

d) an *entrepreneurial* transformation of information into strategies, which leads to a continual readjustment of the firm's strategic position;

e) a *managerial* (organizational) transformation of strategies into actions of management control.

On the basis of the previous definition, we can introduce the following second basic assumption: *the capitalist firm is created and maintained over time only if it succeeds in financing the long-term portfolio investments by a structure of steadily-available capital*, balanced for risk, cost, duration and time distribution.

We can also express this assumption in an equivalent form: a condition for the creation and survival of a firm is that the entrepreneur succeeds in developing a portfolio of businesses with sufficient economic efficiency to acquire and maintain invested the financial capital necessary to activate and continually renew the productive investment cycles that guarantee its autopoiesis.

This condition will occur only if the firm is able to meet the expectations of the suppliers of the financial capital that guarantees its existence.

The overall fitness of the firm thus is indicated by its performance as a transformer of capital into remuneration (Mella, 2002?1992).

4 – A summary of financial performance and financial fitness

From the second assumption above it follows that the *overall fitness* of the capitalistic firm is expressed by its performance as a financial transformation system of capital into remuneration.

There are quite a number of performance indicators for testing financial efficiency; however I feel that only a limited number are sufficient to express the *fitness* of the firm as an economic agent-system.

The most concise performance indicator is the firm's *roe*, defined as the ratio between the net income R and the equity E during a period T: *roe* = R/E.

Though *roe* is an indicator of the performance of the firm as a financial transformer, it is also an indicator of *fitness*, since if *roe* > *roe**, assuming *roe** is the *fair return* (adequate, satisfactory) *expected* by the investor in equity capital, then the survival of the firm is guarranted, since the firm is capable of guaranteeing a return that is sufficient to ensure the capital remains integral, both in monetary terms (preserving its purchasing power), financial terms (financial return,

interest, dividend and capital gains at least equal to that obtainable from investments with similar risk conditions), and real terms (capacity to renew investments at the end of their cycle).

In fact, from *roe* we can derive other concise indicators of *fitness* that refer to the firm's ability to meet the return expectations of investors: the *economic value added* (EVA), the *dividend on equity (doe)* and the *economic value of the firm* (EVF).

In the most concise form, if we let *roe** be the financial opportunity cost for the equity holder – understood as the return that satisfies his expectations, taking account of the risk and return from alternative investments – then we can derive the minimum net operating results necessary to provide a satisfactory return on equity: R* = *E roe**.

If at the same time we let rod* = I*/D = i* be the *return on debt*, that is the interest rate deemed fair by the financier, which is necessary to induce him to invest his finance capital D, then we can calculate I* = D *i**, which represents the minimum net financial return necessary to satisfactorily compensate the finance capital D.

As indicated in the *second* basic assumption, the firm that requires a stable productive investment I = D + E must then be able to achieve an operating income O sufficient to provide a fair return on D, with an interest rate equal to I*, and on E, taking into account the income tax T*.

Thus:

$O \geq I^* + IT^* + R^*$.

In the case of an inequality, the investment produces an *economic* return greater than the sum of the fair *financial* returns.

This additional amount is the Economic Value Added, which represents a performance indicator that includes *roe* in expressing a concise overall fitness indicator of the agent-firm:

$EVA = O - (I^* + IT^* + R^*)$.

In general shareholders, being holders of pure investment equity, compare their satisfaction not so much on the basis of the indications from *roe* as on $doe = \frac{R}{E}d = \frac{DIV}{E}$, where *d* is the average dividend rate that would guarantee a self-financing adequate for the firm's growth (Kee, 99).

A satisfactory return for the shareholders would require that $doe \geq roe^*$.

However, since the self-financing obtained from retained profits reduces the periodic returns for the shareholders while also increasing equity, there is progress in the firm's *fitness*, since this strengthens the financial structure of the firm and reduces the financial leverage, with a potential increase in future earnings.

Precisely in order to take account of the inverse relationship between *doe* and *corporate growth*, while taking account of the *net self-financing*, it is useful to determine the EVF, which is a concise indicator that reveals the firm's ability to maintain its equity financially integral and produce a value in terms of goodwill that, in the case of listed public companies, can translate into an increase in stock value.

In fact EVF is defined as the level of capital capable of producing a net result equal to that effectively achieved by the firm as a financial transformer, under the assumption that this capital was invested with a satisfactory return equal to *roe*°, which is considered favourable for shareholders, since if EVF *roe*° = R, then:

$$EVF = \frac{R}{roe^\circ}.$$

Since R = *roe* E, with *roe* equal to the *effective* financial return, through substitution we obtain:

$$EVF = \frac{roe \times E}{roe^\circ} = E\frac{roe}{roe^\circ}.$$

From the preceding relation we see that EVI > E if *roe* > *roe*°, and vice-versa.

If EVF = E, then the agent-firm maintains its risk capital financially integral at the end of the investment period. If EVI > E, then the agent-firm revalues E and the difference represents *goodwill*. If EVI < E , then E is devalued and *badwill* is produced (financial loss or negative goodwill).

In general, though not necessarily, we set *roe*° = *roe**, in the sense that the satisfactory return should correspond to that which is held to be appropriate by the investor.

It is clear that the agent-firm must manage its own business portfolio so as to provide a fair return to all the capital while also producing an EVA that maintains equity financially integral, thereby producing a goodwill that is proportionate to EVA:

$$EVF = \frac{R^* + EVA}{roe^*} = E + \frac{EVA}{roe^*} = E + GOODWILL.$$

From the preceding performance indicators it follows that the *fitness* of the firm is linked to its capacity to produce a *roe* which is not below the minimum or fair *roe** necessary to satisfy shareholders, thereby creating value, in terms of EVA or GOODWILL.

5 – A summary of economic performance and economic fitness

The most important *performance measure* for the *economic transformation* is *roi*, which is the ratio between the operating result, OR, and the invested capital, IC, over a period of time T: ROI = O/I.

Roi is also the fundamental factor in *financial performance* since it reveals the efficiency of the firm in achieving operating income O from a given capital investment, I. If the firm increases its economic efficiency, either by increasing O and/or reducing the

need for invested capital, I, then fitness improves and *roi* will reflect this. In fact, *roe* depends directly on *roi* by means of the well-known general law of returns (Modigliani & Miller, 1958):
roe = [*roi* + (*spread der*)], where *spread* = (*roi* – *rod*),

and *der* = D/E.

This important relation clarifies how the firm's general *financial peformance*, indicated by *roe*, is a function both of *economic efficiency*, expressed by *roi*, and the capacity of the firm to acquire a financial structure, expressed by *der*, that permits it to take advantage of the *financial leverage* effect in the presence of a differential in returns indicated by the *spread*.

Nevertheless the main expression of *economic fitness* is the capacity of the firm to generate *operating income*, O. Since: R = O – I – T, it is clear that the *financial peformance* involves not only the need to negotiate financing at fair and stable rates (at a level that permits a *financial leverage)*, to determine the best place to minimize the tax burden, and to produce a stable flow of self-financing for the growth of the firm, but also, and in particular, the capacity to produce a flow of O that is sufficient to allow an adequate R. Thus *economic fitness* is an important instrument for *financial fitness*.

