# A population ecology approach to capture dynamics of cluster evolution: Using computer simulation to guide empirical research[1]

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## Abstract
In this paper, we use the social capital theory to extend the topic about the evolution of industrial districts, aiming to verify whether or not social capital may be considered as a critical source in explaining the dynamics of population of co-localised organisations towards the phenomenon of passive internationalisation. The study explores these issues by analysing the pattern of fragmentation of production and the change of internal rules of actors inside a textile industrial district localised in the Center of Italy – Val Vibrata – after the "internal invasion" of foreign business players in different stages of chain value. We use these empirical data to calibrate a computer simulation model so to generate a number of near-histories that capture possible unfolding cluster dynamics.

## 1. Introduction
In the so-called "made in Italy" industrial districts, an increasing phenomenon of internationalisation and delocalisation of production emerges and has been examined by various studies in the last decade (Ice-ISTAT, 2004; Corò, Grandinetti, 1999; Caroli, Lipparini, 2002; Belussi, 2003). In fact, since the '90s many Italian districts from the textile-clothing, leather and footwear industries have started delocating their production abroad, while continuing with their internationalisation process through export strategy (Storper, 1997).

This results in a transformation of the industrial structure of districts as well as a territorial fragmentation of the previous local value chain (Porter, 1998, 2000). As a consequence, many of these traditional local systems have been characterized by a transition from an "internal to the district governance" of knowledge to a more open "globally integrated governance" (Belussi, Pilotti, 2002). In this scenario, Italian industrial district firms had to face the need to implement new strategies, realizing a re-configuration of inter-firm relationships and a complex international opening of business relationships, aiming to get a better control over foreign markets or foreign partners.

In this process of globalization, another correlated observable tendency is an increased number of competitive foreign business operators – small firms or multinationals - inside Italian traditional industrial districts (Cooke, 2002). This new development – so called *passive internationalisation* of Italian districts - gave rise to a potential conflict between the local system network and the newly-entered foreign business players, due to the integration, both economic and cultural- social, of the foreign actors into the consolidated local business systems. In other words, this is posing the question to which foreign business actors are value creating or value exploiting when they localise inside an industrial traditional district in our country (Lorenzen, Mahnke, 2002). In this sense, the relevant unit of analysis of a traditional district is neither the individual firm, nor always the local system of firms, but often extra-local production or global market (Maskell and Malmberg, 1999).

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How can we evaluate the entry of foreign different business actors in the Italian districts? Why were new foreign actors able to rapidly substitute for traditional old local operators? What is the likely evolution and underpinning dynamics of competition between the population of incumbent firms and population of new entrants? How did the entry of foreign firms change the model of traditional governance and development within the districts? The impact of this process is clearly ambiguous and difficult to judge (Feser, 1998). In fact, districts do not seem to be a dominant tendency, but rather different evolutions according to the case. Moreover, while de-localisation and active internationalisation have been shown to strongly influence the dynamics of evolution of industrial districts, there is much less empirical work focused on the analysis of the passive internationalisation in influencing the internal equilibrium of industrial districts (Dunning, 1999).

In this paper, we use the social capital theory (Granovetter, 1985; Lin, 2001; Nahapiet and Ghoshal, 1998) and population ecology dynamics (Hannan and Freeman, 1977) to interpret the evolution of an Italian industrial district. The paper addresses the emerging of different populations of firms and unfolding dynamics of cooperation and competition among the populations.

The study explores these issues by analysing the pattern of fragmentation of production and the change of internal rules of actors inside a textile industrial district localised in the Center of Italy – Val Vibrata – after the “internal invasion” of foreign business players in different stages of chain value, using longitudinal secondary data. This allows us to identify differences in the dynamics of four different co-localised population of organisations (local and foreign; manufacturers and suppliers), considering social capital as the potential explicative factor of these different evolutions.

We use computer simulation to stimulate a dialogue between available empirical data and theory. We use longitudinal data on an Italian cluster in the textile industry to articulate hypotheses on the role of relational capital in explaining the dynamics of population of organisations. Grounding on computer simulations, we speculate on how different contextual conditions and policies may generate different histories.

## 2. The Recent Evolving Trends of Italian Traditional Industrial Districts

Since the '60, the Italian business system has developed specific features which have determined an industrial model based on a significant presence of small and medium firms specializing in different traditional productions. In this context, industrial districts have become more and more important in explaining the competitiveness of small firms and the strengthening of the international expansion of the Italian production system (Brusco, 1986; Beccattini et al., 1987).

Within the district or cluster literature (Enright, 1995; Hill, Brennan, 2000; Porter, 1998, 2000), it is a generally accepted that “cluster embeddedness” allows a firm to take advantage of a number of cluster related externalities, which have a positive impact in its competitiveness and international presence. Such externalities include, for instance, the firm’s access to a specialized labour force or to specialized technological and administrative services, or even to several marketing complementarities (Porter, 2000). This, in turn, tends to increase industrial district firms’ ability to manage information flows and speed up knowledge and innovation spillovers (Jaffe et al., 1993).

The efficiency and flexibility characterizing the organizational pattern of an industrial district have reinforced its international expansion, especially in the terms of a strong vocation to commercial export or to production de-localization. The contribution of district firms to internationalization has increased rapidly throughout the last twenty years in different countries (Putnam, 1993; Hill, Brennan, 2000), but it has reached a significant level in our country, since almost two thirds of Italian exports stem from districts (Fortis, 2004).

This “global” pattern appears to be strongly consistent with the traditional sectors of our economy (so-called “*made in Italy*” industrial districts) (Caroli, Lipparini, 2002; Belussi, 2003), such are the textile-clothing, leather and footwear industries. In particular, the textile sector - concentred inside well-known local industrial clusters - is one of the traditional manufacturing sectors in which both at national and international level, Italy seems to have a strong comparative advantage. Contrary to what is generally supposed in the literature, data from textile industrial districts show that in our country, production delocalisation and internationalisation process are not only realized by large firms able to create new direct investments in other countries (through FDI), but also by a high number of co-localised small actors in traditional sectors that use foreign subcontractors (Coriello, Munro, 1999). Along this vein, studies have identified a number of positive externalities that “cluster embeddedness” may have on the internationalization and de-localization processes of small firms (Porter, 1998, 2000). In fact, the district may represent not only a “facilitating environment”, but also a subject capable of its own collective internationalisation process (Brown, Bell 2001; Porter, 1990), seen in terms of exploitation of both firm and territorial advantage to expand into foreign markets (Enright, 1998; Storper, 1992).

