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**Cluster evolution in mature Industrial clusters. The case of Prato  
Marshallian Industrial District after the entrance of the Chinese firms  
populations (1945-2011)**

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**Abstract**

Cluster life cycle is recently attracting increasing attention and notwithstanding some authors showed some criticism proposing alternative approaches, most scholars agreed the cluster evolution literature is still in search of an appropriate analytical frame work and is necessary to follow an evolutionary approach instead of a deterministic perspective, considering also the analysis of local contexts.

The work deals with the evolution of textile-clothing Marshallian Industrial District (MID) in Prato, focusing on last twenty years, characterised by the settlement of a large numbers of Chinese firms.

We contribute to this debate following an evolutionary approach according to the Organisational Ecology and density dependence theory. The analysis is carried out on Italian and Chinese firms in Prato MID. Data are collected elaborating the Registry of Economic Activity (REA) held by the Province of Prato (1990-2011) and integrated with databases constructed from REA of the Chambers of Commerce of Prato and Florence (1945-1998). We carried out demographic analysis on firms natality and mortality of Prato MID and we tested ecological models in order to establish relationships between legitimation and competition ecological processes and different life cycle phases.

Results allow us to reconstruct the internal dynamics of Prato MID from its birth till today and identify in which stage of the life cycle it is currently, providing a theoretical and empirical contribution to the study of cluster evolution, through the Organisational Ecology.

Jelcodes:R11,R12

# **Cluster evolution in mature Industrial cluster**

## **The case of Prato Marshallian Industrial District after the entrance of the Chinese firms populations (1945-2011)**

### **1. Introduction: cluster evolution and mature industrial clusters in Europe<sup>1</sup>**

The forces of globalisation and the recent economic crises in Europe impacting on local economies pose threats, but also opportunities to mature and decline cluster/district and sectors in transformation. In this context, the scientific debate has started reconsidering cluster evolution, discussing possibilities of renewal through re-positioning in *global value chains* (Bailey et al., 2010, Todtling and Trippl, 2004; 2008; Staber et al., 2010) also in relation with the settlement of foreign communities (Belussi and Sedita, 2010; Chiarvesio et al., 2010). The value of learning, knowledge and path dependence is thus re-asserted by stressing particularly capabilities to react towards external shocks and change (resilience effect) (Cooke and Eriksson, 2012).

The Industry/cluster life cycles theory have been recently re-proposed in an evolutionary perspectives by the scholars of New Evolutionary Geography (NEG), industrial organisation and management studies (Ter Val and Boschma, 2011; Martin and Sunley, 2011; Isaksen, 2011; Menzel, 2014). More efforts are though needed to perform longitudinal studies on cluster transformation and renewing, since contributions have mostly focus on emergence and development phases (Dahl et al., 2011) and on high-technology sectors (Maggioni, 2002), albeit recent applications have been made to creative industries such as fashion design or new media (Sinozic et al., 2013; Wenting and Frenken, 2011).

In general, the evolution of declining and mature clusters in low tech industry is still under-research from an empirical perspective. The investigation of transformation, 'starting a new cycle', decline and death phases are particularly complex as they require the adoption of multiple interpretive perspectives (Grabher, 1993; Hassink and Shin, 2005).

Menzel and Fornhal's (2010) seminal contribution has provided the chance to revive a debate that had been especially intense in the 1990s, when a number of papers (Maggioni 2002, Maskell and Malmberg, 2007) had developed and discussed theoretical proposals by Swann et al. (1998) and Klepper (1997).

Martin and Sunley (2011) have questioned the life cycle model, proposing to replace with an ecology-based, adaptive life cycle model for the evolution of a complex system. They identify four phases (reorganisation, conservation, exploitation and decline/release) according to three strategic factors: connectedness, resilience and capital accumulation.

However, the most of these authors agree that "cluster evolution" literature is still in search of an appropriate analytical framework, and that an evolutionary approach which takes into consideration the analysis of local contexts should be followed instead of a deterministic one. In the past, most studies analysed clusters from a static perspective, while questions such as to why and how clusters decline or transform and the advantages associated to their change over time were largely ignored. Currently, evolutionary perspectives aim to fill such a gap, fostering the proliferation of longitudinal case studies both of a qualitative and quantitative character (Boschma and Fornahl, 2011).

We aim to contribute to this debate by connecting with the literature that has analyzed the transformation of mature industrial districts (Bellandi 2009; Pietrobelli et al., 2013). In particular, we analyse the evolution of the historical Marshallian industrial district (MID) of Prato (Becattini, 1990) by adopting an evolutionary approach that differs from used in literature, which can be reconnected to the Density Dependence Model applied in Organization Ecology (Hannan and Freeman, 1989; Hannan and Carroll, 1992). This socio-organizational approach studies the demographical and ecological processes of organizational populations. Its relatively low diffusion in economic analyses of industrial clusters is mostly due to the difficulty of acquiring the ad hoc databases needed to reconstruct the entire history of the organization.

By integrating demographical analyses and models which identify legitimation and competition processes with the phases of the cluster life cycle, we have attempted to measure the evolution of the cluster with particular reference to its phase of transformation.

The case study selected for the analysis is particularly representative, as over the last two decades the district has seen not only relevant changes in its internal productive structure, but also in its social texture which has increasingly become multi-ethnic likewise to the new clusters born out of the *diaspora effect* (Sonderegger and Täube, 2010). The population of firms and people has recorded an increasing share of Chinese immigrants, whereas the pre-existing Italian, locally integrated filière has declined and been replaced by a Chinese one which is better inserted within global value chains and specialized in clothing (ready-to-wear). These changes have generated an intense debate not only on the issue of transformation

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<sup>1</sup> We express our gratitude to the Research Office of the Chamber of Commerce of Prato for data on foreign firms and for comments to the participants of the MONASH Diaspora Symposia in Prato, 2013. The responsibility of what is written lies solely with the authors.

and the risks of globalization, but also on the fundamental issue of district identity (Johanson et al., 2009). Some contributions have hypothesized the existence of two separate districts - the 'old' Italian one and the new 'Chinese enclave' (Santini et al., 2009) - with scarce mutual relations. Others, on the contrary, have delineated the expansion of the textile industrial district into a new fashion district, partially integrated within Chinese firms (Ceccagno, 2009). Others aim for an integration of the two Italian and Chinese filieres bringing back the attention on the correct identification of the district and on the unit of analysis (Dei Ottati, 2009)

Our analysis focuses on the transformation phase through an in-depth study of Chinese and Italian firms that integrates previously elaborated ad-hoc databases with a new database created by the Chamber of Commerce of Prato/REA. Upon these bases, besides reconstructing the whole history of the district since 1945 to 2011, we have carried out demographical analyses of the natality and mortality of firms and analysed ecological models, connecting legitimation and competition processes with the different evolutionary phases of the cluster life cycle. The study aims to answer the following questions:

- What were the internal dynamics of Prato district since its birth to nowadays?  
In which phases of the life cycle is currently the district?
- What theoretical and empirical contribution can the ecological approach give to the study of cluster evolution?

Results allow us to reconstruct the internal dynamics of Prato MID from its birth till today and identify in which stage of the life cycle it is currently, providing a theoretical and empirical contribution to the study of cluster evolution, through the Organisational Ecology (OE).

The article is structured as follows. After this introduction, we present the current debate on cluster evolution under an evolutionary perspective focusing on the contribution of Organisation Ecology. The third paragraph presents the research design and data collection. The fourth paragraph present the Prato ID evolution from 1945-2011 under three perspectives. It includes the historical reconstruction of settlement of Chinese firms in Prato, the demographic analysis of Chinese and Italian populations and the ecological analysis. The paper ends with some conclusions about the contribution of density dependence model to cluster evolution and implications for future researches.

## **2. Cluster evolution under evolutionary perspective**

### ***2.1. The resurgence of the cluster life cycle theory and new evolutionary geography***

There is an increasing number of contributions on the evolution of industrial cluster on the cluster life cycle metaphor that combine the industrial organisation approach and the NEG approach (Bergman, 2008; Menzel and Fornahl, 2009; Fornahl et al, 2010; Menzel et al., 2014). Some of them point out networks dynamics during time (Giuliani, 2013) till the changing in policy implication (Brenner and Schlump, 2011) or evolution of institutional settings (Staber, 2011). Others have studied the evolution of the cluster concept as an organisation form through bibliometric analyses (Lazzeretti et al. 2013).

