

Labour Market, Entrepreneurship and Human Capital in Industrial Districts. An Agent-Based Prototype

Riccardo Boero
Department of Sociology
University of Surrey, U.K.
R.Boero@surrey.ac.uk

Marco Castellani
Department of Social Sciences
University of Brescia, Italy
castella@eco.unibs.it

Flaminio Squazzoni
Department of Social Sciences
University of Brescia, Italy
squazzon@eco.unibs.it

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Abstract

The paper aims to describe an agent-based prototype that has been created to investigate the relation among local labour markets, entrepreneurship and human capital in IDs. It basically describes the building blocks of the prototype, the agents acting in it and the forces that drive its most interesting dynamics. Some interesting hypotheses to investigate are sketched, too.

Keywords : Industrial Districts, Agent-Based Simulation, Human Capital, Entrepreneurship, Labour Market.

1. Introduction

The paper aims to describe an agent-based prototype that has been created to reproduce the functioning of an “idealised” industrial district (by now, ID), at the micro level of its constituencies. It allows to simulate some fundamental local dynamics, at the edge of labour market, entrepreneurship, technology and market adaptation, and to investigate some hypotheses concerning their relations¹.

¹ The Prototype has been created using SWARM libraries and Java programming language. SWARM is a toolkit for developing agent-based computational simulation (see: www.swarm.org) and it is used by a growing community of social scientists (see: Terna 1998). For descriptions and applications of SWARM to economic phenomena, see: Luna, Stefansson (2000) and Luna, Perrone (2001). For obtaining the simulation code, please write to the authors.

First of all, it is worth to say that we use the term of “prototype” to outline a substantial difference among modelling specific phenomena of an empirical reality (empirical-based models), modelling highly abstracted social mechanisms, such as, for example, cooperation-competition models in game theory (abstraction-based models), or modelling “ideal-typical” processes that work in a well defined family or class of phenomena, such as industrial districts in the case of this paper (ideal-types or prototypes). In the first case, it is a matter of modelling an empirical phenomenon, trying to reproduce as close as possible the space-time of reality; in the second case, it is an abstraction of some specific theoretical mechanisms that have no strong reference to the space-time dimension of reality and that, consequently, can say something with respect to a wide range of different phenomena or classes of phenomena; while in the third case, we are reproducing “stylized facts” that form each others the architecture of an ideal-type able to identify a general class or family of empirical phenomena.

In some foregoing papers, we used a prototype-like approach to understand some mechanisms of IDs, such as the role of inter-firm ties to explain different technological and market performance of ID firms, the impact of institutional agencies upon the adaptation capabilities of IDs (Squazzoni and Boero 2002), the role of cognitive processes and different behavioural attitudes at micro level of ID firms to explain different outcomes at macro-level of ID as a whole, and so on (Boero, Castellani and Squazzoni 2003).

In this paper, we take a quite different step: we go more deeply in the ID modelling, starting analytically not with ID firms, but with individuals that are embedded into a local labour market, which have a different life cycle, job, wage, knowledge, relational ties, which shape different ID firms, and so on. While the foregoing papers were based on the relation between the firms, as micro analytical units, and the ID and the external market as macro ones (with eventual institutional agencies as a meso level), this paper is based on individuals as the micro analytical units, firms as the meso ones and ID and external market as the macro realities.

With this re-articulation of analytical levels, we try to understand the relation between labour market dynamics, emergence of entrepreneurship and technology and market adaptation of firms and of the ID as a whole. It is a matter of a relation that has been deeply discussed in the literature of IDs and industrial clusters, and that is conceived as a driving force of their evolution (for example, see: Saxenian 1994; Albertini 2002; De Propis 2001; Molina-Morales 2001; Russo 1991). According to such literature, diffuse entrepreneurship is viewed as the property of the flexibility of local labour markets and the result of specific cycles of human capital accumulation, life-death cycles of firms are viewed as adaptive dynamics with respect to unstable and volatile markets, and firms are viewed as a market segmentation within labour markets.

The paper is organised as follows: the second section shows how the prototype works, from the point of view of its building blocks, which are divided in agents and driving forces, while the third one suggests some hypotheses that we would investigate by creating different simulation settings, that is to say by giving rise to different but comparable motion pictures of the prototype. Because of the preliminary and descriptive nature of the paper, the results will be reported in a further version.