The acceleration of this international presence can be explained by the evidence that in the textiles industry, firms have experienced a constant increase in productivity, making it less necessary to contain labour costs (Storper, 1997). Of course, also the Italian textiles industry suffers from competition from low-wage countries and in the last ten years the de-localization of production in these countries has unexpectedly increased. As a consequence, textile production - part of international production systems - has become increasingly fragmented across different countries, creating a transformation of the industrial structure of districts as well as a territorial fragmentation of the previous local value chain (Porter, 1998, 2000).

In this globalization process of economy, another observable correlated tendency is an increased number of competitive foreign business operators – small firms or multinationals – localised inside a lot of Italian textile industrial districts (Cooke, 2002). The presence of consolidated skills or profitable knowledge inside a specific area may be the significant factors useful to explain the localization choice of other foreign firms in the same geographic context (Dunning, 1999). The importance of such factors in explaining the foreign firms’ localization choices inside industrial clusters is confirmed by recent investigations in our country. They highlight foreign firms’ propensity to concentrate investment inside consolidated industrial clusters, where a competitive setting similar to their home country’s is perceived as a factor useful to reduce the uncertainty involved in international operations.

However, this new development – so called passive internationalisation of districts - gave rise to a potential conflict between the local system network and the newly-entered foreign business players, due to the integration, both economic and cultural- social, of the foreign actors into the consolidated local business systems. In other words, this is posing the question to which foreign business partners are value creating or value exploiting when they localise inside an industrial traditional district in our country (Lorenzen, Mahnke, 2002). The impact of this process is clearly ambiguous and difficult to judge (Feser, 1998), since textile districts are experiencing dramatic changes too. However, there does not seem to be a dominant tendency, but rather different evolutions according to the case (Lane, 2002). Moreover, while de-localisation and active internationalisation have been shown to strongly influence the dynamics of evolution of industrial districts, there is much less empirical work focused on the analysis of the passive internationalisation in influencing the internal equilibrium of industrial districts.

## 3. The social capital theory

### 3.1 Social capital and industrial districts

In this paper, we use the social capital theory (Granovetter, 1985; Lin, 2001) to extend our knowledge about industrial districts evolution, aiming to verify whether or not social capital may be considered as a critical source in explaining the dynamics of population of co-localised organisations towards the phenomenon of passive internationalisation.

How can we evaluate the entry of foreign different business actors in the Italian districts? Why did new foreign actors may able to substitute in short times to traditional ancient local operators? How did the entry of foreign firms change the model of traditional governance and of development within the districts? Discussing about these subjects, we are particularly interested in determining whether social capital or social network based explanations of the cluster advantage are relevant inside an Italian textile industrial districts. Do local business actors inside clusters develop richer social cooperative relationships due to their joint location, and do these relationships help their probability of success in the strong competition with foreign partners localised inside same area?

Our idea is based on a sociological approach to industrial clusters, which considers social capital as a significant factor in reinforcing the development of co-localised activities (Aldrich, 1999; Sorenson, Audia, 1990). The importance of social capital in explaining the dynamics of evolution of industrial clusters is strengthened by several recent empirical studies which have strongly denied the image of co-localised actors as atomistic actors (Yli-Renko et al., 2001), since these actors are embedded in different social and professional networks with other co-localised business partners (Gorden, McCann, 2000). According to this approach, the peculiar characteristic of a cluster is the strong tie between social and economic elements and the co-localised firms don't represent only the whole of the production unit. Thus, clusters reflect not simply an economic response to the pattern of profitable opportunities and complementarities, but also a peculiar level of relational embeddedness and social identification (Gordon, McCann, 2000).

Sociological analyses focus on how cultural similarities, durable forms of interaction, familiarity and interdependence among close actors, allow local partners to create high levels of social capital in the networks with their co-localised partners (Saxenian, 1994). In fact, networking and cooperation have frequently been suggested as one source of productive advantage in clusters (Cooke 2002) and many authors have suggested that geographic proximity creates significant opportunities for face-to-face learning and the development of trust (Lorenzen, 2002). It is precisely in this type of "communication" that geographic concentration of activity provides a distinct advantage and it differentiates inside and outside social relationships (Maskell, Malmberg, 1999). A local culture with specific norms, values and networks fosters the tacit knowledge transfer between co-localised and close actors, in comparison with external business partners. Thus, local actors prefer to create networks and to realize business exchanges with other local partners, considering external actors as threats to system economic equilibrium or even a deviation from the ideal type (Lin, Cook, Burt, 2001).

### 3.2 Conceptualization of social capital construct

Although a growing group of researchers is now using social capital in the industrial clusters topic, consensus on the definition of this concept has yet to be established. Really, studies arrange that social capital is a valuable asset which stems from the access to resources that it engenders through an actor's social relationships (Granovetter, 1992). For our purposes, in this paper we adopted a personal elaboration of Lin's (2001) view of social capital. We consider it as the "resources embedded in social structure of relationships between co-localised business partners, which are accessed and/or mobilized to reinforce the local business activity in respect to the threat of passive

internationalization". By this definition, the notion of social capital contains three ingredients: resources embedded in a social structure of local relationships, accessibility to such social resources by local actors, and use or mobilization of such social resources by these local actors for profitable actions. It suggests to consider social capital as an asset useful to reach strategic aims of different local actors. Moreover, we prefer to consider social capital as a multidimensional complex construct. In fact, this study is built upon Nahapiet and Ghoshal's (1998) three dimensions of social capital – structural, relational and cognitive. The structural dimension includes the total number of social interactions of a focal actors (Burt, 1992). It may be conceptualized as the knowledge embedded in the social structure of networks of a local business player, useful to its personal aims. The relational dimension refers to qualitative assets that are rooted in relationships of a local actor, such as trust and trustworthiness (Fukuyama, 1995; Putnam, 1993). The cognitive dimension is embodied in attributes like a shared code or a shared paradigm facilitating a common understanding of collective goals and proper ways of acting inside an industrial district (Portes and Sensenbrenner, 1993).