Evolutionary theorising suggests that sectors may take different routes such as further specialisation, emergence of new subsectors, or diversification into new areas, shaped by interactions between firm capabilities, industry life cycles, networks (Ter Wal and Boschma, 2011) and its degrees of relatedness (Frenken and Boschma., 2007). Maskell and Malmberg (2007) state that change at the cluster level is constructed by micro level routines, search processes, memory and history. Simmie (2012) states that cluster change is constrained and supported by regional path dependencies such as cultural conditions that have shaped similar industries in the past (Simmie, 2012). Sonderegger and Täube (2010) analyse the evolution of the IT cluster in Bangalore and its diaspora effect recalling the model of Bergman (2008). In the Italian context, Belussi and Sedita (2009) carry out a qualitative meta-study applied to 12 case studies of Italian IDs and they shed light on the evolutionary process of IDs, evaluating the role of path dependence in their growth trajectories founding a multiple growth pattern.

Most recent contribution refers to the seminal article developed by Menzel and Fornahl, 2010) and the cluster life cycle model is recognised stronger and better capable of deriving testable hypotheses concerning the circumstances under which particular trajectories emerge. Boschma and Fornahl (2011) have confirmed this position by highlighting a "roadmap for future research" that calls for the adoption of different approaches and promotes more longitudinal empirical studies to support the theoretical propositions that have been advanced.

The above reviewed contributions share the identification of different phases of cluster life cycle. Much research on clusters life cycle take into account four main stages such as birth, growth, maturity, and decline or reinvention (Bergman, 2007). Swann (1998) focuses on how the decline of clusters can be turned around to forward new growth within the same clusters, but with a new set of industries. He presents a quantitative innovative model that has generated a debate. He studies cluster life cycle by looking at new firm formation, incumbent firm growth and cross-sector effects. Clusters reach maturity when the entry of

new firms peaks and the cluster is no longer attractive for new entrants; this is due to congestion especially in mono-sector, highly specialized clusters. Finally, clusters reach saturation when no new firms are attracted to it. Swann suggests a model where firms' entry and growth are measured and linked to a cluster's sector composition, size and life cycle. In doing so, Swann's model introduces a new methodology to measure and quantify cluster life cycle with more intangible and contextual variables at the core of the qualitative models becoming fixed.

Menzel and Fornahl (2010) present a model that explains how the very cluster dynamics is both the driver for the movement of a cluster through a life cycle and the reason why this movement differs from the industry life cycle

The model is based on two key processes: the first is that the emergence, growth, decline and renewal of the cluster depend on the technological heterogeneity of firms; the second is that firms have a larger relative absorptive capacity, when they are in the same location, and thus especially localized learning changes heterogeneity: it leads to technological convergence when learning takes place within the cluster and technological divergence when learning takes place outside the cluster, yet in the same region. Grabher (1993) describes the coal and steel district in the Ruhr Area as one example of a region that "became 'locked-in' by the very socioeconomic conditions that once made these regions 'stand out against the rest' [ . . . ] and [ . . . ] fell into the trap of 'rigid specialisation' " (Grabher, 1993: 256).

Menzel and Fornahl (2010) argue that lock-in phenomena comprise several dimensions such as technology, network structure, and policy. The decline of clusters like the textile industry in Manchester and the automobile industry in Detroit was also caused by their former success, that led to mono-structured "company towns" with too little heterogeneity and diversity to generate new ideas. The decline phase is often recognised as due to path dependence trajectories of the cluster and emergence of lock-in situations (Staber et al., 2010; Martin and Sunley, 2006)

The reason for a lock-in situation lies not only in the exhausted regional trajectory, but also in the "long existing, closed, and homogeneous networks", which are unable to renew the cluster with new knowledge. A declining cluster has therefore lost the ability to sustain its diversity, its ability to adjust to changing conditions as well as its potential for an independent renewal (Menzel and Fornahl, 2010: 227). Cluster life cycles have different degrees of change (adaptation, transformation, and renewal). Adaptation corresponds to relatively young clusters that through their adaptation processes are still able to shift back to a growth phase from a phase of maturity. Transformation and renewal are more fundamental and radical changes which are required when a cluster is in a state of decline. Change encompasses all processes in cluster dynamics and evolution. They also distinguish a quantitative and a qualitative dimension of the cluster. The quantitative dimension describes the economic development of the cluster in terms of the number of active companies and employees<sup>2</sup>. In addition, the qualitative dimension describes the heterogeneity of companies' competencies inherent in the cluster<sup>3</sup>. The cluster declines if its heterogeneity cannot be sustained. If the heterogeneity increases again, the cluster moves "back" in the cycle and enters a new growth stage. The connections between the quantitative and qualitative development of the cluster indicate that its heterogeneity of knowledge is the foundation of its development.<sup>4</sup>

For Ter Wal and Boschma (2011), the central idea in the framework proposed here is that the pattern of spatial clustering in an industry co-evolves with three entities: with the firm at the micro-level, with the industry and its technological properties at the macro-level, and with the network that describes the patterns of interaction among firms of the industry. Also these authors identify four stages: an Introductory stage, Growth, Maturity, Decline or Start of a new cycle. The maturity stage points out that the growth of an industry is not infinite since at some point, the industry will show symptoms of maturity. Market size cease expanding, the number of new entrants will decline rapidly and new innovations decrease. There is here a massive wave of firm exits. Firms with higher capability and in stronger network may survive more than other. The fourth phase regards the industry's decline or the start of a new cycle. The maturity phase of the industry life cycle coincides with a shake-out process among the population of the industry and with increasing negative effects of the relatively stable core-periphery profile of the industry network. In the fourth phase, two different scenarios are possible. Firstly, if no radically new technologies are introduced, the industry will eventually decline. The survivors of the industry are forced to exit the industry, when they are not able to diversify to new industrial activities by exercising their dynamic capabilities. Secondly, in case there is an exogenous

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<sup>2</sup> In the first stage "emergence" with only a few but growing numbers of mostly small companies, "growth" with a growing number of employees, and sustainment, when the cluster is able to maintain its employment on a high level in more mature phases. They also add a fourth stage, the declining stage, to account for the fact that a cluster can decline and diminish.

<sup>3</sup> In the first stage as the cluster emerges, there are only a few companies and the heterogeneity increases strongly because every new company ventures into new technological areas of the cluster. In the growth phase, the technological path becomes increasingly focused. The heterogeneity decreases until the cluster has matured and a distinct development path has taken shape. However, if the cluster is focused too narrowly, it loses its capacity for renewal and declines.

<sup>4</sup> The sustainment phase is particularly complex as it comprises three different conditions: adaptation, renewal and transformation. In order to explain these differences, quantitative data are not sufficient and to this purpose the authors draw on case studies.

shock like the development of a new industry or new radical technological breakthrough, a new cycle of industry evolution can be provoked.

Potter and Watts (2011) state an “Evolutionary Agglomeration Theory (EAT) that argues that the industry life cycle plays a pivotal role in explaining the evolution of firms, industries, agglomerations, networks, supply chains, increasing returns, diminishing returns, cities and regions. Such an approach views the growth and decline of the industry life cycle as a important determinant of the rise and fall of different agglomerations and city-regions through time and across geographical space. Recent evolutionary theories suggest that whether agglomeration economies generate increasing returns or diminishing returns depends on time, and especially the evolution of the industry life cycle. The authors found that during the later stages of the industry life cycle, Marshallian agglomeration economies decrease the economic performance of firms and create diminishing returns for the economic development of the city-region.

In summary, it is possible to identify a new research stream focusing on the relations between cluster life cycle theories and economies of agglomeration, which has adopted a variety of measurement modalities and approaches to the different stages. The qualitative one reconstructs the cluster's historical development as well as the economic and ‘industrial’ factors that have influenced it, such as demand, innovation, and knowledge. On the other hand, quantitative studies aim at measuring the structural changes that local production systems experience over time as a reflection of their evolution. To the current state, there is no shared approach, but the most followed path seems to be that of an integration between different approaches within the recent developments of New Evolutionary Geography.

## **2.2. The contribution of organisation ecology and density dependence model**

A further contribution to the study of cluster evolution can be provided by socio-organisational theories, in particular OE and business demography approaches (Carroll and Hannan, 2000) which focus on measuring the different phases of life cycle evolution.

OE draws on ecological and evolutionary models and it has emerged as an approach to study social changes and diversity (Hannan and Freeman, 1989; Hannan and Carrol 1992). It aims to study long term organisational change, focusing on organisational diversity and on the patterns of organisations’ rise and decline over time. In particular, it studies the processes that influence the birth, growth, decline and the disappearance of organisations and organisational forms (Singh and Lumsden, 1990)<sup>5</sup>.

Such approach has been initially applied to industrial sectors<sup>6</sup>, defined as populations of enterprises, and later to clusters and districts meant as an organisational populations identified by inter-related multi-populations of firms (Baum and Singh, 1994). However, the relation with cluster evolution life cycle has not been specifically addressed so far. Among the wide variety of possible approaches to organisational evolution (Carroll and Hannan, 2000; Hannan, Polos and Carroll, 2007), the one that has enjoyed widest applications in economics is that of density dependence.

