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HOW DO RELATED VARIETY AND DIFFERENTIATED KNOWLEDGE BASES INFLUENCE THE RESILIENCE OF LOCAL PRODUCTION SYSTEMS?

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ABSTRACT

This contribution attempts to systematize some first evidence on the sustainability and resilience of local production systems in the economic recession and first hypothetical phases of recovery, 2007 to 2011, focusing on the role played by diversified economy, related and unrelated variety and differentiated knowledge bases, as drivers for territorial competitiveness under unfavourable economic conditions. The results confirm the importance of related variety to growth and stability during recessions and support the creative capacity of culture, providing evidence that a moderate concentration in cultural/creative economic activities contributes to resilience and that industrial districts and international development play a positive role.

Jel Code: R11, R12, O18

Keywords: regional economic growth, industrial districts, sustainability, creative capacity of culture.

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1. Introduction

The spatial dimension has always been regarded as an important key to the explanation of economic phenomena, starting from studies of economic geography (Scott, 1988; Storper, 1995, 1997; Saxenian, 1994, 1999; Maskell, 2001; Asheim, 1996), to relevant contributions written by social economists (Becattini, 1979, 2000; Brusco, 1989; Becattini et al., 2001) and experts in business strategy (Porter, 1990). The recent phenomena of globalization and the consequent opening of markets have tightened the competitive arenas of firms, further highlighting the role of territory and its specificity (not only morphological, but also historical, social and, last but not least, economic), which resulted in 'unbalanced' growth paths, non-homogeneous from the point of view of geography (Perroux, 1996; Berry, 1972; Myrdal, 1959; Vernon, 1966; Rostow, 1962). It is no wonder the spatial dimension of a business plays a crucial role regardless of the specific industry in which a firm is operating.

Many studies confirm that the industrial district model in the past ensured positive economic performance and has been crucial for boosting the growth and development of Italy (Becattini et al., 2009; Belussi et al., 2003). However, some districts have recently experienced poor performance, partially due to the economic crisis that we are still experiencing. Which are the institutional and socio-economic environments capable of supporting a firm's performance when economic trends are not favourable? Some authors focus on the study of business ecosystems[4] (Moore, 1993; Galunic and Weeks, 2002), considering as crucial the ability of a firm to become an active part of a network of relationships between public and private actors that reduces the negative effects of external shocks. Italian companies in the past have found in the industrial districts a place where risk sharing and trust relationships along the value chain ensured remarkable flexibility, and they were thus able to face unfavourable economic cycles successfully (Marshall, 1920; Becattini, 1979). The opening of markets and the gradual emergence of the BRIC (Brazil, India, China) economies have changed global economic balances (Goldstein, 2011), transforming the strengths of the industrial district model into weaknesses. The know-how of the craftsmen who gave birth to a district is no longer sufficient to meet the competitive challenges of the global market, which requires managerial skills not readily available within a company, and where efficient learning processes are no longer linear or slow, but discontinuous and fast. Hence, the importance of an environment capable of pushing the processes of learning, innovation and internationalization of firms emerges (Asheim et al., 2011). The simple allocation of collective resources is not an appropriate solution. The long-established institutions in more mature districts, which are the result of a slow co-evolution process with the business system (Dei Ottati, 1995) and local

[4]Business ecosystems are 'communities of customers, suppliers, lead producers, and other stakeholders interacting with one another to produce goods and services' (Moore, 1998, p. 168).

development policies, are no longer sufficient to ensure competitiveness within the eco-system. The competitiveness of enterprises cannot be enhanced only by increasing resource endowments, but also requires the active construction of a larger system of relationships (Chesbrough, 2003; Etzkowitz, 2008), both formal and informal, and/or internal and external to the district, and/or local and global, within ecologies of value able to self-generate positive externalities. Externalities become an endogenous engine to push the self-sustainability of a diffuse business eco-system, within a continuous circle between value creation and value appropriation through learning-by-learning processes (Ganzaroli and Pilotti, 2007; Pilotti, Sedita and De Noni, 2013). In this sense, membership in a regional eco-(efficient) system of innovation (Cooke, 2001; Asheim and Gertler, 2005), a cluster (Porter, 1998), or a complex network of relationships both local and trans-local (Powell et al., 1996), today plays a different and perhaps even more crucial role in supporting the learning dynamics, the networks of business relationships and the firms' performance that are at the basis of regional resilience. The latter can be viewed as the result of extended interdependences in a complex population of enterprises and institutions that enable the capacity to support external (and/or internal) market shocks through an appropriate change of internal relationship dynamics, fuelling extended cognitive division of labour for enhancing the intangible productivity.