Studies consider several factors able to influence the social capital development. Different studies shared the idea that both the time of interaction and the length of relationships may have a positive impact on social capital development (Bourdieu, 1982; Brass, Labianca, 1999; Coleman, 1988, 1990). In fact, long and durable relationships may stimulate both trust and trustworthiness between partners, since trusting relationships evolve from social interactions (Gabarro, 1978; Granovetter, 1985; Gulati, 1995). As two actors interact over time, their trusting relationships will become more concrete, and the actors are more likely to perceive each other as trustworthy (Tsai, Ghoshal, 1998; Nahapiet, Ghoshal, 1998). Moreover, durable social interactions may improve the development of a common set of goals and values among involved actors, based on shared interests and mutual understanding (Larson, 1992; Nooteboom et al., 1999). Common values and shared visions promote the development of trust relationships, reducing the possibility of opportunistic behaviours (Barney, Hansen, 1994; Ouchi, 1980). When common values and goals organization members are inclined to trust one another, they can expect that they all work for collective aims and will not be hurt by any other member's pursuit of self-interest (Tsai, Ghoshal, 1998). Along this vein, the proximity between business partners, the affiliation of a same cultural setting, a significant level of personal knowledge inter-partners, improving the possibility of interaction and the time of network development, become the significant factors in social capital creation and development (Bagnasco, 2000; Chandler et al., 1998; Sorenson, Audia, 1999). Thus, an industrial cluster, for the features illustrated above, is the ideal context to social capital diffusion among local partners (Saxenian, 1991; Cohen, Fields, 1999). While these different aspects have been shown to positively influence the relational and cognitive dimensions of social capital, there is much less agreement among researchers in considering their impact on structural dimension of social capital (Dunning, 1999). Many authors affirm that frequent and durable relationships between close business partners let these actors to know each other and to share significant information or idea (Grabher, 1993), reinforcing the reciprocal knowledge exchange useful to reach a lot of different personal aims (Bourdieu, 1982; Coleman, 1998; Deeds et al., 1999). Many others, on the contrary, suppose that durable, close, local, deep and high-trust relationships, are negatively critical to provide a better conduit for actually transferring and exchanging complex ideas and knowledge between partners (Burt, 1992; Uzzi, 1997; Gargiulo, Benassi, 1999; Granovetter, 1992). These studies (Yli-Renko et al., 2001) show the presence of information redundancy within such "strong" business ties (Boari, Presutti, 2004) – that are durable and trust-based - and consequently the difficulty of new valuable information diffusion inside this type of networks (Uzzi, 1997). Along this

perspective, a strong embeddedness inside an industrial district may isolate local partners from external relationships and so from new sources of knowledge and information.
In this paper, we prefer to consider together the relational and cognitive dimension, measured by relationship quality indicator (Tsai & Ghoshal, 1998; Yli Renko et al., 2001), according to the literature about social capital and trust (Uzzi, 1997; Tsai, Ghoshal, 1998; Nooteboom et al., 1997), which supposes that the sharing of common aims among partners in a relationship can be facilitated by the development of trust, which in turn encourages the sharing of aims and values. Specifically, on our analysis, this indicator measures the level of personal knowledge between co-localised partners and the level of trust within a network (sharing of common expectations and aims, lack of opportunistic behaviour, development of informal relationships). The structural dimension is measured by "network ties" indicator between business partners (Yli-Renko et al., 2001). This indicator represents the level of relevant information and knowledge embedded in a relationship between business actors.

## 4. The empirical context: Val Vibrata District

The textile sector is one of the traditional manufacturing sectors in which at national level, Italy has a strong comparative advantage. Textile production is highly concentrated in a few regions: Lombardia and Emilia Romagna in the North, Tuscany, Marche and Abruzzo in the central part of Italy, Campania and Puglia in the South. In these regions, the textile sector is geographically concentrated in restricted geographical areas, comprising a few small towns and villages. Specifically, our study explores the issues illustrated above by analysing the pattern of fragmentation of production inside a textile industrial district localised in the Center of Italy after the "internal invasion" of foreign business players in different stages of chain value, using longitudinal secondary data. In fact, the field setting of this research consists of a geographical cluster of micro and small firms in the textile industry localised in the Abruzzo Region, about 14 kilometres from the Teramo province, called Val Vibrata District.
During the years, the firms localised in this restricted context gave origin to an homogenous agglomeration, which represents today a significant example of a textile cluster in Italy with a positive development trend. Actually, about 1163 small and medium-sized firms, which employ around 14000 workers, are located in this area. This district features a long and interesting history of textile activity. For thirty years (1960-1990) the district underwent a relevant number of transformations, providing new models both of structural organization and of strategic pattern of growth. At the same time, it continued to represent a profitable context of diffused industrialization in the Centre of Italy. These positive conditions changed in the course of the 1990s, after the irreversible "invasion" of foreign business actors in different stages of value chain. In fact, since 90' this district has been characterized by the passive internationalization process realized by a large number of Chinese actors, operating in the same business landscape but with more competitive conditions. As a consequence, this district has become increasingly fragmented across business actors of different nationality, creating a transformation of its traditional and consolidated internal industrial structure as well as a territorial fragmentation of its previous local value chain.
The Val Vibrata district of textile industry came into being after 60'. In terms of growth rate, the 1970s represent the period of greatest expansion, with local employees increasing from 10.000 in 1960 to 15000 in 1975, and with total co-localised firms from 900 to 1100 in the same period. The process of division of labour among local firms can already be found in this phase of setting up of the district, and the way this system of production realized shows how it depends on processes of outsourcing of production or stages by large firms located elsewhere.

In fact, the effect of the outsourcing strategy implemented by large and well known firms in clothing industry on the growth of Val Vibrata district is clearly visible. In order to meet the demands for flexibility due to the greater instability after oil shock in 1973, many larger producers in this sector, especially concentrated in the North Italy, relied more and more on outsourcing and concentrated their in-house resources on design, marketing of finished products and co-ordination of outside production. These firms, which have experienced a constant increase in productivity, making it less necessary to contain labour costs, started to formalize a significant number of contracts with a few medium firms previously sorted in the Val Vibrata Area, such as Wampum or Casucci.

As a consequence, in this area there was an increase in the number of subcontracting firms specializing in different production stages of textile industry. The firms that started up in this period in the district were not isolated firms; right from their inception they were characterized by specialization in various stages of the production cycle and by their close relations with each other. The local network tends to organize around one or several medium or large-sized lead firms, strongly dependent on needs of external large firms in the North, which often introduce almost hierarchical control linkages in the system, and owing to their greater ability to work out strategies and to manage market relationships are often playing the role of “innovation agents” in the district (Lorenzoni, 1997). The organization of local production, based on the shared division of labour among the firms, offered the possibility to achieve very high levels of flexibility and efficiency, even in small runs and products variable in time. This period is characterized by the creation of a network of extremely specialized and well organized firms operating in different stages of production value.

Specifically, the district firm population is based on final firms (branded and non branded final producers) and specialised suppliers devoted to labour-intensive phases subcontracting (textile cutting firms - yarns, woven fabrics, knitwear- and wrapping specialized firms). The final firms are in average characterized by medium size, the subcontractors normally are small firms. In this period, it seems to be a Marshallian industrial district, where production is fractionated into a myriad of small and medium size firms, and where activities are organised on the basis of a shared division of labour among partners. Consequently, the relationships between these actors are characterized by high levels of social capital: significant exchanges of knowledge, informality during the business activity management, high levels of reciprocal trust, are the interconnected factors able to differentiate and feature this business local network of relationships towards other territorial contexts.