The model of *density dependence*, which states that the growth path of an industry or a cluster (in OE called a community of organisation) over time is dependent on the number of firms (size) in that industry/cluster. According to this model, vital rates of birth and death of firms are dependent on the size of the population, the population density. Two basic forces are responsible for the size dependency of firm founding and failure: *Legitimation* and *Competition*. Both forces are linked to the size of the population. Legitimation refers to the extent that a new organizational form or industry is known and accepted in society (this as the taken-for-grant of an organizational form). More formally, the legitimation coefficient increases with density at a decreasing rate. On the other hand, competition processes emerge when populations utilise the same set of resources and work in the same field. The competition process, therefore, depends on the number of populations in a community (or of organisations in a population). A way of formalising the concept of competition is to consider how the entry of an additional competitor in a system generates a process of crowding out so that to reduce the total number of existing firms. Therefore, the competition coefficient increases with density at an increasing rate.

Both Competition and Legitimation processes impact on populations’ vitality rates, in that populations’ founding and mortality rates vary with populations’ density rate. In particular, the relationship between the founding rate (or mortality rate) and the density of a population is represented by the rate multiplier coefficient. The latter is defined as the ratio of the founding rate (or mortality rate) to the rate calculated for the lowest observed population density. In particular, at low density increasing founding rates have a positive effect on the density due to the Legitimation process. When the density of a population

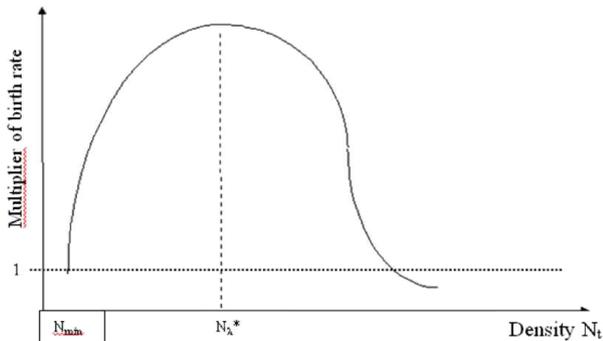
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<sup>5</sup> Populations’ vitality flows (births and deaths) are determined by the interaction that can take place between co-existing populations, and in turn this can have an impact in the evolution of the organisational community. In fact, the community ecology analyses the way in which bonds and relationships across populations affect the survival probability of the community as a whole (Baum and Singh, 1994).

<sup>6</sup> The application of the organisational ecology model to economics means that, in our case, organisations would correspond to firms and institutions, since the latter are the smallest units of analysis. Groups of firms and institutions that have some pre-defined similarities, constitute populations of organisations, in our case, there are branches of trade or production specialisations. Organisational populations could correspond, for instance, to sectors as defined by the standard NACE classification.

peaks, it means that it has reached its 'carrying capacity'. After this point, as competition forces become stronger, the mortality rate increases and the population's density falls. In other words, as the population density increases, the multiplier of the founding rate peaks when the population reaches its carrying capacity. Hannan and Freeman (1987, 1988) found that the relationship between the density of a population and the multiplier of its founding rate is non-monotonic and shaped as an inverse U (Fig. 1), whilst the density dependence of the mortality rate is non-monotonic and U-shaped. In economic terms, a population's carrying capacity reflects the fact that a population (an industry) has reached its critical mass and its growth is peaking.

**Fig. 1:** Density dependence theory: multiplier of birth rate



Source: Hannan and Carroll (1992)

Since its introduction in 1989, the density model has gained popularity especially among organizational sociologists (Carroll and Hannah, 2004)<sup>7</sup>. and more recently, it has found applications in industrial economics and regional sciences. Notwithstanding initial criticism to the model<sup>8</sup>, significant advancements have been made by relating cluster life cycle theories, ecological approaches with economies of agglomeration. Among others Van Wissen (2004), comparing the model of density dependence with that of agglomeration economies, has highlighted relevant similarities between the Legitimation process, and concepts belonging to theories of new MIDs, such as social capital, institutional thickness, and innovative milieu. The agglomeration effects will vary between industries, and are especially relevant in the formative period of the industry and this life cycle aspect may fit neatly in the framework of the density dependence model. The author states that the Legitimation and Competition processes may be viewed also from a spatial perspective. In this case the legitimation contains the centripetal forces, and competition the centrifugal forces in spatial cluster formation. Wenting and Frenken (2011), analysing the global fashion design industry found that Legitimation processes operate locally and Competition processes globally. They attribute the decline of Paris in the Post-war period to "institutional lock-in," which prevented a ready-to-wear cluster from emerging despite the presence of the *haute couture* cluster, an hypothesis that is empirically supported by the OE model.

At an industry level, Lima and Dasa (2009) have recently analysed the foundation of firms in the global liner shipping industry, while De Figueiredo and Silverman (2012) investigate firm survival and competition in vertical related populations in the printing industry. Boschma and Wenting (2007) have studied the spatial evolution of the automobile sector in Great Britain from an evolutionary perspective.

At cluster level, Fortis and Maggioni (2002) have adopted the population ecology approach to study the evolution of some Italian MIDs considering the relationship between agglomeration economies and diseconomies. Guo et al. (2009) have discussed the industrial district of Sinos Valley in Brazil as an "ecosystem", analysing its evolution from the perspectives of population competition and interdependence. Staber (2001) adopts the OE model to study inter-firm relations, mortality rates (competition processes) and spatial proximity in a declining ID in Baden-Württemberg. Fritsch and Noseleit (2013) applied OE to investigate the effect of local market conditions on the effects of new business formation.

Our contribution is framed in this debate to integrate cluster life cycle theory with an ecological approach according to NEG perspective. We presents a composite and multidisciplinary methodology that integrates an historical analysis of the evolution of clusters and IDs with an analysis of its economic and industrial

<sup>7</sup> The main contributions on the application of the organisation ecology have looked at the evolution of populations, such as the beer brewery, computer and automotive industries and trade unions.

<sup>8</sup> First, no account is taken of firm *size* in the theory, whereas clearly large and small firms have very different effects in a population. Second, legitimation and competition explain the S-shaped form of population growth, which leads to a stable population size at the level of the carrying capacity. It fails to explain negative growth rates and the negative slope of the density curve beyond the peak, since a decrease in the population size would lead to less competition and therefore a return of the growth rate to zero. Third, firms differ not only with respect to size and economic activity, but also with respect to geographical location, which may be labelled spatial heterogeneity (Van Wissen, 2004).

structure. In addition, to measure such evolution, firm demography and OE models are drawn on that rely on concepts like firms' entry and exit, and firm and sector density. We argue here that instead of a technological change in the MID of Prato the settlements of Chinese firms in the district has somehow renewed the internal structure of the district. The main industry is therefore shifted from a filiére to another, from textile to clothing, developing then new knowledge capabilities related to global value chain relations and market knowledge. The final issue regards the cluster identity (Staber and Sautter, 2011)<sup>9</sup> because the foreign Chinese community has settled in the ID shaking all mechanism of social capital among local firms.

### 3. Research design: ecological approach and data collection

#### 3.1. Toward an ecological approach to cluster life cycle

According to previous studies, we assume Prato ID as a "community of organizations", (Lazzeretti and Storai, 1999; 2003). Through an historical and economic-industrial analysis, we study the different populations of firms that identify the cluster along time and we measure their density by referring to the categories identified by NACE codes.

After the entry of the first Chinese firms in the early 1990s, firms were reclassified on the basis of their provenance (Italian and Chinese). From an ecological point of view, the district is thus identified by a multiple population of Italian and Chinese firms, whose evolution is measured through vital flows as well as Legitimization and Competition processes. As it has been mentioned in the previous section, the application of the density dependence has found widespread support directly or indirectly. In order to measure cluster evolution, Menzel and Fornahl (2010) have suggested to use the number of active companies and employees, whereas Van Wissen (2004) has explicitly supported the validity of applying this model for studying cluster evolution in emerging phases.

We follow this framework, assuming that in the presence of Legitimization processes the cluster is in an emerging phase when population density is low, whereas if it is increasing the cluster is in a stage of adaptation/growth. When density stabilizes up to the maximum carrying capacity, a phase of maturity/transformation starts wherein Competition processes prevail and mortality rates gradually increase.

This phase of decline may either evolve positively towards renewal if change maintains some relatedness with the existing district, or towards the start of a new cycle if change is highly discontinuous with the pre-existing structure. In the case of a negative evolution, decline may eventually lead to the disappearance of the district. However, the district may experience rebirth due to what cluster theories define as the tacit knowledge embedded in the territory. An example of this trajectory is the jewellery cluster of Birmingham, previously considered as a "deceased" Marshallian district (De Propriis and Lazzeretti, 2009) and later resurged as an urban creative cluster (De Propriis and Wei, 2007).