2. How the Prototype Works

This section shows a description of agents populating the prototype and the leading forces that drive its dynamics. The prototype aims to reproduce the condition of artificial life of artificial individuals that are engaged to live in a idealized ID. Agents are as follows: agents, firms, external buyers, the service agency. They are units acting in the prototype at different levels of aggregation. The driving forces are fundamental processes that the prototype develops over time. They generate complex dynamics and relations that we need to investigate. They are: markets, technological evolution, production cycle and chains, human capital.

2.1 Agents

2.1.1 Individuals

Human individuals are the fundamental agent/unit of the prototype. They are heterogeneous, they have an autonomous life, they born and die, and they earn, spend and eventually cumulate economic resources. They inherit economic resources by their parents, they are embedded in a labour market, they can work in a firm, and they can give rise to new firms. If working they monthly (every 20 working days) receive a stipend, and they have capabilities to build wage expectations, connecting past situations, actual needs and future projections. Their position in the labour market basically depends on their human capital accumulation, while they retire from labour market after about 35 years of activity. They expect to be able to live following a “life style”, which is the result of their human capital accumulation level that affects their needs and then their level of consumption. They can be employed or unemployed, they can become entrepreneurs, and as entrepreneurs they can move back to the employee status, too. The contract between firms and employees lasts for a fixed period (for instance two years). One month before the contract expiration, workers are engaged in a phase of wage bargaining with the firm, during which they can look around to seek for different contract conditions. During the bargaining period they try to fit the wage level offered with their wage expectations, and they can even become unemployed, according to a classical supply and demand dynamics. When they are unemployed, they can receive job offers, if there are firms searching for workers to assume. Workers are able to adapt their the wage level expectations (as said, they are mainly based on the workers’ qualification and thus on their life style) depending on the easiness to get a job and, if they have a fresh experience in a firm, comparing their expectations with the wage levels encountered at work.

2.1.2 Firms

Firms are created by individuals and they are a collection of workers, raw materials and equipment. They belong to different classes, final firms and semi-manufactured firms, according to the given division of labour and of production segmentation that characterise the ID (see below).

They can born, grow assuming new workers, downsize themselves firing workers, collapse, and go through the hands of the family heir. The corporate governance

structure is regulated by the traditional principles of the family ownership. The strategic, managerial and commercial control of a firm is in the only hands of the entrepreneur and of its successors, while the production is made by the workers.

The simulations used to test the model start with an heterogeneous population of individuals: some of them immediately create new firms. During the simulation lifetime, firms emerge with the transformation of an employee in an entrepreneur. A worker can become an entrepreneur if some conditions are present: i) he has enough resources to sustain the costs for setting up a firm and for starting the production processes; ii) entrepreneurship seems to ensure a certain degree of profitability, which is calculated by observing some data of the old employing firm, such as the storehouse cycle (if the cycle is quick and the storehouse is minimised, then the market is supposed to thrive); iii) the worker wage expectations point out a period of future stagnation, which is perceived as a mismatch between offered wage level and subjective aspiration's level in a phase of wage bargaining; iv) the employee perceives that, in other firms, other workers with similar status get higher wages than his own. Entrepreneurship thus depends on the intersection between a positive objective situation (market, resources, costs) and a supposed negative forthcoming personal situation. Furthermore, we assume that an employee, become an entrepreneur, starts a firm in the production specialization which he knows most.

The life of a firm is carried on by means of the articulation of different, interrelated and complementary functional areas. Areas are five and they are as follows: accounting, strategy, production, input-output, and human resources.

The accounting area has the function of recording data, storing up daily information about costs generated by other functional areas, and generating semester data, with a report that contains information about revenues from sales, operative costs, investment costs, and profits.