For the sake of simplicity, let's define the *full cost* for producing QP as:

CP = QP [(qM pM) + (qL pL) + kS],

where M, L and S, are, respectively, the factors of production: Materials, Labour and Structure, with the *unit average quantities* indicated for each of these: qM, qL, qS, as well as the input prices pM, pL and the unit absorbed cost, $kS = \frac{NS \times pS}{QP}$, for the use of structure factors, where $NS = \frac{QP \times qS}{K}$ represents the number of the structure factors to acquire in the period T in order to produce QP, supposed a average production capacity, K, for each capacity factor.

We can rewrite the function for the o*perating income* in the following form (leaving out the time indicators): O = QP [pP - cP], having defined the unit average production cost as: $cP = \frac{CP}{QP}$ and the output average price as pP.

The preceding expression for the operating income shows how *the economic and productive performance* – and thus the *financial* one – depends on the *economic fitness*, which consists in the capacity of the firm to produce at average unit costs that are below prices; for example:

a) to contract the unit factor requirements, qM, qL, qS, by means of an efficient *production function*, thereby modifying the production combinations, or restructuring the product in order to reduce factor requirements, thereby *increasing productivity*;
b) to increase as much as possible its production volume, QP, and the selling price, pP, by searching for monopolistic positions, increased quality, appropriate distribution policies, and an efficient *marketing function;*
c) to reduce as much as possible the unit cost of input factors, pM, pL and kS, by looking for new supply markets through an efficient *supply function;*
d) to search for conditions that increase the rotation of the invested capital, for example by controlling production and stocks, or by searching for greater fertility in the sales outlets, as demonstrated by the well-known relation: *roi* = *cir roc*, where cir = $\frac{CP}{I}$ is the *Cost Investment Ratio* and roc = $\frac{O}{CP}$ the *return on cost.*

Since the control of prices, both selling and supply, can only be a short-term strategy, due to both the existence of antitrust laws as well as the increase in market risks, for economic performance, productive fitness based on the continual increase of productivity (for example with the search for fertile buying and selling areas) plays an essential and increasing role.

The consequent reduction in production costs makes it possible to keep prices unchanged and to increase the roc, and thus roi, or to reduce prices, thereby better controlling the market risk and helping to increase the sales volumes.

6 – The firm as an explorative agent. From the fitness landscape to the attractiveness landscape.

The basic measures of performance, which reveal the fitness of the firm, can be determined on an historical basis, a prospective basis, or a hypothetical one. In the latter case the measures can be quantified taking into account future management programmes.

According to traditional theories on entrepreneurial behaviour, *fitness* depends on internal factors of strength and weakness which can heighten or depress the reaction of the firm to opportunities, threats and risks.

The *performance* measures can, however, also refer to various spatial contexts: areas, regions or territorial subdivisions in general. In this case they can be viewed as *spatial indicators* (advantage or probability) for the territory in terms of external factors that support or inhibit the *fitness* of the firm acting in that territory or of a business or production process developed in

We can introduce the idea of *fitness landscape* mainly by considering the distribution of the performance measures for different businesses (or parts of them) in different areas as spatial detectors of fitness and their possible influence on the internal factors, and thus on the performance of the firm.

Depending on the *fitness landscape* the entrepreneur can generally derive a *function of attractiveness* for the territory or a *fitness attractiveness landscape*.

Let us assume that in a given territory the firm can subdivide into limited operational areas and that for each of these a value can be determined for the chosen *function of attractiveness* in terms of fitness, after having determined the most significant performance indicators.

For example, by choosing as indicators of *fitness* *roe* and *roi* and their components, it is plausible that an area full of potential consumers and lacking in competitors is highly attractive, since it has potentially high revenue prospects, both in terms of quantity and price, and thus a high *roi*.

On the contrary, an area full of competitors would be scarcely attractive, since a lower *roi* would by assumed for this area. On the other hand, an area with a reduced tax burden would have, with all other conditions equal, a higher *roe* than others with a higher tax burden. An area with a high amount of pedestrian traffic could favor sales for a small retailer, while one with a large parking area could increase the fitness of a large retailer.

It is likely that, in relation to the characteristics of the various areas, the attractiveness landscape will present “valleys” of moderate attractiveness, “peaks” of high attractiveness, or “pits” of repulsion (negative attractiveness) to be avoided at all costs.

The assumption of the firm as a *rational agent* imposes the following *optimal behaviour* on the entrepreneur:

- explore all accessible territories and areas that can be reached by the transformation processes: financial, economic and productive;

- shape, update and continually explore, looking to the future, the *attractiveness landscape*;

- choose the area(s) characterized by the highest level or *attractiveness*, trying to avoid the “pits” and attain the highest “peaks”.

Therefore the entrepreneur must be viewed as an *explorative agent* that, continually seeking improvement in the conditions of fitness in all possible forms (rational agent), explores his own territorial environment and moves towards those areas with the greatest attractiveness; that is, with favorable conditions for the increase in *roe* and *roi* (for example, the ease with which new businesses can arise, greater sales volumes, expectations for better prices and supply costs, greater productivity and public subsidies, high levels of social protection, stimulating environment, abundance of infrastructures, lower tax burden, etc.).

7 – The thesis: the clustering effect of collectivities of firms exploring fitness landscapes

Our thesis can be summarized as follows: if we refer not to the dynamics of the single firm but to a *collectivity of firms*, which act as *explorative rational agents* continuously attempting to improve their *performance* measures and their *fitness*, we can consider such a collectivity as a *combinatory system* capable both of *co-localizing* in a given territory by forming a *cluster* and of generating new enterprises.

Before attempting to demonstrate this thesis let us first of all observe that *clusters* of firms situated in limited areas are widespread in all contexts and in various forms (Albu, 1997), among which:

1. *conglomerate clusters*, typical of industrial and commercial areas (Brusco,1992; Jonsson, 1999; Porter 1998; Storper, 1997), which we normally observe at the periphery of cities, along the main streets, near a tollbooth or around universities (Lawson, 1999);

2. *industry cluster*, composed of a group of business enterprises and non-business organizations for which membership within the group is an important element of each member firm’s individual competitiveness; binding the cluster together are "buyer-supplier relationships, or common technologies, common buyers or distribution channels, or common labour pools” (Bergman and Feser, 1999b);

3. *specialist clusters*, or *districts*, typical of single-business or mainly-business industrial areas; if the jointly-located firms are independent and there are no inter-company ties, we have the form of joint-location commonly known as *industrial zone* (Lorenzoni & Lazerson, 1999);

4. *vertically-integrated clusters*, typical of a “filière” or pipeline, composed of independent firms which carry on different phases of a single process along the value-added chain, and which are connected “up the line” and/or “down the line” with other firms in the same area (Brusco, 1992);

5. *vertically*-and *horizontally-integrated clusters* of firms, typical of *networks*, closely linked by inter-company ties in terms of supplies, manufacturing, and process (Hakansson & Snehota, 1988, 1994; Harrigan, 1985; Jarillo, 1988; Thorelli, 1986); the network represents an organized system forming a single productive entity that does not depend on joint-location but on the activities of all the firms in the social network, wherever they are located;

6. *hub* or *constellation* cluster (neck or spider-web) joint-location, arriving or departing, which we observe when there are common facilities, a common supplier, or a common client in the centre of the web (Lorenzoni & Lipparini, 1999).