A preliminary representation of cluster evolution phases in relation to density dependence models is offered at Tab. 1, where life cycle stages, natality and mortality rates and legitimization processes are put in relation.

**Tab. 1:** Toward an ecological approach to cluster life cycle.

Evolution phases	No. of populations (degree of diversity)	No. of firms in different populations (density)	Ecological processes	Interdependence among populations	Clustering
<b>Emerging</b>	Few populations / low diversity	Increasing / Low density	Legitimation	No interrelation	No clustering
<b>Growth</b>	Many populations / diversity increasing	Numerous firms and increasing / High density	Legitimation	Co evolution/ cooperation/ symbiosis	Emergence of clusters
<b>Maturity</b>	Many populations / diversity stable	Stable / High density	Competition	Co evolution	Cluster lock-in
<b>Sustainability / Transformation</b>	Populations in change / diversity increasing	Some pops growing / others in decline / density decreasing	Competition and Legitimation	Some pops co-evolve. Other declining. Possible predatory competition	Over cluster lock in
<b>Starting a new cycle</b>	New populations / low diversity	Few firms / Low density	Legitimation	No interaction	No clustering
<b>Decline / Death</b>	Population Declining	Declining	Competition	Co-declining	Disappearing clusters
<b>Re-birth</b>	New populations emerging (after death)	Increasing	Legitimation	Interaction with the death cluster	Emergence of New clusters

Source: our elaboration.

<sup>9</sup> Staber and Sautter (2011) define the cluster identity as the shared understanding of the basic industrial, technological, social, and institutional features of a cluster and it is deeply connected to social capital, trust and collective understandings,

As it has been observed, the attempt to measure cluster evolution by solely relying on density represents a major limitation of the model. However, this variable can be integrated with the variety of existing populations and their relative density, obtaining a proxy of the rate of intra-district diversity and heterogeneity, which is considered essential by recent literature (Menzel and Fornahl, 2010; Ter Wal and Boschma, 2011). The variety of populations grows together with the district's specialization and diversification, both in the phase of adaptation/growth and transformation. It stabilizes in the maturity phase when the structure of populations stabilizes and starts increasing again in the transformation phase.

The way in which variety manifests can be considered as an indicator of relatedness. In other terms, the variety of firms can be related or unrelated to the existing district structure, as in the cases of Chinese sub-suppliers located in Prato that are inserted in the local value chain, or in the case of Chinese firms that are only connected to mainland firms and position themselves in another global value chain. This information can be obtained at a first approximation through the analysis of the economic activities performed by the firms as synthesized by NACE codes.

The diversity rate can be also useful for studying co-evolution phenomena (Ter Wal and Boschma, 2011) that can be measured through the ecological interdependences among populations (Brittain and Wholey, 1988). Thanks to these analyses, symbiosis, competition and prey-predator relations among populations can be measured in order to understand their reciprocal dynamics (Lazzeretti and Terchi, 2002). Symbiosis is an index of co-evolution, whereas fierce competition may lead to the start of a new cycle.

These analyses may also be useful to define the new identity of evolving clusters. In the case of the Black Forest clock-making cluster (Staber and Sautter, 2011), identity became an impediment to innovation by insulating the firms from the transformations necessary in a new market. This question remains open also in the Prato Industrial District, where local firms could be locked in the traditional textile identity of the industrial district.

A further limitation is also the fact that the ecological approach does not consider firms size, as well as technological or market variables and institutional settings. Finally, it should be remarked that the concepts of competition and legitimization refer to resource-based socio-organizational issues rather than to economic factors.

### **3.2. Data collection**

Several databases have been integrated in order to reconstruct the evolution of Prato MID from its birth till today (1945-2011). Main data sources to reconstruct the natality and mortality flows and the density of the two populations is the Registry of Economic Activity (REA) collected by the Chamber of Commerce of Prato and elaborated by its Research Office.

Regarding the Chinese population, it was possible to consult all the information regarding birth and death of foreign firms in the Province of Prato, together with other information related to the firms localisation, typology, and NACE codes of economic activity. This data source permits us to reconstruct the whole historical series - from their first settlement at the beginning of Nineties - of the population of Chinese firms, as every firm has to be recorded in this registry by law.

The database on foreign firms includes more than 16.800 records of which 11.400 of Chinese firms (almost 70%). The database registers more than 11.000 births and 6.000 deaths of Chinese firms<sup>10</sup>. The 78% of the records included in the database regards to firms operating in the manufacturing economic activities of textile, clothing and leather, confirming the role played by foreign firms in Prato.

Data on Italian firms have been collected from the REA elaborated by the Chamber of Commerce of Prato and elaborated also from previous studies of Prato ID from Forties (Lazzeretti and Storai, 1999; 2003; Lazzeretti and Terchi, 2003). The recent information related to the population of Italian firms have been collected also from the analysis elaborated from the Chamber of Commerce in Prato, that from 1995 describes density, births and deaths of firms in the Province.

Regarding limits, unfortunately the REA database does not register firms transformations either from an economic activities to another or the transfer of the firm registered Office from outside to within the province of Prato. In these cases in fact a firm is firstly cancelled from the REA and then registered newly with the new information. The administrative nature of the REA therefore overestimates then the natality and the mortality of firms<sup>11</sup>.

Regarding the territorial unit of analysis, the database refers to the municipalities only in the Province of Prato, as the data on foreign firms were available only at provincial level. Although this is an administrative

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<sup>10</sup> Here the sum of birth and deaths is more than the number of records because a record contains both the birth and the death of a firm.

boundary, the labour local system coinciding with the MID has been also identified with the 7 municipalities of the Province of Prato (ISTAT, 1997)<sup>12</sup>.

Finally, we decided to adopt the definition of Chinese firm of the research office of the CCIAA of Prato that defines a Chinese firm as that with at least a proprietary, a manager or an associate of Chinese nationality. It is possible then to consider also society and not only individual firms.

#### **4. The Prato ID evolution from 1945 to 2011**

##### ***4.1. Historical perspective: focus on settlement of Chinese firms in Prato***

Tuscany is one of the Italian regions with larger Italian and also foreign entrepreneurship, localised mainly in IDs. As for the nationality of the entrepreneurs, Chinese entrepreneurs are the predominant ethnic group (with 17.8%) and are found in particular in Prato. In Italy in 2011, Chinese operated in activities related to the fashion industry as textile, clothing and leather, in which were concentrated more than 95% of Chinese initiatives in the manufacturing industries (Unioncamere, 2012).

The entrepreneurial spirit of Chinese is also related to the high percentage of the Chinese residents in Tuscany (with a high 9.4%), concentrated mostly in the district areas (Unioncamere, 2012). This community shows a strong propensity for entrepreneurship, more accentuated than in other ethnic groups, as pointed out in other contributions, in particular for the ethnic group originated from Zhejiang and Fujian (that are in Prato) (Johanson et al. , 2009). In fact, respect a percentage of Chinese residents of about 10% on total Tuscan residents, the percentage of Chinese entrepreneurs almost doubles (18%).

Chinese community is often in fact recognised as an "ethnic entrepreneurial community" which has developed in indigenous local production systems through a system of closed relationships. In 2007, for example, 64% of Chinese enterprises were in fact located in Tuscan IDs (Dei Ottati, 2014). This phenomenon has continued to grow in last years in fact the recent data of the report of Unioncamere (2012) ranks Prato by far in the first place among the Italian provinces on the share of foreign companies (23%).

Moreover, to understand the important evolution of this phenomenon, it is possible to notice that while in 1989 the Chinese residents in Prato were only 38, in 1991 they were already more than 1,000. At the end of 2006, there were over 10,000 Chinese and of them 78% were born in China, while 18% already belonged to the second generation (Ceccagno, 2009).

Chinese companies begun to develop from the early Nineties as mentioned with the entry in the activities of textile finishing and knitting. Chinese enterprises in this first stage were mainly subcontractors of Italian textile companies and they represented an opportunity for local businesses, both for labour flexibility and lower costs for subcontracting. With the recovery of production in the Nineties, knitting mills of Prato begun to meet more and more difficulties to find Italian homeworkers and subcontractors willing to sew knitted garments. It is then that Chinese started to transfer in Prato (Dei Ottati, 2014).

This is the first development of Chinese immigrants in Prato, as it went to satisfy the local demand of jobs (at home and subcontracting in knitting) and then more and more in clothing that would otherwise have remained unsatisfied. In this period, companies operating in clothing grow at a fast pace and this provoked a first shift from the textile industry (mainly knitwear). In practice, Chinese subcontracting textile enterprises amounted to less than 200 in 2011, and then work mainly for final Chinese firms.