The strategy area has the function of developing strategic decisions built upon the information available. This area can take five kinds of decisions (a, b, c,...), basing the choice on the presence of some conditions (i, ii, iii,...), as follows:

a) Innovation through a technology break-up

- i) new technology available from external environment;
- ii) there has been a great variability in the profit dynamics of the firm in the last period of time (shortly, things are going too much well, or too much badly);
- iii) economic resources of the firm are much bigger than the requested to implement the new technology;
- iv) output storehouses are not full (shortly, an increase of productivity has no sense because there is no market for the good produced).

b) Investment in human capital training

- i) economic resources are available, that is to say they are much bigger than the costs of training, assuring the continuation of production in the near future;
- ii) there has been a light fall-off in profits in the last period of time considered.

c) *Employment of new workforce units*

- i) output storehouses are empty;
- ii) economic resources are available;
- iii) profits show a light fall-off in the last period of time considered.

d) *Discharge a workforce unit*

- i) there are more than one worker employed by the firm;
- ii) profits show a strong fall-off in the last period of time considered;
- iii) there are few economic resources, letting suppose that continuing production could be difficult in the near future.

e) *Liquidation*

- i) there are not economic resources, and maybe indebtedness;
- ii) there is a loss;
- iii) the loss amount is growing in the last period of time considered.

The switch among strategic options conforms to the principle that the area can take just a decision per time, and that, for instance, if all conditions for taking the first decision are satisfied, then the other options are not even considered. The period of time considered in conditions can be the last six months between the completion of two reports or the comparison of partial actual data with the last rectified.

The strategic option of technological innovation (option *a*, condition *ii*: “things are going too much well, or too much badly”) lays upon some well-known cognitive mechanisms. The Simonian view of bounded rationality in terms of aspiration level adjustments argues in fact that agents decrease their aspiration levels, and/or increase search, when alternatives become difficult to find. Vice versa, if it turns out to be easy to find alternatives, agents increase their aspiration levels, and/or decrease search (Simon, 1955; 1987). This well-known mechanism has been elaborated by many scholars within the decision making area, and revisited in the light of the relationship between the feedback of agents’ decisions and their aspiration levels (what is often called *ex-post* rationality). This perspective shows that agents have a tendency to reason by correspondence or by a similarity-based viewpoint, comparing performances of related kind of decisions. In a sort of analogy with the Simonian theory, the main consequence of this relief is that aspiration levels of agents are influenced by previous performances, through their perception of what can be viewed as a failure (performance worse than aspiration level) or as a success (performance better than aspiration level). The mechanism shows that agents decrease aspiration levels in case of failure and increase them in case of success (March, 1994; Elster, 1983). This scheme has also been enlarged to the main interesting situations, the boundary ones, i.e. when agents are facing deep failures or big successes (high discrepancy between performances and aspiration levels on both sides). In these situations things are observed to be not the

same as described. A frame which could be labelled as an “expanding model of satisficing search” (March, 1994) shows that when agents face deep failure, they increase aspiration levels by means of a risk taking attitude, which pushes them to select (accept) high levels of risk in order to increase chances to reach the target (for a socio-cognitive experimental perspective with various task environment scenarios, see Castellani 2003). At the opposite circumstance, in front of big successes, agents tend to take greater risks because they can count on what March himself defines “large cushion”, which in psychological terms recalls a sort “euphoria effect” (agents thinks that everything will go as well as it’s been going till now, despite high risk conditions) on one side, and, on the other, a mental condition that lead agents to underestimate the real “state of the world”. Although the two boundary conditions presents different characteristics (about the different aspiration adaptation, downward and upward, see Selten, 1998), both of them show that agents act by playing upon high risk levels and choose a critical alternative, and so they increase aspiration levels. In conclusion, in our prototype, agents innovate through a technological break-up, which stands for a reactive respond to performances driven by the mechanism above described.

The production area allows firms to regulate their production operations. If the output storehouses are not full and if inputs, raw materials or semi-manufactured products, are available (stored in the input storehouse), the production daily goes on. The production process consumes inputs and work, and uses the equipment available (from the productivity point of view, equipments are different depending on the technology adopted). It allows to transform all production inputs into finished products (final goods or semi-manufactured products), according to the characteristics of the technology used, the availability of workers and their productivity level, which is the outcome of their human capital accumulation. Every worker has his own capability to transform inputs in outputs, according to the past experience on the process and to the amount of training received, i.e. to his human capital accumulation level. Daily activities produce units of finished products that go in storehouses, whilst un-finished products are overcharged to the activities of the day after.