It is clear that clustering represents a general phenomenon that is not limited to the firm; but if the phenomenon of the clustering of productive units in the same area is so general, then it is clear that "*numbers count*", "*quantity is rewarded*".

The *mass* appears to gain the *force of gravity* and generates *attraction*, representing *global information*, so that individuals are inevitably drawn in to increase the mass of the cluster as part of a positive feedback or reinforcing loop.

Our hypothesis is that the explanation for the phenomenon of the *co-localization* of firms and the formation of clusters is basically generated from the action of two *combinatory systems*:

- *systems of accumulation*, which favor the exogenous genesis of clusters characterized by units from other territories locating in the area in question;

- *systems of diffusion*, which instead favor the endogenous genesis and growth of a cluster in a particular area, characterized by units from within the area where a cluster already exists locating in the same area (typical of districts).

8 – The tool: Combinatory Systems

In plain words I define as a *combinatory system* any collectivity (composed of individuals or organizations) of agents that operate (perservere, act, expand, etc.) in a given environment (locality, territory, geographical area, etc.) and that, consciously or unconsciously, act (exclusively or prevalently) on the basis of *global information* which they direcly produce and update as the consequence of their micro behaviours (Mella, 2014).

The basic idea behind the Theory of Combinatory Systems is that, on the one hand, the *global information* is - or derives from – a macro state, a macro-behaviour or a macro effect, attributable to the collectiviy as a whole, whose values are produced by the combination of the micro states, micro-behaviours or micro effects of the agents (hence the name *Combinatory System*); on the other hand, the global information affects the subsequent micro-behaviours as a result of a *micro-macro feedback*, acting over a period of time and producing interesting forms of *self-organization* and *synchronization* in the agents' micro behaviours (accumulation, diffusion, pursuit, order, improvement and progress) (Mella, 2001, 2002b).

The feedback arises from *necessitating factors*, which force the agents to adapt their micro behaviour to the system's macro behaviour, and is maintained by the action of *recombining factors*, which lead the collectivity to recombine the *micro* behaviour, or the micro effects, in order to produce and maintain the macro behaviour, or the macro effect.

Recognizing *the existence of a micro-macro feedback and understanding the nature of both the* necessitating *factors and the* recombining *ones is indispensable for interpreting collective phenomena as deriving from a combinatory system* (Mella, 2000).

In order for the dynamics of the combinatory system to manifest itself we generally require a casual *input*, which sets in motion the micro-macro feedback.

We can thus think of the activity of *combinatory* systems as derived from the joint action of "*chance*" and "*necessity*"; they can thus also be called *chance-necessity systems*, and the effects produced by combinatory systems are *path dependent* (Arthur, 1994; Liebowitz & Margolis, 1998).

If we accept the traditional definition of self-organization as the characteristic behaviour of agents that appear to be "directed", or "organized", by an *Invisible Hand*, or *Supreme Authority*, then it is easy to recognize that the *invisible hand* is nothing other than the *synergetic effect* of the *micro-macro feedback* action (or *circular causality*) that generates and updates the *global information* that produces *self-organization* and *synchronization* and the emerging macro behaviours attributable to the collectivity.

9 – Accumulation and diffusion: two effects produced by combinatory systems

Combinatory systems can be ordered and classified into several classes according to the macro effect produced. The most relevant are:

1 - *systems of accumulation*, whose macro behaviour leads to a macro effect which is perceived as the accumulation of objects, behaviours, or effects of some kind; these can be described by the following heuristic model (figure 1):

Fig. 1 – Model of accumulation systems

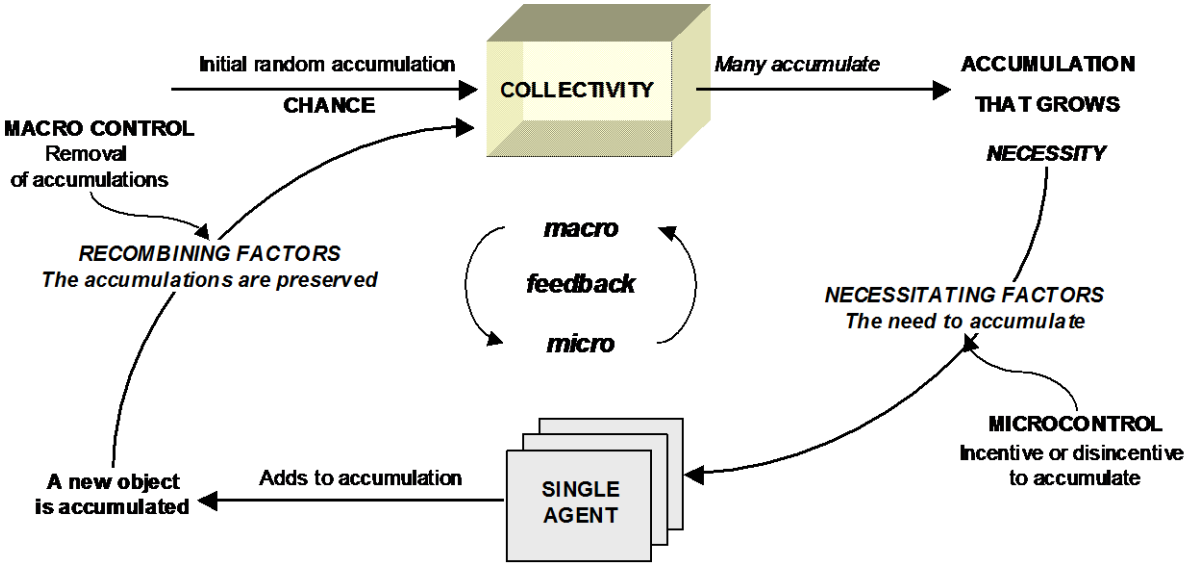
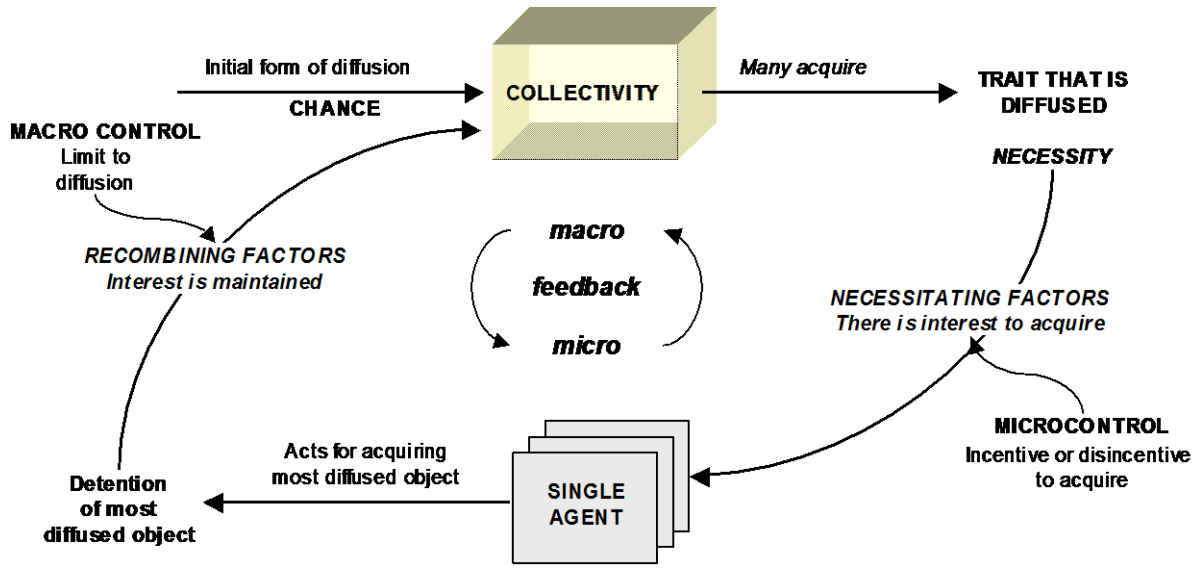