This situation of internal equilibrium changed in the course of the 1990s, because of the rapid localization inside this district of a lot of small foreign specialised suppliers devoted to labour-intensive phases subcontracting. It begins a strong competition between local and foreign suppliers in a same restricted area. With regard to the local system development, the spread of these small foreign actors has contradictory implications. On the one hand, it ensures a further competitive supply of labour in textile manufacturing which becomes a profitable factor to reinforce the production capacity and the distribution competencies of the local medium final producers. In fact, these firms may reinforce the contractual force towards their external buyers firms. Moreover, the presence of these new competitive players allows cluster to reach high level of performance, trough an increase of total sales. By contrast, during this decade, the local firms were subject to very extensive downsizing: there was a sharp fall in the number of firms and employment, and the local industry lost importance with respect to other manufacturing activities in the Abruzzo region. The subcontracting firms lost about 2000 employees from 1990 to 1998. In the same period, in the final firms many more jobs were lost, down from 8000 at the start of the period to 6700 at the end. A strong loss of employers is especially significant in the final local producers

and in the wrapping industry specialized firms. Up to the beginning of 2000s, the process of substitution of foreign players with local traditional actors is strong especially for the small subcontracting firms and not for the final producers, as results from different rates of firms failed in this period according to different analyzed stages of chain value. In this period, a second form of social capital between local final producers and foreign subcontracting firms begins to create. It seems to be characterized by less cognitive identification between partners tied by not-trusting relationships. They result engaged in relationships conditioned by reciprocal interests and opportunism, without a real knowledge exchange. Probably, the origin and affiliation in different contexts becomes a real obstacle to social capital development.

Today, the cluster is characterized by a high number of foreign players, specialized both in the final production and in the intermediate phase of textile value chain. These partners are frequently integrated, creating a threat for a lot of local old operators, since they seem industrial local district value exploiting. Thus, this new development rises to a strong conflict between the local system network and the newly-entered foreign business players, due to the integration, both economic and cultural- social, of the foreign actors into the consolidated local business systems. An other form of social capital among foreign players now localized in the Val Vibrata District is realizing. It is characterized by high levels of reciprocal trust and cognitive identification between foreign partners, able to create a familiar model of network relationships in a different socio-economic setting. At the same time, the final local producers have responded to the crisis of internal equilibrium in various ways: by changing output and markets, changing sales strategies, and reorganizing the outside production. Under pressure from price competition by co-localised foreign partners in the lower segments of the market, a lot of these firms shifted towards products of higher price/quality, offering a wider variety of products with own brand. Moreover, they turned increasing attention towards the international markets in the terms of production de-localization in order to monitor their costs. In this situation, a few old local survivor suppliers are integrating with local final producers. Consequently, the social capital between local final producers and foreign suppliers has become more and more less strong. Despite the co-localization in a same local context, for these players it results difficult to share aims and create reciprocal trust.

Table 1 summarizes a personal elaboration of social capital development between these four different populations localized in the Val Vibrata District, according to different stages of its growth during the years. Graphs 1 and 2 depict substitution dynamics among populations of Italian and Chinese suppliers (graph 1) and final good producers (graph 2).

Table 1

| **Years** | **Type of population** | **Type of social capital** | **Social capital features** |
|---|---|---|---|
| 1960-1980 | Local final producers Local suppliers | CS1 | CS1: High levels of trust embedded in the relationships; cognitive identification; significant knowledge transfer; informality; familiarity. |

| | | | |
|---|---|---|---|
| 1980-1990 | Local final producers<br>Local suppliers<br>Foreign suppliers | CS1<br>CS2 | CS2: (foreign suppliers and local final producers): low trust; instability; opportunism. Cultural distance.<br>CS1: similar features of 1 stage but with some elements of uncertainty. |
| Since 90’ | Local final producers<br>Local suppliers<br>Foreign suppliers<br>Foreign final producers | CS1<br>CS2<br>CS3 | CS3: High levels of trust, reciprocal solidarity, knowledge transfer.<br>CS1: Stronger than previous stages. Integration between partners.<br>CS2: Higher than previous stage. |

**Figure 1**

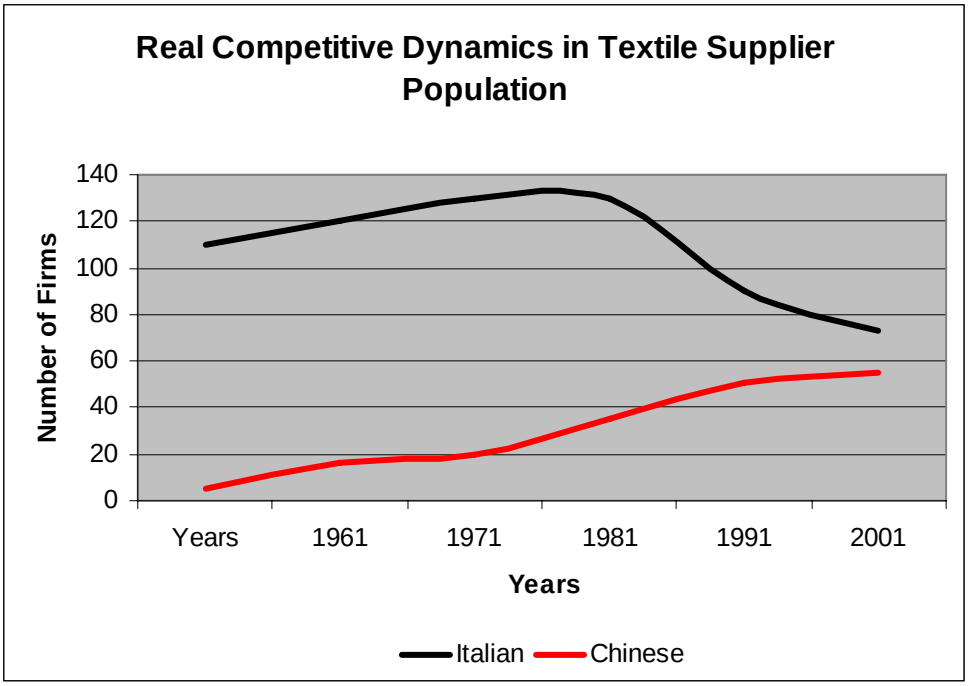
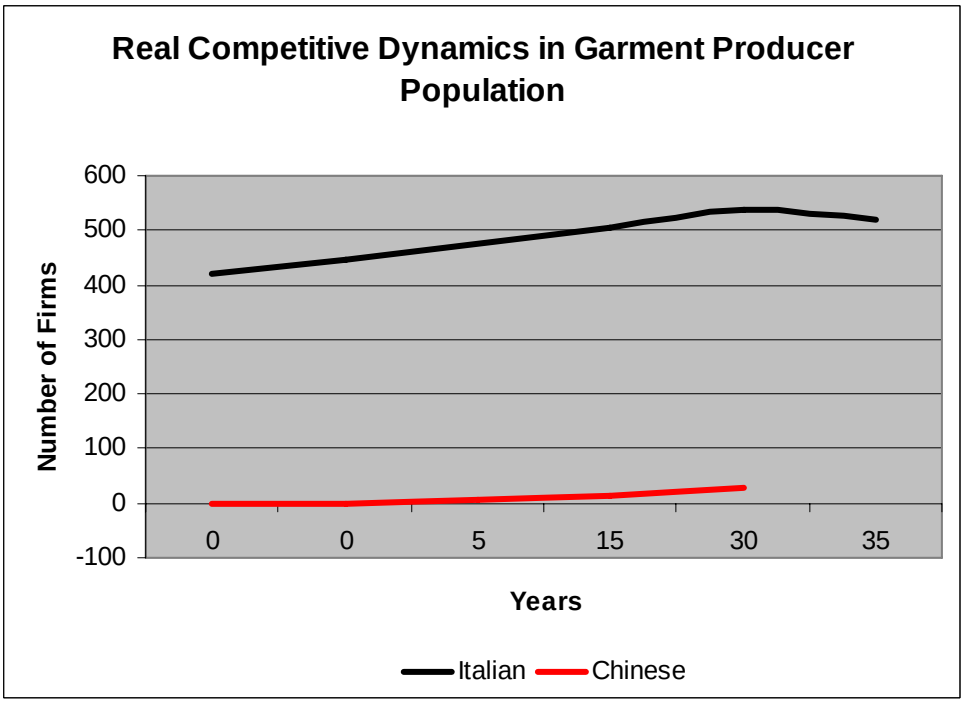