The input-output is the fourth area. It has specific competence on the management of storehouses of inputs (raw materials or semi-manufactured products) and outputs (final goods or semi-manufactured products). It manages the purchasing and the selling activities, according to the rules that characterise the specific markets in which the firm operates. The optimal and maximum dimension of storehouses depends on the type and dimension of firms (final or subcontracted firm), as well as on the number of employees (the firm adapt the dimension of storehouses to its size).

Final firms have threefold storehouses, according to the three kinds of semi-manufactured products that we assume are needed to be assembled to obtain a final good.

In the case of sub contracted firms, the area has the function of buying raw materials, whilst in the case of final firms it has the function of buying semi-manufactured products. While the price of raw materials is assumed to be exogenous and unique, because they come from a competitive market outside the ID, the price of semi-manufactured products is regulated according to a supply-demand dynamics emerging among firms, with a potentially unsteady price that goes up and down according to the degree of product availability.

The area sells products on markets, according to a threshold of price that fluctuates in accordance with the situation of the storehouses (prices levels demanded are higher if storehouses are almost empty, lower if they are full) and the operative costs of production.

The input-output area has moreover the function of buying new machineries when the decision of adopting a new technology has been taken.

The last area is the human resources area. It has the function of managing internal human resources, paying wages, employing new workforce units, discharging them, as well as organising training activities.

The recruiting activities follow market price dynamics. The salary policy of the firms is based on the interlacement among three mechanisms as follows: the productivity level of the applicant (that is a proxy of his human capital accumulation level), the technology actually used by the firm, and a multiplier that is modified by the market information. It gradually increases the availability of the firm to converge towards the expected level of wage of the applicant, if there have been difficulties to find new workforces, and decreases it, if the average level of wages offered by other firms is lower than its own (the other firms considered are the ones with which the company has recently had contact).

One month before the expiration of the agreement of work, the area notices it to the employee and offers a new agreement that should be higher than the older one, because of the supposed growth of human capital accumulated by the employee, over the period of work.

Finally, the training costs are assumed to be exogenous, unrelated to the number of employees that are trained, and the value of human capital generated by the training is supposed to be equal for all the employees which are involved in.

The representation of firms as a collection of different specific functional areas does not imply the assumption of the presence of specialised organisational structures and roles, or a division of organisational labour, as in the bureaucratic big business model.

It is rather as assuming that a firm, no matter what dimension it has, is a set of different but interrelated activities and practices that define its operational closure with respect to the environment and the plexus of its strategic decisions. For example, as several empirical investigations have pointed out (Albertini 2002), despite the familistic degree of their corporate governance structures, small and medium firms in IDs carry on human resource management policies, a strategy of human capital accumulation, even in absence of dedicated internal structures and specialised roles.

2.1.3 External Buyers

Outside the ID, there are many buyers in the global markets which are looking for ID final goods. They buy them from ID final firms, with specific expectations concerning the prices to offer. Buyers have an adaptive price level that they are able to offer to firms, and considering that these latter have also a dynamic demanded price level, the market of final goods results to be a competitive one, based on a supply and demand dynamics.

Everyday, a buyer can try to buy many products by ID final firms, trying to satisfy his need for goods. Buyers have a short memory of interactions, starting to explore the ID market by the final firms from which they have recently bought in the past.

2.1.4 Service Agency

Some exogenous services, needed by ID firms and bought in the global market outside the district, are offered in the prototype by a “meta-object” that is called “agency”. Its functions are related to a set of services, such as machineries, raw materials, and so on.

Prices for setting-up firms and for buying raw materials are somehow related to the inflation trends (in terms of the average market price of final goods), while prices of machineries and training courses are related to inflation and to the technological paradigm.

2.2 Driving Forces

2.2.1 Markets

The functioning of IDs is based on the overlapping of markets that show a different typology, according to the degree of influence and interdependence that agents can exercise each others, along the interaction that constitutes the matter of the transaction.