Fig. 2 – Model of diffusion systems



MICRO-RULE = NECESSITATING FACTORS: if you have to accumulate some «object» with others similar in nature (micro behaviour), look for already-made accumulations (global information), since this generally gives you an advantage or reduces some disadvantage (necessitating factor);

MACRO RULE = RECOMBINING FACTORS: the environment preserves the accumulated objects or is not able to eliminate them, and maintains the advantages of the accumulation; everyone accumulates (macro behaviour) and an accumulation of some kind is created (macro effect);

MICRO-MACRO FEEDBACK: the larger the accumulation (macro effect or global information) the more incentive there is to accumulate (micro behaviours) objects (micro effects); the collective accumulation (macro behaviour) leads to an ever greater accumulation.

2 - *systems of diffusion*, whose macro effect is the diffusion of a trait or particularity, or of a "state", from a limited number to a higher number of agents of the system; the heuristic model that describes *these systems* contains the following rules (figure 2);

MICRO RULE = NECESSITATING FACTOR: if you see that an «object» is diffused among the collectivity (global information) then it is «useful» for you to possess it or harmful not to possess it (necessitating factor), and you must try to acquire it;

MACRO RULE = RECOMBINING FACTOR: the environment or the collectivity preserves the diffused objects and maintains the utility of possessing the «object»; the higher the utility or need to acquire the object for the individuals, the more the object will spread throughout the collectivity;

MICRO-MACRO FEEDBACK: a greater diffusion (macro effect or global information) implies a greater desire to acquire the object (micro effect); the single acquisition (micro behaviour) widens the collective diffusion (macro behaviour).

10 – A multi-agent model of clustering processes

In order to interpret (and simulate) *the joint-location process* according to the Combinatory Systems Approach let us present a general multi-agent model in which we imagine a territory as a lattice of regular adjacent cells of equal size (for convenience) each of which represents a possible location site for an economic agent.

From an abstract point of view an agent *settles* in the territory if it occupies a cell.

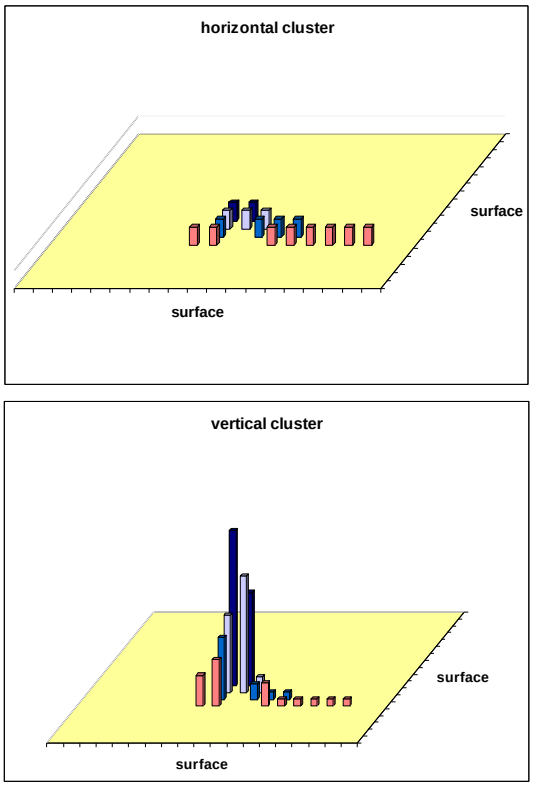
A cluster is thus a *subset of adjacent cells* occupied by agents.

According to this model, an *economic cluster* may be interpreted as the effect of the gradual occupation of a territory by a certain number of intelligent agents jointly-located around an attracting nucleus.

If we consider a two-dimensional space, a surface, then the joint-location can be (figure 3):

1. *horizontal*, if the occupied surface expands in a contiguous manner (ever larger commercial areas); *vertical*, if the units are superimposed on the same surface area (for example, skyscrapers);
3. a *mix* of the two (cities whose buildings increase in height and grow in numbers).

Fig. 3 – Horizontal and vertical clusters



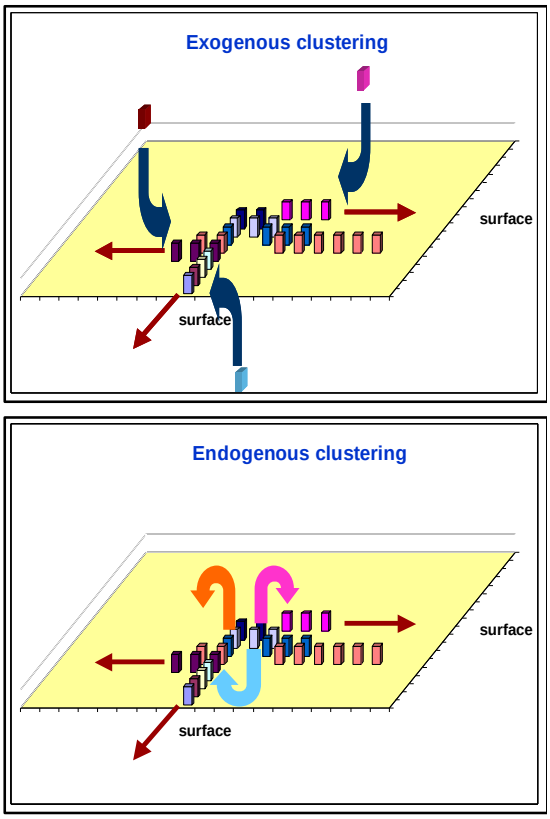
We can represent the two typical clustering processes (figure 4) as follows:

1. *exogenous joint-location*, if the clustering agents come from other areas external to the one observed;
2. *endogenous joint-location*, if the units come from within the area where a cluster already exists, locating in the same area (typical of districts). Let us assume that agents can evaluate their *fitness landscape* on the entire grid, so that each cell can be characterized by an *index of attractiveness* (or of *preference, advantage* or *probability*) *of occupation* and that the grid shows about the same attractiveness landscape for each agent. At first let us assume that the space is empty and does not reveal particular factors of attractiveness, so that the attractiveness landscape is flat (figure 5-A).

Following the combinatory systems view, our *hypothesis* is that if a new agent is attracted to one cell the *attractiveness landscape* is modified; the *attractiveness* of the occupied cell (for endogenous clustering) and/or that of the neighboring cells (for exoge-

nous clustering) increases (usually non-linearly) and a *force of attraction* begins to act (figure 5-B).