**Figure 2**




## 5. Methodology

We use empirical data generated in-depth field study to articulate hypotheses on determinants of cluster dynamics and to calibrate a computer simulation model. We generate a number of near-histories that capture possible unfolding cluster dynamics. In particular, we use computer simulation to generate hypotheses on how relational capital, which is built up as a consequence of the continuity of a commercial relationship, influences competition and, thus, moulds the evolving dynamics of populations of firms that operate within a cluster. Our research strategy is to capture and model key traits of

relational capital dynamics and plausible causal relationships. Using computer simulation, we deduce plausible unfolding competitive dynamics and compare the simulations with empirically observed trajectories. The comparison support speculation on how the plausible causal structure defined may explain a number of unfolding behaviours.

## 6. The model

To model competition among populations of suppliers and finished goods producers within an industrial cluster, we adopt an ecological point of view. Finished good producers within an industrial cluster create a resource niche for competing populations of suppliers. Suppliers that originally belong to the cluster and suppliers that start to enter the cluster are considered different populations since they show different selling prices and have built different relational capital therefore they ground their strategy on different competitive advantage and differently react to exogenous environmental dynamics. On the other hand, finished goods producers, both originally belonging to the cluster and arriving from outside the cluster, are two different populations of organisations, which operate with different costs and selling prices but impinge in the same niche of resources.

Thus, grounding on Hannan and Freeman modelling (1977), we use the equation $\frac{dPop_i}{dt} = g_i \cdot Pop_i \cdot \left( \frac{r - c_{ji} \cdot Pop_j - Pop_i}{r} \right)$ to describe competition among populations of both suppliers and finished good producers. In the equation, *i* and *j* represent competing populations, $g_i$ is the rate of growth of population *i*, *r* is the resource available in the niche in which the two populations *i* and *j* are competing and $c_{ji}$ is the competitive aggressiveness of population *j* on population *i*. The competitive aggressiveness can be considered as the probability that a member of population *j* beats a member of population *i* in acquiring resources. Thus, had *c* to be equal to1, population *j* will always be more competitive than population *i* in acquiring scarce resources.
More precisely, *r* is described as the number of firms that are clients of the populations within the same niche. Therefore, if we call $Pop_{s1}$ and $Pop_{s2}$ two populations of suppliers that belong to the same niche, $Pop_{fg1}$ and $Pop_{fg2}$ two populations of finished good producers that belong to the same niche, and *u* number of firms that represent final users of the product, the rate of growth of the four populations is modelled as:

$$\frac{dPop_{s1}}{dt} = g_{s1} \cdot Pop_{s1} \cdot \left( \frac{(Pop_{fg1} + Pop_{fg2}) - c_{s2s1} \cdot Pop_{s2} - Pop_{s1}}{(Pop_{fg1} + Pop_{fg2})} \right) \quad (1)$$

$$\frac{dPop_{s2}}{dt} = g_{s2} \cdot Pop_{s2} \cdot \left( \frac{(Pop_{fg1} + Pop_{fg2}) - c_{s1s2} \cdot Pop_{s1} - Pop_{s2}}{(Pop_{fg1} + Pop_{fg2})} \right) \quad (2)$$

$$\frac{dPop_{fg1}}{dt} = g_{fg1} \cdot Pop_{fg1} \cdot \left( \frac{u - c_{fg2fg1} \cdot Pop_{fg2} - Pop_{fg1}}{u} \right) \quad (3)$$

$$\frac{dPop_{fg2}}{dt} = g_{fg2} \cdot Pop_{fg2} \cdot \left( \frac{u - c_{fg1fg2} \cdot Pop_{fg1} - Pop_{fg2}}{u} \right) \quad (4)$$

To model the competitive aggressiveness, we use a weighted average of the impact on competitiveness of price and relational capital. The idea is that firms compete on two dimensions. First, they compete in term of pricing. Second, they compete by building

relational capital between actors that at different stages of the production chain. Therefore, in the model, different emphasis that, within a niche, is posed on price elasticity or on social relations and trust, determines the different aggressiveness of a competing population. The more a niche regards as important to build and sustain trust and social relations with suppliers, the less importance will be given to price differences. In other words, firms may be ready to pay a bit more for their supplies in order to maintain a trustable commercial relation. Thus, $c_{ji} = k_{ji} \cdot \phi + p_{ji} \cdot (1 - \phi)$ and $0 < \phi < 1$ where $\phi$ is the weight assigned to trust in commercial relations, $k_{ji}$ and $p_{ji}$ are the differential advantage of population *j* on population *i* in terms of, respectively, relation capital and price. The relational capital advantage $k_{ji}$ is modelled as the ratio $\frac{k_{ji}}{k_{ji} + k_{ij}}$ ; thus, if, for example, $k_{ij} = 0$, meaning that population *i* has not built trust with the population of clients, the ratio will have the value of 1, entailing that population *j* will have very strong survival advantage in niches in which trust is important. On the other hand, $p_{ji}$, the differential advantage in price is calculated as $c_{ji} = \frac{p_{ij}}{p_{ji} + p_{ij}}$. The formulation implies that the competitive aggressiveness of population *j* increases as the average selling price of population *i* exceeds average selling price of population *j*. Had average selling price of population *j* to be equal to zero, its competitive advantage will tend to be equal to 1, meaning that any member of population *j* has a competitive advantage on any member of population *i* in acquiring scarce resources.