A very interesting aspect to note is that the Chinese firms once settled in the MID in a non-primary industry (knitwear) first facilitated the development of a new mode of production, the "ready-to-wear", virtually absent in Prato before their arrival, and after they promote the development of a whole new industry, the clothing, ignored by local entrepreneurs (Dei Ottati, 2014; Johanson et al., 2009).

We presents in Tab. 2, the macro evolutionary phases of the Prato ID from 1945 till 2011, elaborated from previous contribution on Prato MID (Lazzeretti and Storai, 1999; 2003). We added here the fourth phase of decline/transformation of Prato ID with settlement of Chinese firms, operating in the apparel industry. In this phase, as said the textile filière is more and more in crisis, while the clothing industry, with the entrance of Chinese firms, develops and grows.

Chinese firms localised in Prato, specialised in clothing activities closer to the market, were able to exploit localisation advantages in the districts, such as specialised suppliers and access to foreign markets, enriching these aspects with link to the global value chain and international relationships with Chinese community in China. In following paragraph, we will try to describe and measure this evolution and internal changes in the MID.

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<sup>12</sup> Prato ID is often recognised as diffused in all the municipality of Prato, the municipality of Agliana, Quarrata and Montale in the Province of Pistoia and Calenzano and Campi Bisenzio in the Province of Florence (Beccattini, 2001).

**Tab. 2:** The evolution of Prato MID (1945-2011): focusing on the development of Chinese firms.

PHASES OF PRATO HISTORY		INDUSTRIAL DISTRICT APPROACH	DEMOGRAPHIC APPROACH
1) 'The Metamorphosis' (1945/46-1953/54)		From 'double production circuit' (i.e. large firms and small firms) to the industrial district	<ul style="list-style-type: none"> <li>▪ Increase in the population density of impannatori and subcontractors specialised in the production of carded wool.</li> </ul>
2) 'The canonical development' -long period of growth- (1954-55 and 1974-75)		<ul style="list-style-type: none"> <li>▪ Development and consolidation of the industrial district model</li> <li>▪ Increase in the degree of the external division of labour among district firms</li> </ul>	<ul style="list-style-type: none"> <li>▪ Increase in the density of existing populations.</li> <li>▪ Birth of new organisational populations (e.g synthetic materials).</li> </ul>
3) 'Prato transformation'	3a) Prato diversification (1975-76 and 1993)	<ul style="list-style-type: none"> <li>▪ Diversification of activities and functions within the industrial district</li> <li>▪ Development of service sectors related to textile production</li> </ul>	<ul style="list-style-type: none"> <li>▪ Fast growth of firm populations (both final and stage firm populations) specialised in the production of yarns, knitwear, garments, new textile products and machinery for textile industry.</li> <li>▪ Birth and fast growth of firm populations specialised in service sectors</li> </ul>
	3b) Prato restructuring (1985-1990)	<ul style="list-style-type: none"> <li>▪ Industrial district organisational restructuring: a) change in the organisation of production among firms located both inside and outside the district; b) purchase of components and intermediary goods outside the district; c) subcontracting of some activities outside the district</li> </ul>	<ul style="list-style-type: none"> <li>▪ Increase in the population density of subcontractors specialised in the finishing phases of productive cycle and drop in the population density of subcontractor specialised in the first phases of productive cycle.</li> <li>▪ Increase in the population density of fabric traders and decline in the population density of yarn and weaving producers.</li> <li>▪ Increase in the population density of impannatori and drop in the population density of subcontractors.</li> </ul>
4) Decline of Italian textile ID (1990s-2011)		<ul style="list-style-type: none"> <li>▪ Decline of Italian Textile ID</li> <li>▪ Weakening of social capital elements in the ID (in the Italian community)</li> <li>▪ Globalization, opening of the European market to China, intensification of international competition from countries with lower labour costs, financial crisis, etc. (external causes)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Decrease of Italian textile firms</li> <li>▪ Entrance of Chinese firms operating firstly in Textile from 1990 (knitting)</li> </ul>
4b) Renewing or starting a new cycle?	Rise and affirmation of the clothing Chinese population (1990-2011)	<ul style="list-style-type: none"> <li>▪ Rise and affirmation of the Chinese clothing filière</li> <li>▪ Increase of Chinese population</li> <li>▪ Emergence of a Chinese community with own rules and social capital elements</li> <li>▪ Social and business relationships with Chinese community in China</li> <li>▪ International relationships with global value-chain</li> </ul>	<ul style="list-style-type: none"> <li>▪ Increase in the population density of clothing</li> <li>▪ Increase in the population density of Chinese firms and decline in the population density of Italian firms</li> <li>▪ Increase of import-export firms with China and Clothing filière</li> </ul>

Source: our elaboration on Lazzeretti and Storai, 1999, 2003.

## 4.2. Demographic analysis of the Chinese and Italian populations in Prato

### 4.2.1. The populations of firms in Prato

The MID of Prato begun to develop in the years after WWII from a 'double production circuit' based on large and small firms to mainly SMEs (Becattini, 1990; 2001).

The population density starts to increase at the end of Forty (Fig. 2, Tab. 1). The canonical development identified as a long period growth is recognised in the period until 1975. In Eighties there is a phase of transformation of the Prato MID, diversifying its activities and functions also in services sectors related to textile production. Then a second phase of restructuring from mid-Eighties to Nineties where there is change in the organisation of production among firms located both inside and outside the district and the begin to purchase of components and intermediary goods outside the district and subcontracting of some activities outside the district.

The crisis is occurring from nineties where the density of firms operating in the industrial district fall from a peak of almost 10.000 units in mid-eighties to 6.000 firms in 2011. The crisis of the MID of Prato is in fact more acute in the last decade, due also to exogenous factors, such as the process of globalization, with the opening of the European market to China, the intensification of international competition from countries with lower labour costs (BRIC), the financial crisis and the dollar devaluation (Dei Ottati, 2014).

In the period 1995-2011 there has been a significant decrease in the Province of Prato from over 7,000 to about 6,600 companies with a minimum point of 6,000 enterprises in 2005 (Fig. 2).

**Fig. 2:** The evolution of textile and clothing firms in Prato Province, 1945-2011.



Source: our elaboration on CCIAA Prato.

This crisis is, however, more deep if we proceed the analysis at sub-sectors within the macro-industry. In fact, if we considers the main industry subdivided in the three statistic economic activities of textile, clothing and leather, we register different results.

As already known, in fact, during the period, textile enterprises decreased from about 9,000 firms in end of Eighties to just under 3,000 in 2011, a decrease in the period of more than 60%, while the clothing sector shows an inverse trend, passing from just more than 1,000 enterprises at the beginning of the Nineties to about 4,000 in 2011, quadrupling its number (Fig. 2). The leather sector is not a significant phenomenon with few firms during the period at least in the province of Prato.

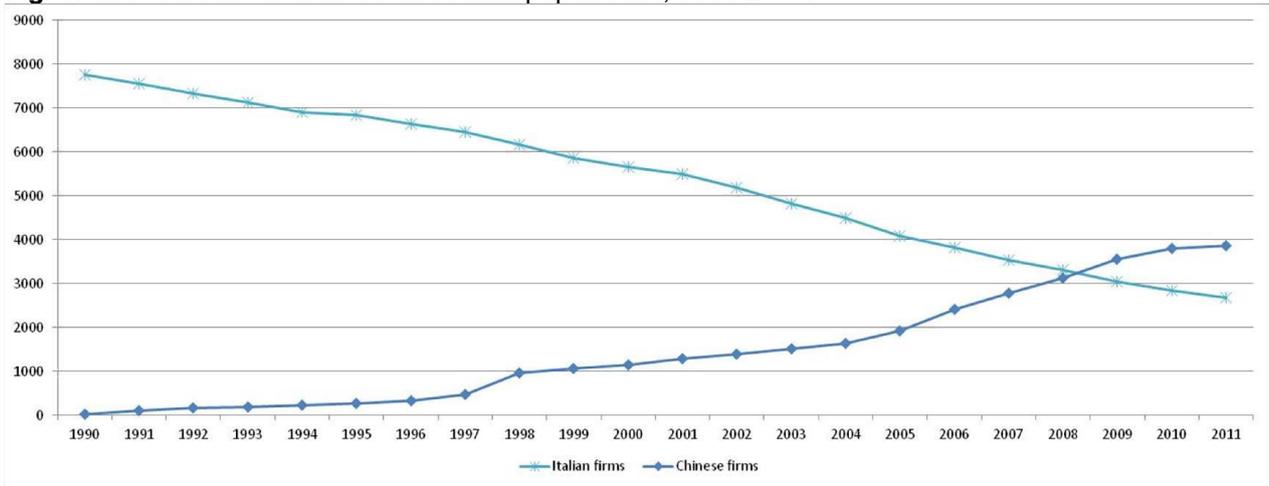
In summary, while textile industry results in a significant decline in its life cycle, clothing industry passes from the initial stage of birth to its full development and it asserts itself as the principal one at districtual level. In 2008 Fig. 2 shows the intersection of the density lines of the evolution of the two populations with the overtake of the firms operating in clothing of those operating in the textile industry. The development of the apparel industry is also known as due to the settlement and significant development of the Chinese community in Prato since the early nineties.