Fig. 4 - Exogenous and endogenous clusters



This means that now the grid has a certain number of adjacent cells with a higher *attractiveness* of occupation. A peak of preference forms on the grid.

If a new agent *is attracted* to this peak and locates in one of its cells, the *attractiveness of occupation* of the neighboring cells increases further and a *force of attraction* begins to form that derives from the (usually non-linear) increase, from the greater *attractiveness of occupation* of the cells.

For the sake of simplicity, in figure 5-A we have assumed a field of equal preferences; in most cases, however, a territory presents different attractiveness for different zones, so the normal case is the one represented in figure 5-B: the location (figure at left) is the consequence of a field of preferences showing a peak over the territory (figure at right).

In any case, the phenomenon can start when "by chance" (or even by an "external decision") an initial cell is occupied and this initial settlement increases the index of preference for occupation of the neighboring cells.

The mass of a cluster of firms appears to gain the *force of gravity* and generates *attraction* on the new entry and on elements already localized.

It is confirmed that "numbers count", "quantity is rewarded".

If the grid is sufficiently vast we cannot exclude the possibility of other clusters forming that can coexist or join together (figure 5-C).

If we introduce the assumption of *irreversibility*, then the clusters coexist, and they are enriched by new settlements, with the densest one increasing even more. If instead we introduce the assumption of *reversibility* - that is, of delocalization - then the merger between clusters of differing densities is possible and the greater cluster absorbs the smaller one.

The same descriptive logic can also be used for the endogenous formation of clusters.

We must assume that a cluster already exists and that it generates from within new agents that cause an increase in the preference for new location in the cluster.

A – Empty space and flat attractiveness landscape

B – First localizations and modified attractiveness landscape

C – Further localizations and increased force of attraction

11 – The exogenous joint-location explained by accumulation systems

We have defined as *exogenous* the *cluster* deriving from the *joint-location* in a given area of productive units which were previously located elsewhere (figure 4, at left). The procedural *explanation* of the phenomenon may be achieved by applying the logic of the *combinatory systems of accumulation*.

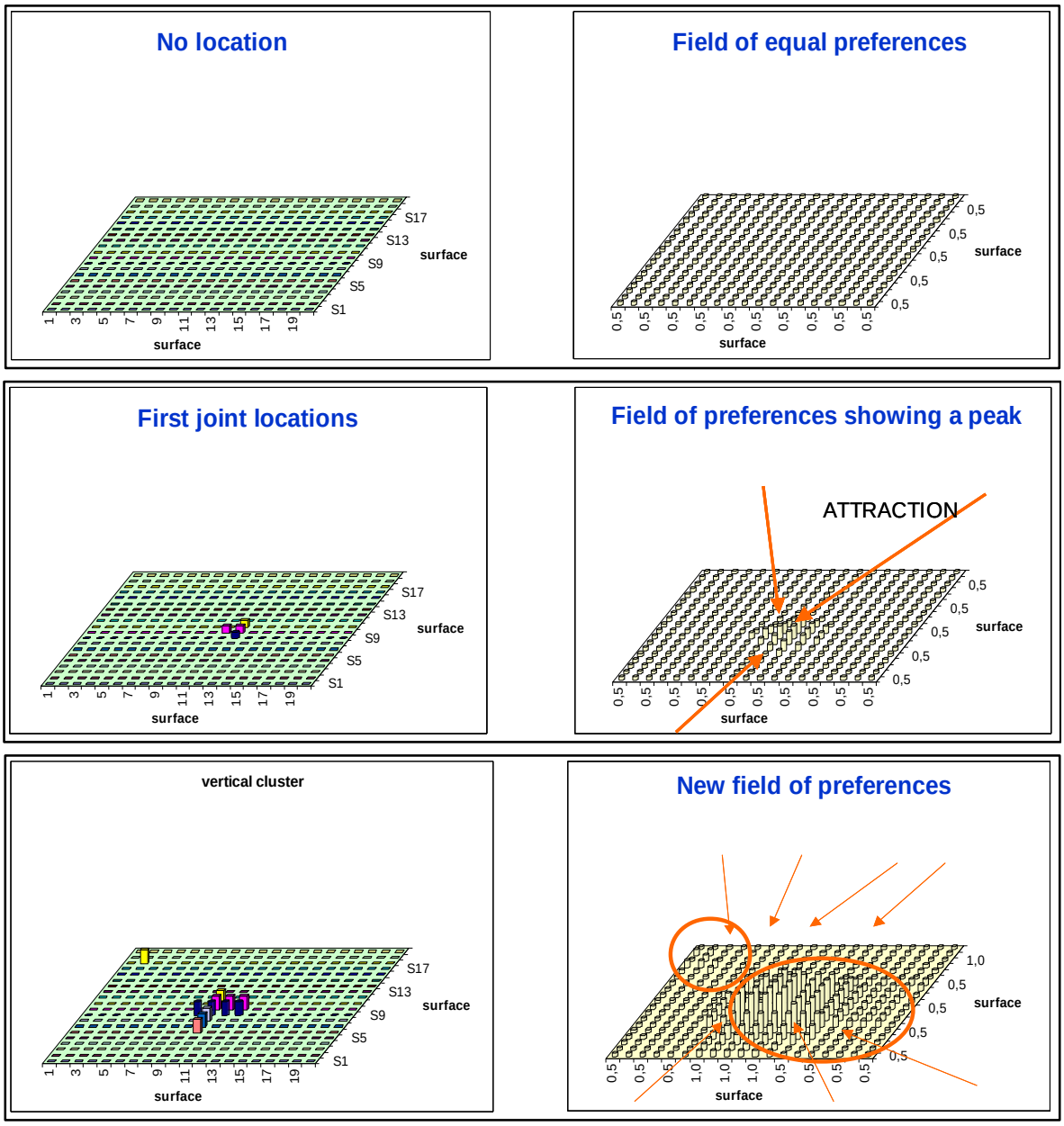
When a given area reveals advantages for the fitness of the firm, in that it can offer a *positive differential* in financial and economic *performance measures* (tax reduction, infrastructures, facilities, aid and subsidies, etc.) with respect to other areas [necessitating factor], then the *attractiveness landscape* presents a peak, so that the probability that a certain number of entrepreneurs will decide to locate [micro behaviour] their productive or commercial units [micro effect] in that area rapidly increases and the combinatory system can begin to produce the collective phenomenon of joint-location [macro behaviour], with the development of typical industrial and commercial clusters [macro effect].

If the joint location of the *initial nucleus* of enterprises [by chance or by external planning] produces, maintains or increases intrinsic financial or economic advantages for the settlement [recombining factor], then the *attractiveness landscape* changes and the peak rises, so that the probability of new locations rises further, and this attracts new productive units [necessity], which produces strengthening actions in a typical *micro-macro feedback*.

The system accelerates if *strengthening* actions are carried out (for example public aid, the building of infrastructures, etc.) and decelerates or ceases when

weakening actions intervene (for example, urban constraints, taxes, etc.) that reduce the fitness for new potential entrants.