Finally, we included in the model a formulation to mimic the accumulation of relation capital. In the model, relation capital and trust between two populations of commercial partners develops as a function of time, cultural distance among the populations and the stock of trust itself. Thus, the formulation is $\frac{k_{ji}}{dt} = d_{ji} \cdot k_{ji}$, where $d_{ji}$ is the cultural distance between the two populations.

## 7. Discussion on simulation experiments

In the simulation experiments, we grounded the setting of parameters on the collection of empirical data and, where these latter were missing, by using plausible values[2]. As shown in graphs 3, 4, 5, 6, 7 and 8, the model is able to provide a fairly good replica of the real phenomenon under study. Yet, the behaviours shown in the graphs are dependent on the parametrisation of the model. Thus, in our approach, we speculated on what happens if we change parameters. If, for example, by changing a model parameter, we produce behaviours that do not correspond to real data, it means that the explanation that we propose the parameter is key and we need to collect further information on the parameter and the causal links in which the parameter is involved. On the other hand, if we need to use strange parameters to obtain behaviours similar to the real data, this suggests that we need to close scrutinise the causal explanation involved with further interviews and data collection. In other words, simulation experiments help to envision and highlight new area for further empirical research. More specifically, our experiments highlighted three key areas for further analysis.

[2] Parameter values are in table A in the appendix.

First, we noticed that was very difficult to create a model that produces the substitution dynamics empirically observed among populations only modelling price differences among populations. The speed at which a population invades the niche of another population depends on the dynamics of relational capital. More precisely, price differences alone is not enough to explain the empirically observed substitution dynamics between the population originally located in the area and the population newly arrived, unless a large, not necessarily plausible, differences in selling prices is assumed. In this respect, the simulation experiments help to reveal the role played by an hidden variable, the relational capital.

Second, given that finished good producers population, is much greater than suppliers' one, predation and substitution takes place only if the average size of textile supplies on the side of finished good producers is smaller than the average production capacity of textile producers. In this case, competition pressures would put the two populations of suppliers in direct competition. Second, substitution can be equally obtained by assuming that a portion of finished good producers import textile from another population that is geographically located outside the area.

Third, in the experiments, substitution dynamics depends on the assumptions we make on demand elasticity to price. For example, if we imagine that a number of finished good producers decided to adopt a quality strategy in order to decrease elasticity, then these producers would probably want to increase the quality of textile supplies. As a consequence, the elasticity to price would decrease in the upstream populations as well. A number of Italian textile suppliers would survive even maintaining an higher prices for their supplies. If this is the case, why we observe the substitution and the decrease of the number of Italian textile suppliers? The model explains the phenomenon in two ways. The first explanation deals with the fact that the hypothesis would ask for a revision on the size of competing populations since a niche would emerge in which competition is weaker. Yet, in the rest of the population, the competition would very strong. In this case, the Italian textile suppliers that survived are only the firms that produce better quality product for a specific downstream market. On the other hand, the decreased number of Italian textile suppliers might be explained by the fact that those downstream firms that diversified their products, decided to integrate their suppliers.