#### **4.2.2. The evolution of Italian and Chinese populations (1990-2011)**

The evolution of firms in the province of Prato is here divided in the two Chinese and Italian populations focusing in particular in the period 1990-2011, as they are the main populations of firms in the ID. This is the most relevant period in order to consider the birth and rise of the Chinese population of firms.

Fig. 3 presents the evolution on the two populations in the macro-industry of textile and clothing. As already mentioned, the two populations registered opposite trends, the population of Italian firms steadily decreased from the Nineties from more than 7,500 units to less than 3,000 firms, while the population of Chinese firms increased with a remarkable growth from about 1,000 firms in 1999 to nearly 4,000 in late 2011.

**Fig. 3:** The evolution of Chinese and Italian populations, 1990-2011.

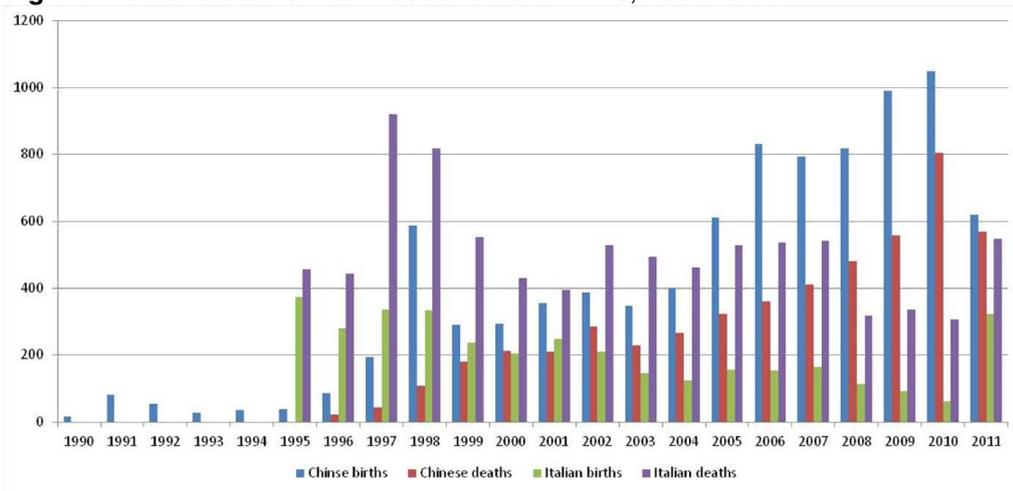


Source: our elaboration on CCIAA Prato. Line interpolated for Italian firms before than 1994.

Fig. 4 presents births and deaths of Chinese and Italian firms in Prato, while Fig. 5 introduces the mortality and natality rates of the two populations, constructed in the traditional mode<sup>13</sup>.

Natality rate of Chinese firms larger than that of Italian firms and consequently a mortality rate of Italian firms higher than that of Chinese firms. This is true only until 2008, when the mortality of Chinese firms exceeds that of Italian companies. In addition, throughout the period, although the Chinese population is clearly growing, its mortality is always relevant, confirming the dynamism of the population of Chinese enterprises recording both high rates of birth and death<sup>14</sup>.

**Fig. 4:** Births and deaths in Chinese and Italian firms, 1990-2011.

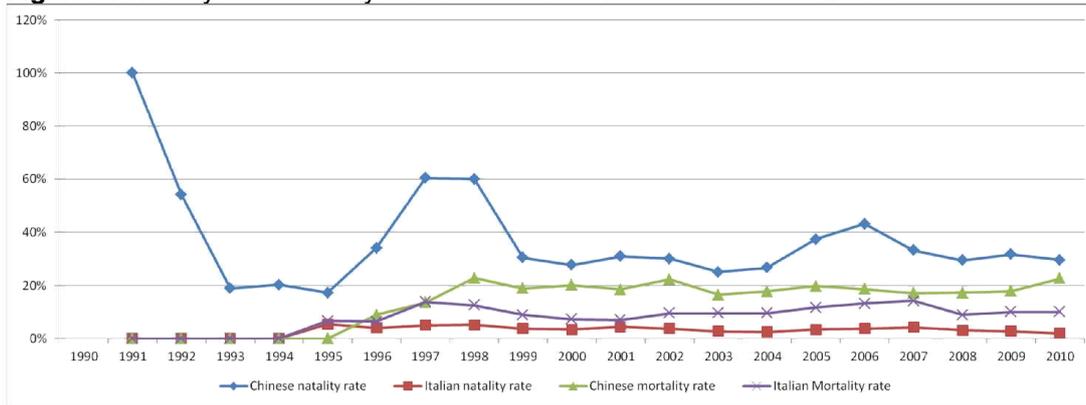


Source: our elaboration on CCIAA Prato. Missing data for Italian firms before 1994.

<sup>13</sup> The Natality (mortality) rate is calculated as the ratio between the number of births (deaths) in year and the population in the previous year.

<sup>14</sup> One reason for this dynamism is also attributed to the possibility of avoiding administrative and tax controls by companies that remain alive at most for 2 or 3 years. At national level, for example, these data are confirmed as foreign firms are more fragile than the Italian ones with a mortality rate significantly higher (17% versus 7.8%) (IRPET, 2010).

**Figure 5: Natality and mortality rate. Chinese and Italian firms. 1990-2011.**



Source: our elaboration on CCIAA Prato. Missing data for Italian firms before 1994.

#### 4.2.3. The evolution of the Chinese sub-populations

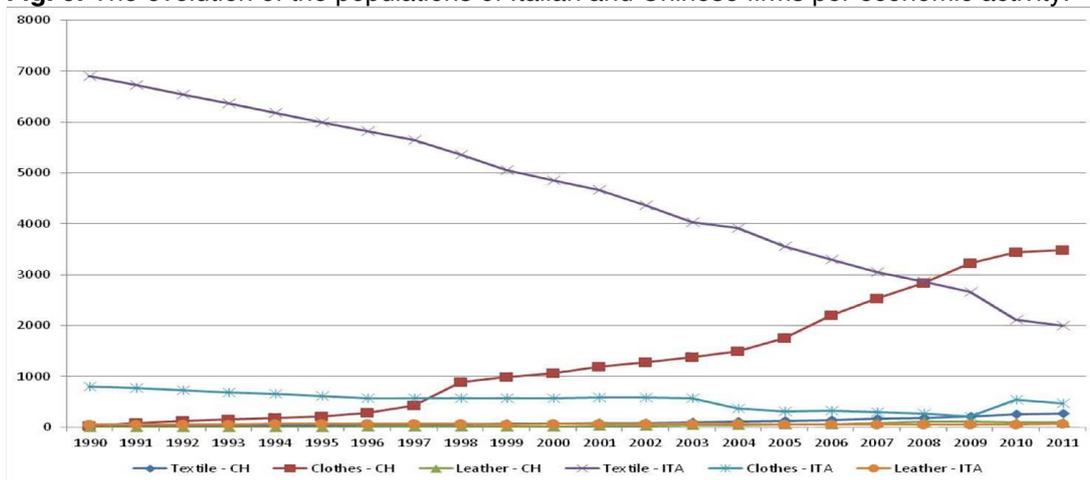
We now analyse the textile, clothing and leather firms sub-populations in Prato subdivided by nationality (Italian and Chinese), because, as we will see, the most interesting comparison will be between the population of Italian firms in the textile industry and the population of Chinese enterprises operating in the clothing industry.

Fig. 6 presents the evolution of populations of Chinese and Italian firms subdivided by NACE Rev. 2 codes of economic activities. The most important Italian population is the one operating in the textile industry, which recorded a significant decline from about 7,000 units at the beginning of the Nineties to almost 2,000 companies at the end of 2011. Italian companies operated then also in the clothing industry, which remains fairly stable over the period, except from the bend during the period 2004-2009.

The population of Chinese firms operating in Clothing records instead the main growth in the period, passing from nearly 1,000 companies at the end of the nineties to 3,500 units at the end of it.