Fig. 5 – Exogenous and endogenous clusters



The heuristic model can assume the following form (figure 6):

MICRO RULE = NECESSITATING FACTOR: if you must locate a productive or commercial unit (micro behaviour), look for sites that present peaks in the attractiveness landscape, since they offer positive economic differentials;

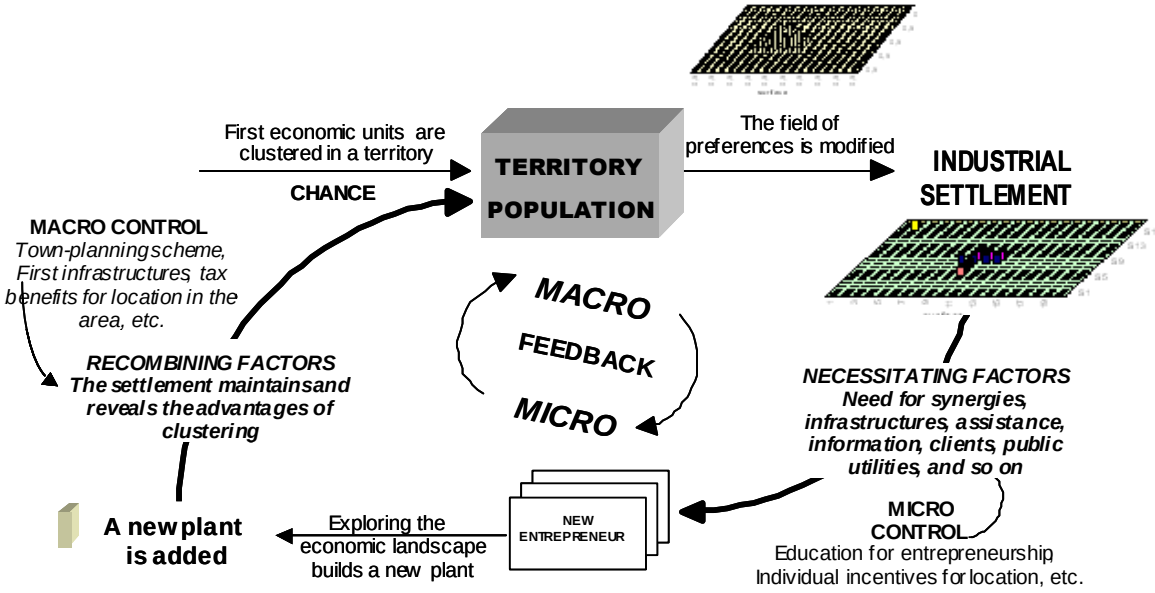
MACRO RULE = RECOMBINING FACTOR: the site by maintaining economically-quantifiable advantages also so maintains the attractiveness and favours the arrival of new enterprises;

many locate there (macro behaviour) and an ever larger settlement is formed (macro effect);

MICRO-MACRO FEEDBACK = CHANCE AND NECESSITY: the more the area grows with enterprises (macro effect), the more advantages and incentives there are for new settlements (micro behaviours) of productive units (micro effects); initial locations due to chance

lead to increasingly larger settlements (macro behaviour).

Fig. 6 – Model of the system of accumulation for exogenous joint-location



12 – The functional explanation

In order to arrive at a *functional explanation* of the *modus operandi* of the system that produces a cluster by *exogenous joint-location*, we must specify some fundamental elements (figure 6).

A – *Necessitating Factors*

The convenience of *exogenous* joint-location always resides in *economic advantages* which improve the performance measures of fitness with respect to the previous location, so that the new area is considered as more attractive.

Following Marshall's view on districts (Bellandi, 1996; Marshall, 1891) and Williamson's transaction cost perspective (Dyer, 1997; Lazerson, 1988; Williamson, 1993), improvements in performance measures can derive from *lower costs* and/or *higher revenue* and/or *knowledge exploitation* and *preservation*.

Cost savings come from *advantages from specialized processes* offered by the site, and can be connected to the presence of better production and logistical conditions; for example (Albu, 1997):

- presence of materials or the availability of work offers advantages in terms of quality/cost; the cluster is named as a resource area;
- presence of favorable logistical conditions (lines of communication, parking areas, the nearness of suppliers);
- extensive functional division of labor between small and specialized firms as a source of external economies of scale and scope (Bellandi, 1996);
- a local labour market (Scott, 1992);
- ecological advantages (water, waste-disposal sites, etc.);
- tax and financial advantages (reduced tax burden, incentives, aid and subsidies to businesses locating in a given area, etc.) (Stöhr, 1988).

Revenue advantages are connected to market advantages, which are associated with the market "fertility" of the site; that is, the relative abundance of potential clients (especially for commercial areas). These advantages may also derive from prices and are connected to the quality of production or the efficiency of marketing processes (Chandler,1990).

Knowledge and learning advantages are connected to greater possibilities for information search and share aimed at the behavioural control and coordination of activities and processes, and at performance evalutation; other advantages also derive from learning the best practices and from the ease with which innovations spread (Asheim, 1996; Pilotti, 1998, 2000), in line with the cognitive approach, which considers knowledge as a codifiable resource that can be managed by the individual or the firm and transferred from one individual or firm to another . Industrial

clusters and industrial districts, in particular, become geographical examples of a *learning economy* (Lundvall & Johnson, 1994). Thus in districts, "*Knowledge is the most important resource and learning the most important process*" (Lundvall, 1992), and districts can be viewed as learning regions (Asheim, 1996).

B. *Recombining Factors*

Due to the advantages from the physical proximity of the firms in the area (Myrdal, 1957; Kaldor, 1970), which allow increasing returns in the economy of clusterized firms (Arthur, 1994), the cluster maintains the economic advantages and creates a critical mass of productive units that improves efficiency in productive, commercial and administrative practices and influences urban and territorial policies, with further improvements in economic differentials (Bellandi, 1996); as an "invisible factor" a network of information relationships and internal commercial transactions erects barriers to entry in order to maintain the economic advantages for a maximum number of firms in the cluster; the greater the advantages the site presents and maintains, the larger the number of firms that seek to locate at that site by overcoming the barriers. This reinforces the advantages, generating the typical micro-macro feedback that produces path dependence (Belussi, 1999: Lecoq, 1999; Niman, 1991).

When there are fewer recombining factors the necessitating factors are also less intense; when they are eliminated the macro behaviour ceases and the process of joint-location is interrupted; when they are negative the system shows signs of slackness (abandoning of productive units) or reversibility (processes of moving out and migration to other areas) (Dunford et al., 1993; Harrison, 1994).

Clusters are not necessarily closed to the external environment; they can represent a system area presenting various forms of connections with other areas.

C. *Genesis*

In general, exogenous joint-location arises as a spontaneous process, especially when the necessitating factors are in evidence; these are represented by revenue advantages (*rows of shops*, *shopping centers*), or by cost advantages (joint-location in areas with low-cost labor) or logistical ones (Schmitz, 1992**)**.

Chance moves the initial firms to locate jointly at a favorable site; the intervention of necessitating factors then pushes the system to get under way as soon as the minimum activation density (critical mass) is reached, producing a typical path dependence (Antonelli, 1997).

Exogenous joint-location can nevertheless be favored by certain exogenous *strengthening* actions that create the conditions for producing the economic differences.

The possibility of the artificial activation of clusters and, in particular, of districts is controversial but in principle not impossible.

Particularly evident are *government policies* of incentives or constraints and actions directed at creating logistical infrastructures (highways, ports, equipped building lots, etc.) or research and educational centers (Jaffe et al., 1993; Nelson, 1995) and the specific recognition of cost advantages (lowering of labor costs, and tax and financial advantages).