**Figure 3**

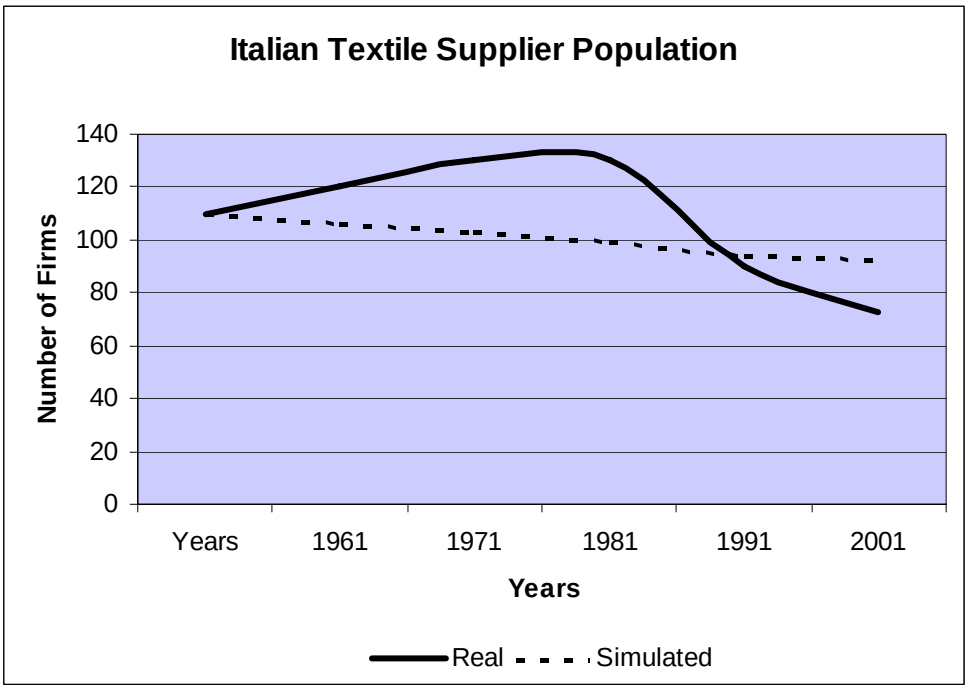



**Figure 4**

**Figure 5**

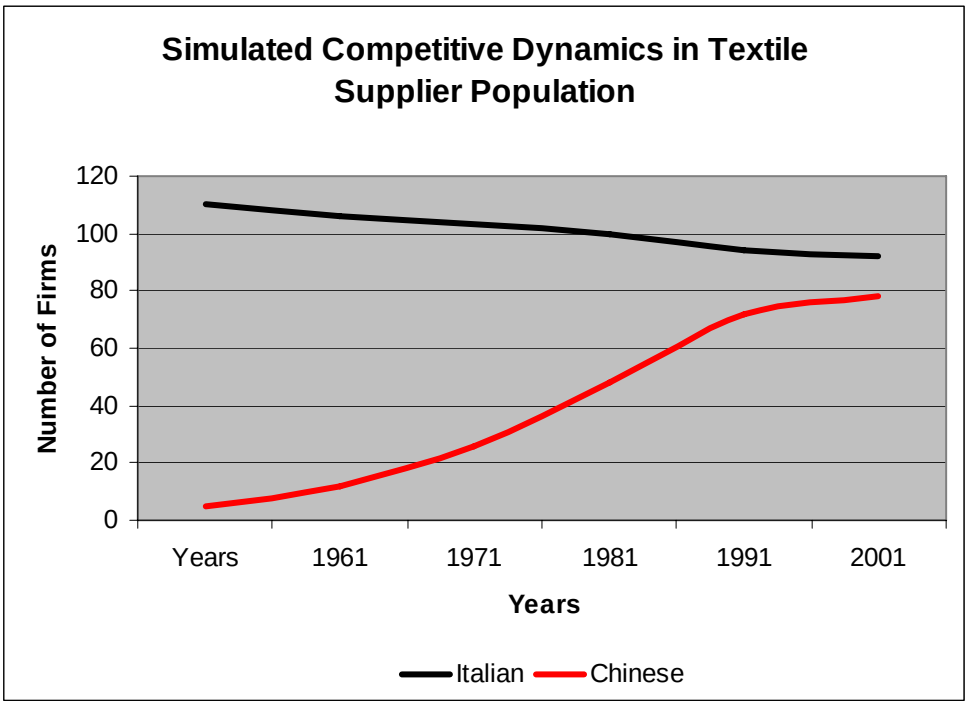



**Figure 6**

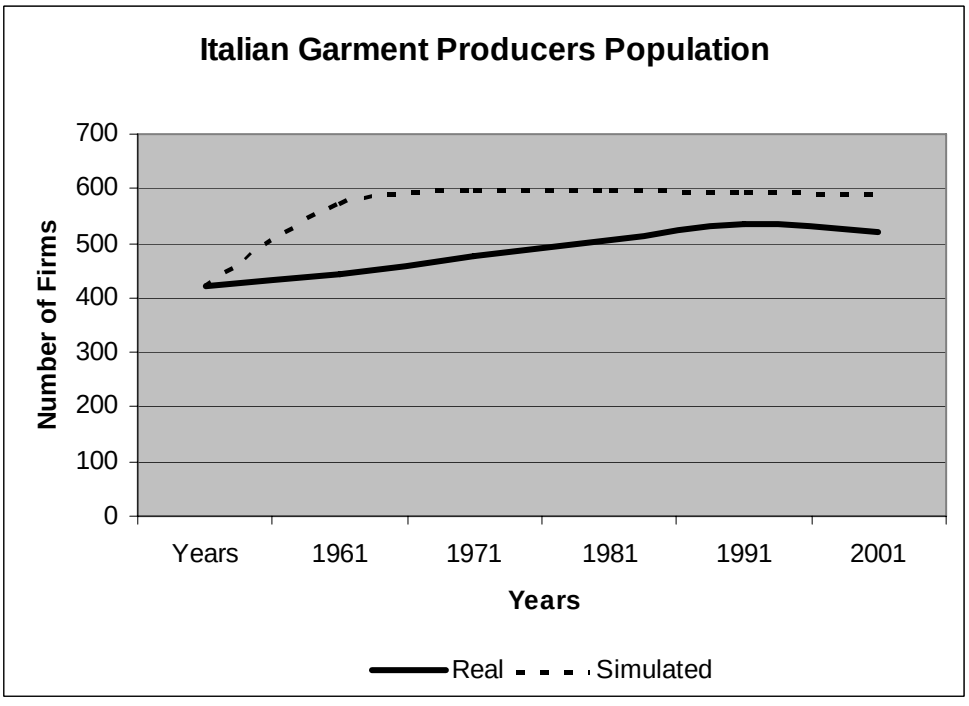


**Figure 7**

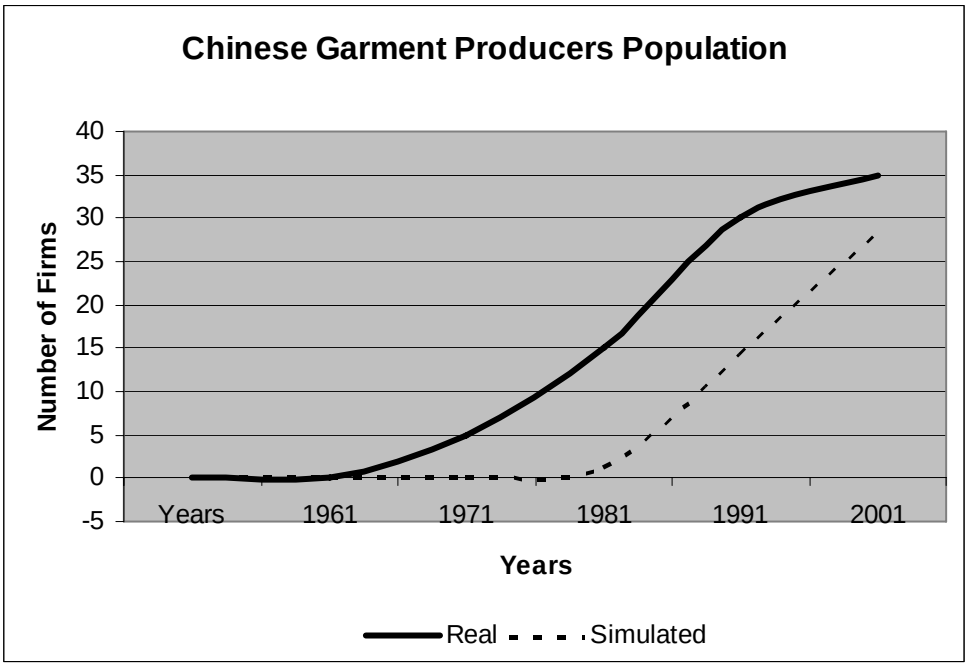
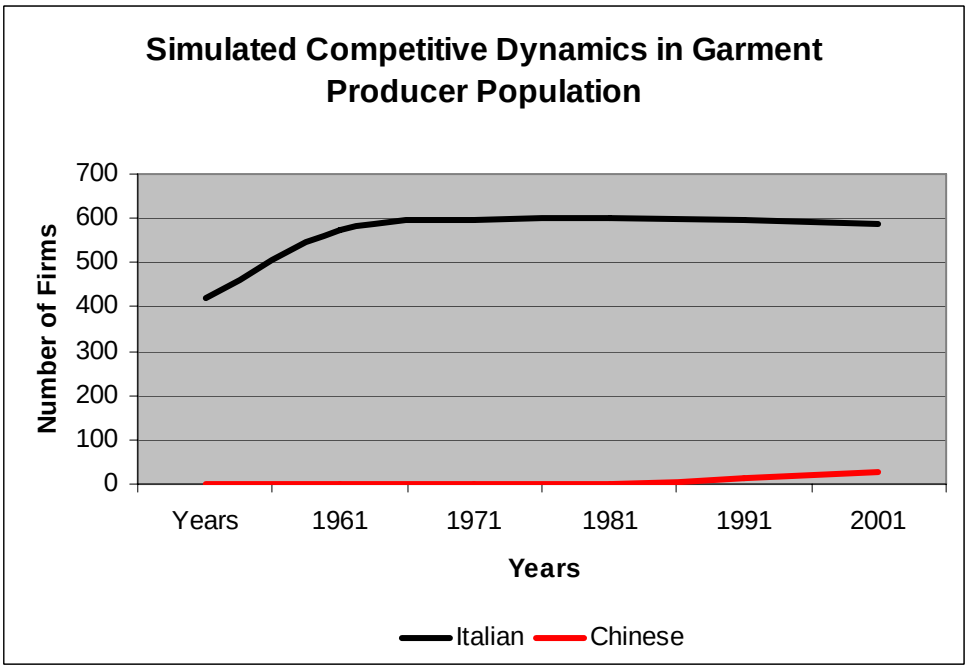