Finally, we underline that this evolution is exclusive of the Prato ID in fact if we consider the evolution of the employment at national level, the textile industry responds better than the clothing. From 1991 to 2011 the textile sector registers a decline of 23%, while the clothing presents a decline of 29%. In Prato, textile decreases with an 8%, while clothing increases by 66%.

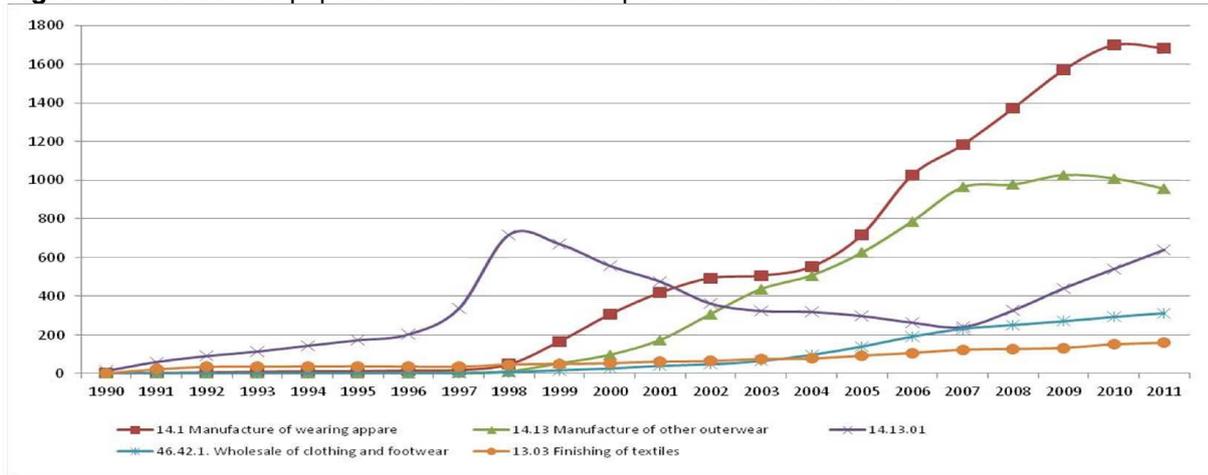
**Fig. 6: The evolution of the populations of Italian and Chinese firms per economic activity.**



Source: our elaboration on CCIAA Prato. Interpolated data for Italian firms before 1994.

This background is also confirmed by the distribution of Chinese companies in Prato subdivided per economic activities from 1990 to 2011 (Fig. 7). In fact, approximately 71.3% of Chinese firms belongs to Clothing, while just 5.2% belongs to Textile. Leather is represented with about 2%, while firms in Trade of clothing are about 5%, turning to be the second most important statistic economic activity. If we consider all the activities of an enlarged filière of textile and clothing, Chinese companies records a percentage of over 85% (textiles, clothing, leather, trade).

**Fig. 7:** The evolution of population of Chinese firms per economic activities.



Source: our elaboration on CCIAA Prato.

It is also important to underline the development of Chinese enterprises in Import-Export Trade. In fact, in 2011 there were almost 400 importers and exporters that connected the Chinese firms in Prato to the Chinese global value chain, benefiting from the low cost of raw materials imported from China (from the same ethnic community), and from the access to European distribution channels for finished products.

### 4.3. Ecological analysis of Chinese and Italian populations in Prato

#### 4.3.1. The model

A methodology to study social or economic events is the event history analysis. In particular, event history analysis uses different methodologies according to the kind of event being studied. When analysing firm foundings, the most frequently models are those that consider recurring events as the outcome of stochastic processes. Firm foundings are considered discrete events<sup>15</sup>, therefore the stochastic process – and the underlying distribution of probability - must be discrete. In particular, Poisson processes are used (Hannan and Freeman, 1989); they assume that the rate of arrival is independent from the history of previous arrivals and from the current state of the system. Among other things, this assumption implies that the order of events does not affect the arrival rate. If the rate at which new organisations are born in a population follows a Poisson process, then the rate is a time-independent constant. Since we know the number of foundings per year, the model of the founding rate is based on a simple Poisson model:<sup>16</sup>

$$\lambda(t) = \exp(\theta_1 N_t + \theta_2 N_t^2 + \delta_1 F_{t-1} + \delta_2 D_t) \exp(\sum \phi_i X_{it})$$

where the two orders of density are represented by  $N_t$  and  $N_t^2$ ;  $X_{it}$  is the vector of co-variates, and the vector of parameters  $\phi_i$  correspond to the period variables<sup>17</sup>. Finally, we introduce in the model, firm foundings at  $t-1$  ( $F_{t-1}$ ) and firm deaths ( $D_t$ ) in order to ascertain how they influence the density rate over the period.

The study uses the basic model of density-dependent evolution (Hannan and Freeman, 1989; Hannan and Carroll, 1992) applied successfully to the analysis of multi-populations of Arezzo Jewellery District in Italy (Lazzeretti, 2006) and BJQ in UK (De Propriis and Lazzeretti, 2009). Carroll and Harrison (1994) introduced competition into the model by including simple monotonic effects of the density of each population on the vital rates of each other populations.

<sup>15</sup> Firm foundings are considered as discrete events since they are computed at  $t_1, t_2, t_3$ , etc. usually corresponding years, rather than as continuous which would require the exact the day, month and year of the birth.

<sup>16</sup> The most frequently used model to represent these relationships is the log-quadratic approximation (Hannan and Freeman, 1989; Hannan and Carroll, 1992). Other common models to represent these relationships are the generalised-Yule models (GY) and the log-quadratic approximation model. Yet, some authors have demonstrated how these latter models do not always offer convergent estimates (Hannan and Freeman, 1989; Hannan and Carroll, 1992).

<sup>17</sup> Period variables have been computed as dummy variables each covering 10 years: 1990-1999, 2000-2011. We have also tried using period variable of five years, results are similar.

### 4.3.2. Results and discussion

The analysis is realised through separate estimations of three regression models for the entire macro population of textile and clothing firms in Prato and for the two populations of Chinese and Italian firms in order to present a benchmarking of them. Tab. 3 reports the maximum likelihood estimates of the Poisson model of density dependence for firms' foundings. Model 1 analyses the clothing Chinese population, Model 2 analyses the Textile Italian population while Model 3 considers the whole district macro-population.

All parameters are significant and in line with the hypothesis. Model 1a,b estimates for Chinese population first and second order effects of density. Model 1b includes also lagged birth (birth t-1) and also the second-order effect of lagged births, and also lagged deaths (t-1).

Model 2 analyses births of Italian population first and second order effects of density and also lagged deaths (t-1). Model 3 analyses first and second order effect of density of macro-population and use a dummy for the comparison of Chinese firms natality. Model 1 considers also period dummy variables, allowing the study of different probabilities of births with respect to the period 2000-2011, which is omitted in the model.

According to the hypothesis, the first-order effect of density (density) is significant and positive in all model except in Model 2 for the Italian population. Second-order effect (density<sup>2</sup>) is significant but close to zero in all model and positive in Model 2 for the Chinese population.

These results does not confirm the inversely 'U' shape of the birth rate for all the populations. Chinese population (model 1) seems to be in the first part of the inversely 'U' shape of the birth rate as the coefficients are all positive. The same results is similar also to the Model 3 for the entire macro-population, but with a smaller effect. The Italian population besides shows a negative first order effect of density and seems to be in the decreasing part of the inversely 'U' shape of the birth rate. Second order effect is close to zero and does not influence the birth rate.

Regarding other variables, lagged deaths (t-1) are significant and influences negatively births, except in model 2 where the relations is inversed (for Italian firms). The period variable underline that in the period 2000-2011 there is a higher probability of birth of Chinese firms. The dummy in model 3 for Chinese firms underline a higher natality of 1.75 times more for Chinese firms than Italian firms.

The first-order parameter associated with lagged births (birth(t - 1)) is negative and the second-order parameter (births(t - 1) ^ 2) is positive, but close to zero for the Chinese population. Lagged births are therefore also found in the first part of the inversely 'U'-shaped curve, where the effect of the legitimation process prevails on the competition process in determining firms' births.

We remind that in the legitimation phase, the birth of enterprises promote the birth of other enterprises. It is the opposite in the competition phase. The Chinese population seems to be in the first phases.

In other words, while the density of the Chinese population has a positive effect on the natality rate, confirming to be in the process of legitimation and growth of the population, the Italian population density has a negative effect on the natality rate, confirming to be from time in the process of competition, and the decline. These last results are also confirmed by other studies in which the population of Italian firms in Prato was already in the state of ecological Competition at the end of Nineties, where the natality rate was already braked by the competition effect (Lazzeretti and Terchi, 2002).