This is the reason why in the prototype there are three “many-to-many” and many “one-to-many” markets. The first type of markets includes:

- a) labour markets, which relate entrepreneurs and workers each others in job contracts (actors: firms in general and individuals);
- b) markets of semi-manufactured products, which relate firms each others along direct transactions of products (actors: firms producing final goods and firms producing semi-manufactured products);
- c) markets of final goods, which relate final firms and buyers each others, along transactions of products (actors: external buyers and firms producing final goods).

Transactions in these markets are not based on an exogenously settled price, but on an endogenous one determined by means of direct interactions among agents, according to a dynamic interface and a mutual influence among parts that are involved in the transaction.

The transactions in the second kind of markets (one-to-many) happen between ID firms and external service providers. They are based on a commonly known price, settled exogenously and thus ID firms can not strategically influence it. These markets are:

- a) materials markets, where raw materials are bought by firms producing semi-manufactured products;
- b) training markets, where training courses are offered to firms;
- c) machineries markets, where firms can find the equipment to adopt new technologies;

- d) set-up markets, where services in order to create a new firm are offered.

2.2.2 Technological Evolution

During the model lifetime, the technological paradigm is not static. But, looking at empirical studies on IDs, it is common to notice how the function of R&D of new technologies is outside the ID (Corò and Grandinetti 1999). IDs have no R&D functional structures or formalised activities, and thus ID firms buy technologies on global markets (Belussi and Gottardi 2000).

For these reasons, in our model the evolution of technology is exogenous and it is modelled as a random process that make available new technologies after “long” periods of time (the length of the time period is the random part of the process).

Each new technology available lets the firm potentially increase its productivity over the level possible with older technologies. But the process of adoption of a new technological paradigm is a long one because it is not just the fact of buying new machineries, but also the one of training the workforce to exploit them. Shortly: the adoption of a new technology could mean for a firm a short term decrease in productivity and a bigger increase on the long term.

Finally, new technologies give a potential increase of productivity that is not a fixed one: the amount of the increase is bigger for new technologies than for older ones.

2.2.3 Production Cycle and Chains

The ID production cycle lays upon a set of relations between outside markets and ID firms. The process of transformation of raw materials into finished products is what ID firms carry on, through a web of interaction that works according to a given division of labour among them (Carbonara, Giannoccaro, Pontrandolfo 2001). We assume the presence of four production activities. The first three concern semi-manufacturing operations, that is to say the transformation of raw materials into semi-manufactured products (thus there are three types of semi-manufactured products), while the last one concerns assembling functions, that is to say the final operation of assembling and making up the product to be sold in the market. This last one is the function of final firms.

The production cycle leading to a final good is made by two main steps. In the first one, a firm operating as a supplier of semi-manufactured goods, buys raw materials from external markets and using machineries and workforces transforms them in a semi-manufactured product of a particular kind. In the second step, a firm, operating as final good assembler, buys at least one semi-manufactured product for each type (thus at least one for each of the three types in the model) and then, using machineries and workforce, produces the final good.

The production cycle is depicted in figure 1, where also the external relevant markets are shown.

As a final remark, it is important to underline that firms, in the simulations used for testing the model, are specialised on a particular activity, thus they can be firms assembling the final good or producing one of the three semi-manufactured products. It

is a constraint that obliges firms to be specialized on a particular activity, but it can be removed, letting firms developing more production lines or merging other companies.