Furthermore, policymakers might stimulate entrepreneurial activity in a local area by providing venture capital and preferential loan finance; by offering favorable tax incentives; by removing impediments to business start-up; and by providing management training and business advice. The policy of attracting *foreign direct investments* is another important economic development strategy of many city-regions (Gordon, 1999).

Porter (1990) nevertheless argues that government policy will be far more likely to succeed in reinforcing an existing or nascent industrial cluster rather than in trying to promote an entirely new one. Following Porter, the emergence of new clusters is produced by the systematic interrelationships between the following four factors: the nature of local demand conditions; the development and specialisation of factor conditions; the interactions with related and supporting industries; and the nature of cooperation and competition between firms within a cluster. Therefore, according to Porter the role of government is to reinforce these determinants rather than introduce them in a non-industrial area.

13 – Endogenous joint-location explained by diffusion systems

The formation of industrial, commercial and professional areas can be the result of a process endogenous to the area itself: we must assume that a cluster already exists and that it generates from within new agents which find in the existing cluster the best environment for their *economic fitness.* The cluster thus increases in size by producing its own agents on the basis of a generative rate which depends on the dimension of the cluster.

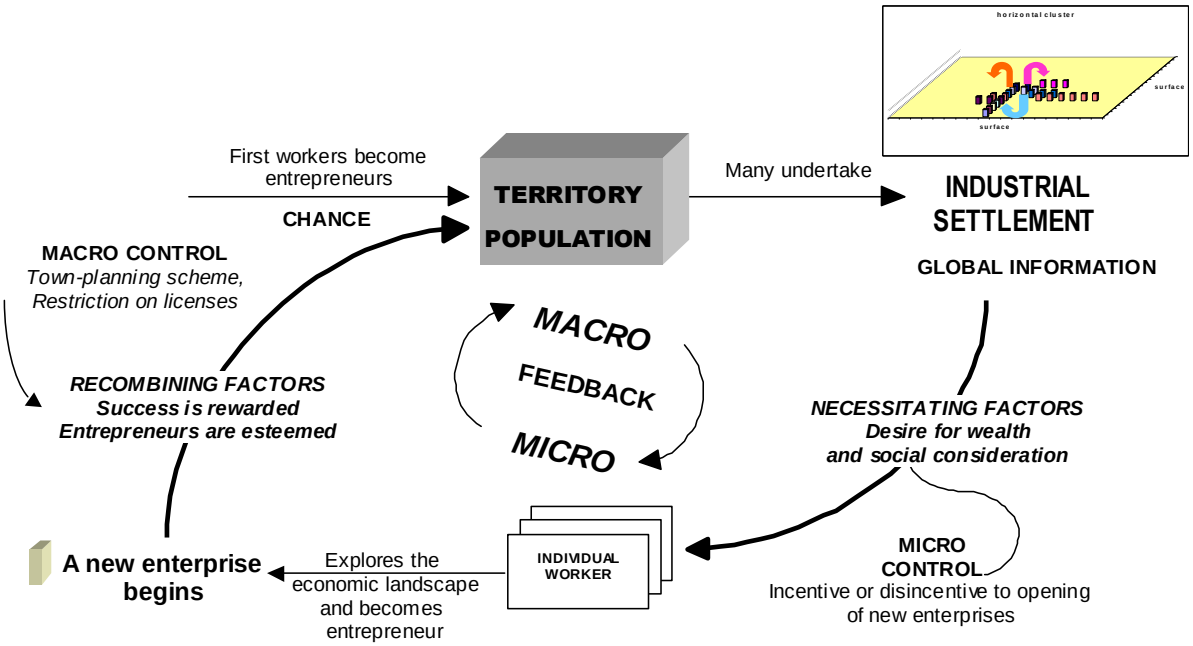
The presence of firms creates competencies, stimulates risk acceptance and the entrepreneurial will to create new enterprises in the same area, although many authors have doubts about these possibilities (Amin, 1993; Murray, 1987).

A convenient system-procedural explanation is offered by the logic of *Diffusion Systems*.

When *by chance* successful firms locate in an area (original nucleus) and are able to internally develop their personnel (employees, managers, professionals), it can happen that *by chance* some of the personnel, after having acquired the necessary competencies and evaluated the fitness landscape of their potential firm, decide to undertake an activity [micro behaviour] to take fitness advantage of their acquired capacities for personal profit. New enterprises are born [micro effect]. If they are successful in their new business activities the combinatory system can get under way, and more firms will locate in the area [macro effect] through endogenous growth (Rabellotti, 1997).

This represents an incentive for other workers with similar capacities to take a personal risk by starting new enterprises. The process spreads [macro behaviour] and the group of workers is gradually transformed into a collectivity of entrepreneurs (Antonelli, 1996).

Fig. 7 – Model of a system of diffusion for endogenous joint-location



The firms become increasingly more numerous [macro effect], and this raises the probability that individuals will start new enterprises [micro behaviour], in a typical *micro-macro feedback* that characterizes systems of diffusion. An area of workers gradually becomes an area of entrepreneurs that soon will have to import subordinate workers from other areas.

The heuristic model of the combinatory system is based on the following rules (figure 7):

MICRO RULE = NECESSITATING FACTOR: if you see that many are successful in an entrepreneurial activity, and you too want to become richer and not be left behind (necessitating factor), and consider your ability as a factor of fitness, then you must try to "go it on your own" by setting up "your" own enterprise;

MACRO RULE = RECOMBINING FACTOR: the environment and the collectivity have high regard for those persons who become rich by taking risks in a business activity (recombining factor); the firms are considered to be useful and the entrepreneurs successful people; many families hope their children can sooner or later open up a business; exclusive clubs for entrepreneurs are formed; personal wealth and the growth of the enterprise are variables of social success (recombining factor); the need to become an entrepreneur in order to be successful and wealthy spreads throughout the collectivity;

MICRO-MACRO FEEDBACK = CHANCE AND NECESSITY: the higher the number of successful enterprises in an area (macro effect), the more widespread the entrepreneurial desire (micro effect); the creation of a new enterprise (micro behaviour) increases the collective diffusion of the entrepreneurial activity (macro behaviour) and increases even more the density of enterprises in the observed area (macro effect).

In order to have a full understanding of the *functional explanation* we need to specify the fundamental elements.

A – *Necessitating Factors*

An enterprise is born when someone, perceiving a peak in the fitness landscape of a potential firm, decides to risk his own capital and work at an independent activity. According to the institutionalist view (Camagni, 1991) the combinatory system for exogenous entrepreneurial development is set under way only if, within the collectivity living in a certain area, there is a spread of the entrepreneurial vision (mentality, logic, attitude, etc.), a sort of cultural isomorphism (Powell, 1990) which is the logic of investment, and thus of risking it alone (Kristensen, 1994); this mentality is based on three *necessitating factors*:

- the entrepreneurial activity offers a high probability of success, thus of *profit* and *personal prestige* as a reward for the risk of the investment;

- the entrepreneurial activity is held to be *socially useful* and offers adequate forms of social recognition; this favours the formation of a social identity: the entrepreneurs feel part of a community, "*defined as a state of mind…a place based on faith in certain assumptions and values…"* (Darrah, 1996);

- the entrepreneurial activity involves production for which it is easy to acquire the necessary skills, and there is the awareness of being able to put the acquired skills to good use.