The macro-population of Italian and Chinese companies in the MID besides records the same results as the population of Chinese firms, with less pronounced effects. There emerges a greater contribution of the Chinese population to the whole community than that of Italian firms, that permits a more positive trend of the whole community of populations.

**Tab. 3:** Poisson Regression Model Estimations of Births of Chinese and Italian firms. 1990-2011;

	Model 1	Model 1b	Model 2	Model 3
	Chinese	Chinese	Italian	Macro population
Intercept	5.2706 (0.0367)	3.9188*** (0.1409)	5.2889*** (0.1866)	3.2294*** (0.0832)
Density	0.0009*** (0.0000)	0.0017*** (0.0001)	-0.0004*** (0.0001)	0.0006*** (0.000)
Density ^2	0.0000*** (0.0000)	0.0044*** (0.0003)	0.0000*** (0.0000)	0.0000 (0.000)
Births (t-1)		-0.0011*** (0.0006)		-0.0004*** (0.0001)
Births (t-1)^2		0.0000*** (0.0000)		
Deaths (t-1)	-0.0032** (0.0032)	-0.0038*** (0.0002)	0.0010*** (0.0001)	
Period 1990-2000	-0.6362** (0.0413)	-0.3157 (0.0904)		
Period 2000-2011				
Dummy Chinese				1.7499*** 0.0811
DF	5	7	4	5
Chi quadr. Pearson	268.57	227.66	268.88	2214.68
Log likelihood	47,242.68	47,666.66	23,747.21	70,568.01

Standard error in brackets. \*:  $p < 0,0001$ ; \*\*:  $p < 0,001$ , \*:  $p < 0,01$ ; Period Variable Omitted 2000-2011. Events 14.150 births.

It is then possible to describe this phenomenon analysing the value of the *multiplier of the natality rate* that is no more than the effect of the density (first and second order) on the probability of birth of new firms in the considered population. The calculation of the multiplier of the foundings rate is achieved considering only the two parameters of the density equalling to zero the values of other covariates. It is the ratio between the value assumed by the function at the density  $N_t$  and the function of the minimum density  $N_{MIN}$ . Calculations are presented in Tab. 4.

Fig. 8 presents the three multipliers of the birth rate of the macro-population and of the two populations of Chinese (and Italian firms. If the multiplier is higher than 1, there is an increase of the population, if the multiplier in the birth rate is less than 1 there is a decrease of the density.

The multiplier of the Chinese population (Fig. 8a) is more than 1 and is growing exponentially at a maximum density of approximately 4,000 companies (at the beginning of the Nineties). This shows that the population of Chinese enterprises is still in a period of Legitimation, from the point of view of density dependence theory, and that the Competition process does not influence yet this population. This recalls a growth/development phases in the life-cycle model.

**Tab. 4:** Quantitative implications of estimates of density dependence in founding rates

Model	Nmin	Nmax	$\lambda^*$	$\lambda_{min}$	$\lambda_{max}$	T(Nmax)	T(Nmin)	Legitimation effect	Competition Effect
Chinese (1b)	17	3847	1	$\approx 1$	31	2011	1990	0.0017	0.0044
Italian (2)	7762	7762	1	$\approx 0$	$\approx 1$	1990	2011	-0.0004	$\approx 0$
Macro Population (3)	7779	7779	1	$\approx 1$	9.95	1990	2005	0.0006	$\approx 0$

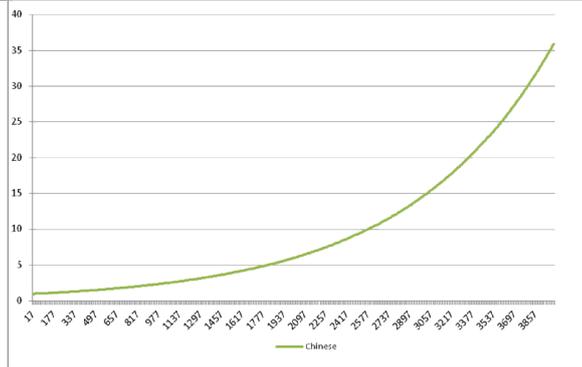
Source: Author's calculation.

The population of Italian firms (Fig. 8b), besides, registered in the period a decrease, as the multiplier rate results less than 1. From the point of view of ecological analysis, this highlights the supremacy of the process of Competition on that of Legitimation. In other words, it seems that for Italian companies we are analysing the end tail of the multiplier birth rate (inversely 'U' shaped).

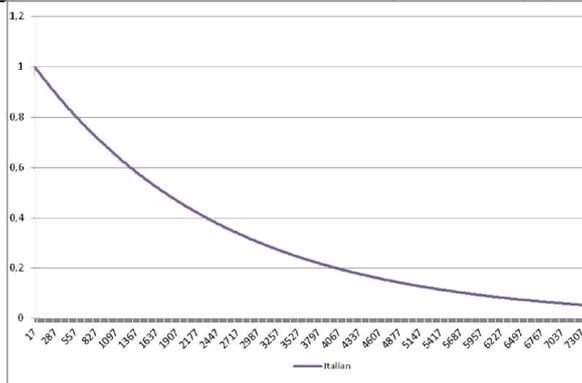
The trend of the multiplier of the birth rate for the macro-population (Fig. 8c) seems to recall in part the tendency of the multiplier of the population of Chinese enterprises, then it seems partly influenced by its natality. The multiplier is greater than 1 and then a slight increase is recorded. It is intermediate between the two multipliers of the birth rate of Chinese and Italian firms. As mentioned, at the level of macro-population there appears to be an 'Chinese' effect that allows the macro-population in the MID to be still in a lively phase.

**Fig. 8:** Multiplier of birth rate per population;

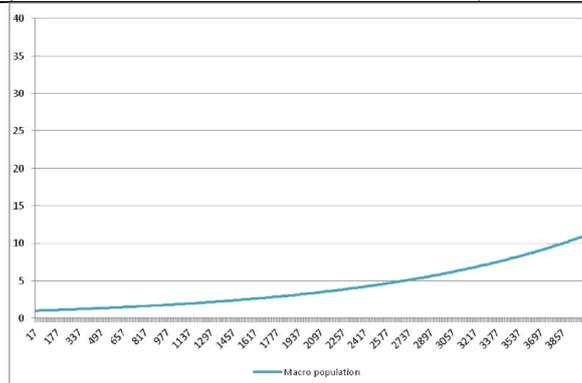
**Fig. 8a:** Multiplier of birth rate of Chinese firms (1990-2011) (Model 1)



**Fig. 8b:** Multiplier of birth rate of Italian firms (1990-2011) (Model 2)



**Fig. 8c:** Multiplier of birth rate of whole District firms (1990-2011) (Model 3)



Source: Authors' elaborations;

## 5. Conclusions and future research

The aim of the work was to investigate the evolution and internal dynamics of the MID of Prato according to an ecological approach and contributing to the current debate on cluster evolution. We propose to integrate the cluster life cycle theory with the OE according to an evolutionary approach in a density dependence model.

Demographic analysis show clearly the substantial transformation of the internal structure of the Prato MID. A process started from early Nineties with the settlement of Chinese firms, that have contributed to ignite a profound internal change in the district.

In a first approximation, from ecological analysis, the Prato MID in its complex seems to be in a new phase of legitimation, due to the transformation process to ascribe to the increasing presence of Chinese firms, but if we distinguish the analysis at level of Chinese and Italian populations, results change profoundly.

At the beginning, the two populations seems to coevolve together and they can be considered belonging to the same district of textile-clothing, further they presents opposite trends more and more specialised in two different filieres.

Ecological models point out that the native population of Italian firms of textile is at the moment in a phase of acclaimed decline, where the competition process and high mortality rates prevail, while the

population of Chinese firms of clothing (ready-to-wear) is an emergence phase where the legitimation process has the upper hand, registering a demographic trend of progressive development.

The MID of Prato is in a phase of transformation that could be considered, in a first instance, both as a case of renewal and starting a new cycle. Other information are needed on the composition of internal structure of Italian and Chinese population in order to reconstruct the level of diversity and the co-evolution relationships.

At the moment we have only indications from demographic trends of the two populations, that are even in complete contrast. Further integrated analysis are needed to achieve a correct interpretations of the phenomenon. Moreover the theoretical debate ignited among scholar of local development and opinions of local stake-holders are even conflicting.

The most urgent issue become the identification of the identity of the industrial district, that is not anymore clear and in quick evolution. At the moment, we prefer to leave the issue open waiting that competition and legitimation processes operate, delineating more evidently the next configuration.

We may however conclude that beyond every interpretations, the Prato MID is still very lively. A place where a population of firms and persons proceed to develop a project of life and work, as the lesson on Marshallian industrial district has taught us.

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