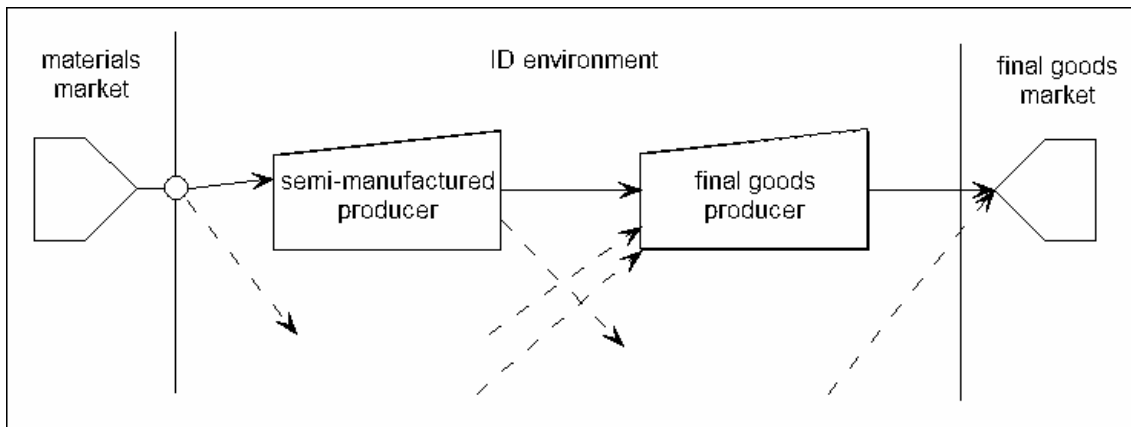


Figure 1. The production cycle.

The internal structure of the ID is dynamic and based on the exchange of semi-manufactured products. As said, these products are exchanged on a market generically driven by supply and demand. Firms assembling the final good have a short memory of past interactions, trying to find semi-manufactured products from their last supplier but, if they have failed to satisfy their demand with old suppliers, they search for new partners.

The market so sketched is a very competitive one and it is important here to underline how this is an option chosen for first tests of the model: for some IDs the internal market is more tied to the relational network that grows even outside the dimension of the “pure” economic rationality (Albino, Garavelli, Schiuma 1999; Dei Ottati 2002; Mistri and Solari 2001; Piore 2001; Squazzoni and Boero 2002).

2.2.4 Human Capital

Human capital is one of the main intangible asset that affects the path of economic development of local industrial areas (Storper 1995; Hand and Baruch 2003). Since the seminal writings of Alfred Marshall, it is argued that one of main essence of geographical clustering of firms can be found in the pooling mechanism of labour with specialised skills and knowledge accumulation (Becattini 1990). The literature has recently suggested some taxonomies of human capital mostly focused on the difference between generic and specific human capital, transferable and non-transferable knowledge (Becker 1993). To paraphrase the dichotomy suggested by Nonaka and Takeuchi (1995), codified knowledge concerns the formation of human capital by formal educational institutions, training, learning seminars, and so on, and is based on the transfer of highly manipulated symbolic knowledge. The latter concerns the formation of human capital by training on-the-job, direct mentorship among workers, learning by doing, and so on, and it is based on the transfer of specific tacit knowledge (Rullani 2002).

The case of labour market and inter-firm division of labour in IDs imposes strong limitations to the effectiveness of taxonomies above mentioned (for a critical view of these taxonomies, see Breschi and Lissoni 2001). Because of the complementarity-based production specialisation, the inter-firm labour mobility, the diffuse entrepreneurship, and so on, which characterise the IDs, the definition of transferable and non-transferable forms of human capital, as well as of codified and tacit knowledge, is a misleading one in a firm-level perspective of analysis (from firm to firm), while could be of a little help only if it is stated in a district-level perspective (from ID to external markets). For instance, fundamental knowledge of an ID could be rightly viewed as embodied into a tacit form of knowledge, but it is temporally and spatially transferred by means of labour mobility and relations among complementary specialised firms, as though it was codified by the language of the ID as a whole, as well as institutionally reproduced over time by means of specific institutional mechanisms working within the ID.

ID workers move within labour markets that are highly segmented by firms, because of the specialisation-based division of labour, but, at the same time, highly inter-connected by the homogeneous kind of production at the ID level. This coupled mechanism implies that workers can move along the segmentation levels of ID labour market, without losing human capital and competencies they created by work experiences within specific firms, as though they were moving within the internal labour market of a large firm (Cingano 2003).

According to this perspective, our understanding of human capital starts with the analytical distinction between two different but interrelated forms of human capital, a generic and a specific one. By means of a linguistic analogy, generic human capital could be conceived as the acquisition of the general grammatical rules that allow to develop a language, while specific human capital as a specific vocabulary that allows to initiate and carry on a specific sub-set of linguistic communications (a metaphor of production activities), which, in our case, are spatially and temporally bounded within the ID, that is to say what define the ID itself. The former is the context, while the latter is the text. The former matters as a set of background principles, while the latter matters as a set of specific and appropriate instructions. The former can be enacted just because it requests the latter, whilst the latter needs the former to be formulated in appropriate and inter-subjective forms.