There is no need for there to be particular economic advantages in the area, which creates differences in economic possibilities; the economic advantages are considered to be the result of ability rather than the consequence of location advantages.

B. *Recombining Factors*

When a *critical activation mass* is reached, the endogenous joint-location system is set under way, but only under the condition that the system can recombine the micro behaviours, within an *innovative milieu* which conserves and accentuates the entrepreneurial mentality (Aydalot, 1986; Camagni, 1991; Maillat, 1998) and makes possible the selection of the best routines and procedures (Nelson & Winter, 1982; Nonaka, 1994) *"by imitating the observed behavior of one or more "masters", in a community of practice"* (Nooteboom, 1999).

The cluster and the area create or maintain externalities concerning *knowledge spillover* between firms in this area (Glaeser and al., 1992; Henderson and al., 1995), following the social-constructive approach (Nightingale,1998) by which "*A consequence of the embodied nature of knowledge is a return to the social.*" In other words, knowledge creation takes place in a social context of firms; the cluster environment is the place in which entrepreneurs can create knowledge.

There are several fundamental recombining factors:

1) the system is composed of successful enterprises; the collective success spreads the *faith* in individual success and provides incentives for personal risk taking (Fukuyama, 1995); the cluster produces and reinforces networks of cooperation and trust and maintains a climate of social dialogue, with institutions that materialize those human meanings and intentions (Feldman & Francis, 2001);

2) the entrepreneurial activity is able to transmit competencies to all personnel (in production, finance, and marketing); the system must be composed of enterprises that use transmissible competencies (Lawson, 1999); this favors apprenticeships, learning, specialization, and thus the awareness of the acquisition of the necessary know-how for starting up an independent entrepreneurial activity that is similar or complementary to that which has provided the acquired skills and capacities (Florida, 2000; Garnsey, 1998);

3) the enterprises in the system carry on business activities on a reduced scale or, in any case, through activities divided up into discrete operations that can be carried out in productive units even of a modest size; this provides faith in the possibility of putting the acquired compentencies to good use (Staber, 1998);

4) the system must be able to sustain the new activities with adequate capital flows; in particular, it must supply equity and financial capital to allow the new firms to take advantage of the financial leverage effect (Christensen, 1992; Dosi, 1990);

5) the cluster generates some form of *governance*; internal and external stakeholders sustain the clustering processes, operate in order to maintain cluster advantages (Alberti, 2001) and create and maintain an *industrial atmosphere* (Dei Ottati, 1994);

6) the cluster produces and reinforces a climate of social dialogue, with institutions which materialize those human meanings and intentions as well as reinforce them.

If the enterprises are successful and the Return on Equity is adequate, then the capital is available for new investments; the propensity to undertake entrepreneurial activities sustains the propensity to form companies for the raising and investment of equity.

When the recombining factors weaken, even the necessitating ones lose their intensity; when they are eliminated the macro behaviour ceases (the settlements that already exist remain, but the process

leading to the genesis of new enterprises is interrupted); when they become negative the system begins to break down (closing of enterprises) or reverse itself (liquidation and trasferrence of capital to enterprises in other areas).

C. Genesis

While *exogenous* joint-location is based on differences in economic advantages that firms in the area can benefit from, *endogenous* location is based on the transmission of competencies, of faith, of rewards for risk (Nonaka, 1994).

The genesis of the combinatory systems for the diffusion of entrepreneurial activity usually requires a *chance* event (Porter & Sölvell, 1998), but once the system is under way the necessitating and recombining factors make it particularly resistent. As with any cultural change the culture of the firm, of risk, of investment is difficult to create but, once created, difficult to eliminate. When a class of entrepreneurs has been formed at a certain site, and the system of enterprises rewards the new business initiatives, the site is maintained and grows through endogenous genesis.

Chance can act in several ways to generate the systems of diffusion in the *entrepreneurial culture*:

- there can be an initial exogenous, chance location of firms that use local manpower, which they train by transmitting competencies; if the firms that jointly locate through exogenous processes have the necessary recombining characteristics then, again by chance, the first enterprises can form by means of endogenous processes;

- a firm that is already located in an area needs other forms of production to integrate its own processes both "up the line" as well as "down the line"; rather than import enterprises from outside the area, an initial spider-web of firms is endogenously formed; this sets off the system that widens the web;

- a fountain of ferility is discovered that is exploited either by firms exogenously located in the area or by those that have come about "by chance" from within; if the fertility guarantees a premium for risk, then the culture of the enterprise spreads and, when the critical mass is reached, the system is set under way.

The combinatory system of endogenous joint-location can be favored by particular *strengthening* measures, among which:

- the activation of professional schools that guarantee an initial employment in a certain career;

- the availability of risk and loan capital;

- the incentive to form new enterprises through facilitating measures (e.g., young entrepreneurs);

- the creation of forms of protection against unsuccessul activity;

- the incentive for the exogenous joint-location of small enterprises;

- the creation of places for exchanging knowledge; the idea is to look at the cluster as a "ba", "as a shared place for emerging relationships" (Nonaka & Konno, 1998). In this sense the success of the cluster form could be found in the fact that it could represent a natural form of "ba".

The exogenous creation (or that by public authorities) of enterprises with the appropriate features (small-scale businesses, the need for small-scale collateral production, professional training) can artificially set off the system, on the condition that the *critical mass* of new enterprises arising *in loco* is reached, so that the necessitating and recombining factors emerge which can assure the occurrence of the micro-macro feedback.

14 – Business dynamics: brief conclusions

Although many authors have doubts about the possibility of clusters and districts to revitalize stagnant economies (Amin, 1993; Amin & Robins, 1990), the process of joint-location is important for local employment and welfare.

The joint-location of enterprises in a circumscribed area can be explained, when it is not completely a casual development, as the macro effect of a combinatory system.

We can arrive at some immediate conclusions regarding *exogenous* joint-location:

We can come to the following conclusions regarding *endogenous* joint-location:

- endogenous joint-location arises in an area when it is possible to train people in the necessary skills and there is a climate that rewards the entrepreneur who is successful;

- it is equally necessary to have a *climate* of faith in the possibilities of investment and in the realization of the economic results that this entails (business atmosphere);

- in order to begin the endogenous joint-location process the presence of productive units managed with public capital could be useful, but on the condition that these units are involved in activities which are split up into discrete processes, and thus can be managed by new enterprises; or that they require the integration of processes "up the line" and "down the line" which can be managed by new enterprises and, above all, can generate the necessary know-how;

- *cathedrals in the desert* have never favored the creation of local entrepreneurs, precisely because they have not set in motion any combinatory system due to

the lack of the requirements we have mentioned above.

A *final observation*: the two forms for the development of enterprises in a given area are not mutually exclusive; in fact, they are usually complementary: on the one hand, an initial exogenous settlement can start up the system of diffusion that leads to endogenous joint-location; on the other hand, the endogenous formation of entrepreneurs, which occurs *by chance*, not only is able to set under way the process of endogenous joint-location but, if the local public authorities provide the appropriate incentives, can also set under way the system of accumulation of enterprises, which leads to the migration *in loco* of other productive units.

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