**Figure 8**



## 8. Conclusions

In this paper, we use the social capital theory (Granovetter, 1985; Lin, 2001) to extend the topic about the evolution of industrial districts, aiming to verify whether or not social capital may be considered as a critical source in explaining the dynamics of population of co-localised organisations towards the phenomenon of passive internationalisation. The study explores these issues by analysing the pattern of fragmentation of production and the change of internal rules of actors inside a textile industrial district localised in the Center of Italy – Val Vibrata – after the "internal invasion" of foreign business players in different stages of chain value. This allows us to identify significant differences in the dynamics of four different co-localised population of organisations (local and foreign; manufacturers and suppliers), considering social capital as the potential explicative factor of these different evolutions. Basing on longitudinal data in this district, we use computer simulation to stimulate a dialogue between available empirical data and theory.
The preliminary results of our experiments stimulate further empirical inquiries in this area. In particular, we aim at discovering further determinants of substitution dynamics between different populations, as shown during computer simulation process. At this stage, we provide preliminary answers to critical elements.

First, given the fact that finished good producers population is much greater than suppliers' one, interviews collected after the completion of this article, confirm that observed substitution dynamics is augmented by the emerging shift of a significant number of finished local good producers toward suppliers located in several foreign markets. This new direction will be included in our future analysis since the existence of another population (foreign suppliers located outside the district), in direct competition with local population of both Chinese and Italian textile suppliers inside the cluster, includes a new element to account for in the explanation of emerging inter-population competitive dynamics. It could be interesting, for example, to highlight correlated mechanism of relational capital accumulation.

Second, we are collecting data confirming the emergence of a high-quality niche in the market of finished good producers' population. Available data in this moment suggest that about 20% of total local producers implement a quality strategy. To do so, they build tight business relationships only with Italian textile suppliers in the clusters. Such a phenomenon suggests that observed aggregated data need to be closely scrutinised to reveal different micro-dynamics at the level of sub-populations in the population of Italian textile suppliers. It is realistic to suppose that in this population two sub-populations emerge. The first population, which supplies textile to branded producers in the high-end segment, experiences weaker competition. On the contrary, in the second sub-population, which includes Italian firms that supply textile to the low-end market, we expect a strong competition among other producers aimed to reduce the prices and to reach the mass market. Thus, we are collecting data in order to understand whether surviving Italian textile suppliers are only the firm that produce better quality product for a specific downstream market. Along this vein, social capital can be considered an explicative factor of different dynamics of population of co-localised organizations especially in the case of products with high quality, according to idea that local actors prefer to create networks and to realize business exchanges with other local partners, considering external actors as a potential threat to system economic equilibrium in medium-high segment of market (Lin,

Cook, Burt, 2001). Thus, in this niche of market, we may conclude that cultural similarities, durable forms of interaction, familiarity and interdependence among close actors, allow local partners to improve the social capital diffusion useful to reinforce cluster survival (Saxenian, 1994). Further analysis are necessary in order to verify the importance of social capital in explaining different dynamics of populations operating in mass market and characterized by a significant attention to price level.

In this state of research, we suppose that our findings may offer some interesting reflections in the field of research concerning social capital, population ecology, entrepreneurship and industrial clusters. In fact, whereas past research focused on social capital as a macro-level concept in industrial networks (Burt, 1992) or as a micro-level concept within organizations (Tsai, Ghoshal, 1998), our research contributes to the understanding of "population"-level social capital dynamics, empirically observing the inter-organizational social networks developed between different populations of firms. Along this vein, our results ought to add insight to delineate the role played by social capital in a industrial cluster, by developing a structural and relational approach. Doing so, we empirically support recent suggestions that different social assets may have different impacts on economic outcomes as performance or growth of co-localised organizations, according to different structural or organizational factors. Finally, further results could highlight the important intersection of entrepreneurship and strategic management in discussing the dynamics of populations of co-localised firms, verifying whether or not different populations of firms may accomplish economic and innovative aims inside local clusters, using social relationships. Since these results show that it is impossible to clearly define, in a positive or negative way, the passive internationalization inside a cluster, we can also contribute to improve policymaking in relation to local economies. In fact this paper shows how different simulations of social, structural and organizational variables could lead to different expected results in terms of cluster evolution (and local firms performance), a first policy implication suggests clearly defining the object of policy and specific targets when conceiving cluster policies aimed, i.e., to attract the entrance of new foreign business actors. Moreover, from a practical point of view, the utilization of simulation tool may help us to find the profitable level of social capital inside business relationships, useful to guarantee a pacific coexistence of different actors - in strong competition - in a same local area.

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## APPENDIX

| Parameter | Value |
|---|---|
| FGPop1 endogenous rate of growth | **0,2** |
| FGPop2 endogenous rate of growth | **0,3** |
| SupPop1 endogenous rate of growth | **0,01** |
| SupPop2 endogenous rate of growth | **0,1** |
| FGPop1 initial population size | **420** |
| FGPop2 initial population size | **0,001** |
| SupPop1 initial population size | **110** |
| SupPop2 initial population size | **5** |
| Final users population size | **600** |
| Ratio FGPop/SupPop | **3/1** |
| Demand elasticity to relation capital in FG sector | **0,5** |
| Demand elasticity to relation capital in Sup sector | **0,1** |