The first one refers to background and highly symbolic knowledge. It can be acquired in different ways, both with formal education, life experiences and cultural interests. It is a background that supports the creation, and fosters the accumulation, of specific forms of knowledge.

The second one refers to a specific set of competence-based specialised knowledge, instructions, domain-specific rules, that need to be acquired, for example, to use and manipulate in appropriate ways specific technology machineries. It can be achieved both with training on-the-job and off-the-job. It can have a tacit or explicit dimension, and it can be transmitted by means of direct contacts and interactions (for example, mediated by mentorship relations) or through formalised media (for example, using a handbook, or attending a workshop). It grows and spreads because it directly enacts forms of pre-requisite background knowledge.

These different forms of knowledge interact each other over the job, moulding the level of human capital accumulation of individuals. It is usually assumed that, in the long term, a high level of accumulation of general human capital can foster the capacity of accumulation of forms of specific human capital, that specific human capital is closely related to technological learning and production activities and that it has a trajectory of growth, accumulation and dispersion that is closely coupled over time to cycles of innovation, exploitation and saturation of technological regimes which the firm moves within. Consequently, if generic human capital has a gradual and continuous positive accumulation over time and affects the level of specific human capital accumulation, as the experience of the worker cumulates over time, specific human capital accumulation conforms to the rule of decreasing returns and needs to be re-qualified according to specific technological trajectories defined by firm over time.

The cycle of human capital accumulation affects the professional trajectory of individuals and their level of productivity, connotes their position within the labour market, shapes their wage expectations in the phase of wage bargaining, and defines their lifestyle, affecting their cycle of economic resources accumulation.

Moreover, human capital is the principal intangible asset that affects the productivity of a firm as a whole, because it allows to tie technology absorptive capabilities developed by firm and productivity of organisational processes. It is one of the main object of policy of firms. Firm can choose to improve its human capital by organising training courses, while, at the same time, the level of human capital becomes the crucial item upon which firm selects the applicant for a job and a proxy used to regulate and redefine the condition of the internal job agreements, that is to say the functioning of internal labour markets.

It is worth to notice that, for the time being, at this level of the prototypic stylisation, we do not consider factors, such as the role of formal institutions (i.e., schools and educational institutes), both on the formation and accumulation of generic and specific human capital.

3. Some Hypotheses to Investigate

Simulations of the prototype should allow to investigate some hypotheses on the relations among waves of innovation, entrepreneurship and labour market dynamics in a local context, as follows:

- a) if firms work as a segmentation within labour markets, in the form of an operational closure between internal labour market and external labour markets, is there a relation between technology, innovation and labour market dynamics?*
- b) and consequently, is there a close relation between emergence of entrepreneurship, innovations and labour market dynamics?*
- c) finally, does entrepreneurship work as a driving force of adaptation of local markets with respect to global challenges?*

These are some questions we should begin to investigate with the simulation of the prototype. Basically, they imply to focus our view on the relation among some macro

emergent properties that the prototype allows to develop over time. But, there are a couple of more complex questions that we should be able to investigate, in a second time, too. They mostly concern the problem of the development of human capital in IDs, that is to say one of the most controversial issues in literature.

It is a matter of fact that, historically, forms of collective joint actions and local institutional engineering in IDs mainly apply to problems of “tangible assets”, such as technological innovation and transfer, marketing, legal and financial issues (Bianchi and Giordani 1993; Cooke and Morgan 1998; Glasmeier 1999; Helmsing 2001; You and Wilkinson 1994), and so on, rather than to “intangible assets”, such as knowledge and human capital management. Despite the fact that ID firms follow policies of human capital development, even if not formalised within specific and dedicated functional structures, they seem to be very far from recognising the relevance of structuring joint actions in the field of human capital development and management (Albertini 2002). Why ID firms effectively institutionalise forms of strategic cooperation, along specific segments of their business chain, but not on human capital development and management?

If a sound answer should be formulated only after a set of comparative empirical studies that overcome our work, we would contribute in the next future by offering a computational analysis of the ID mechanisms about the process of human capital development and management, with the aim to figure out an evaluation of the possibilities given by institutionalising such collective actions in IDs.

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