This study aims to assess the critical factors of the resilience of local production systems (LPSs). In particular, following the regional policy framework put forward by Asheim et al. (2011), the analysis focuses on the role of 1) diversified economy (not simply differentiated), 2) related and unrelated variety (and their interdependences) and 3) differentiated knowledge bases (synthetic, analytical and symbolic), as drivers for territorial resilience. Aggregate data from Istat were extrapolated with reference to the period 2007-2011, which encompasses the economic recession and the first hypothetical phases of recovery. The unit of analysis is the LPS.

The study is structured as follows: Section 2 presents the theoretical background, the research questions and hypotheses. Section 3 presents the methodology: it defines the unit of analysis and the research design, implements some models of multivariate statistical analysis and displays the results. Finally, some concluding remarks follow in Section 4.

2. Theoretical background, research questions and hypotheses

As claimed by Crespo et al. (2013), research on regional resilience is promising and is growing, starting from some seminal contributions from formal communities of scholars (Swanstrom, 2008), seminal special issues (Christopherson et al., 2010) and special economic geography sessions in well-known international conferences (i.e. Association of American Geographers 2010, Royal Geographical society-Institute of British Geographers 2010, European Regional Science Association 2012). If, on the one side, there is a general agreement on the fact that regional resilience can be defined as the ability of a local socio-

economic system to recover from a shock or disruption, on the other side, the way in which the system is affected by the shock and reacts encounters a variety of interpretations. As clearly put by Martin (2012), there are at least three different but related interpretations of resilience: the 'engineering' (physical science), the 'ecological' (ecological sciences) and the 'adaptive' (complex adaptive systems theory) view. The engineering resilience view is connected to the ability of a system of recover from a shock or disturbance, returning to a stable equilibrium state. The ecological resilience view is connected to the ability of the system to move from one domain or state to another, without reorganizing its internal set of processes and structures. The adaptive resilience view 'has to do with the capacity of a regional economy to reconfigure, that is adapt, its structure (firms, industries, technologies and institutions) so as to maintain an acceptable growth path in output, employment and wealth over time' (Martin, 2012, 10). Alongside this evolutionary view of resilience, the adaptive capabilities of a region's economy affected by a crisis depend on the nature of the pre-existing economy. Which are the characteristics of a region's economy that are more likely to move a system to recovery after a shock? In other words: which is the socio-economic structure that is most flexible and adaptable? This is our main research question.

The instability of the global economic system asks for an evolutionary approach to regional development studies, which combine the analysis of endogenous growth factors with more context-driven aspects that can differently influence the performance of regions. Evolutionary economic geographers are prone to adopt as the unit of analysis the 'regional ecosystem', which is composed of organizations, institutions, their reciprocal relationships (Boschma and Frenken, 2006; Martin and Sunley, 2007) and the underlying market and non-market mechanisms. Martin and Sunley (2007) proposed a new perspective for the analysis of local production systems, conceived as emerging organic structures that are generated by complex interaction between internal elements and the outside environment in a relationship of co-determination. An organic perspective, as we shall see, takes on increasing ecological character and provides us with a new interpretative framework useful to reading, even within a governance perspective, the dynamics that are at the basis of local development. Resilience is one of the attributes of a socio-ecological system that determines its future trajectories (Walker et al., 2004). The way in which a system responds to exogenous shocks is inherently linked with the system's properties. In the literature, we find only limited contributions geared towards providing an analytical platform to support local development policies that consider the inherent complexity of a territorial business ecosystem. We find, among others, the interesting contribution of Asheim, Boschma and Cooke (2011), which proposed considering the impact of the sectorial structure of the territory on its competitiveness. The theoretical considerations of the authors provide a useful impetus to the implementation of an analytical framework to support local/regional decision makers. However, to date there is a lack of empirical evidence that validates the theoretical framework proposed, since often recent

research focuses on other drivers of regional economic growth (the related variety on the one hand and the knowledge bases on the other). Our work aims to fill this gap and to provide an empirical test useful to identify and decompose the regional competitive advantage into its relevant strategic components. To do so, this work embraces an evolutionary approach to investigate the complex system of factors that support the resilience of local production systems. In this work, aligning with Asheim, Boschma and Cooke (2011), we identified three main factors:

1. Diversified economy,
2. Related and unrelated variety,
3. Differentiated knowledge bases.

These factors have been considered so far as supporting the growth of a specific region. We add to previous studies by analysing those as sources of regional resilience. Our contribution thus offers an original perspective on regional development research, and positions itself together with Martin (2012), Fingleton et al. (2012) and Holm and Østergaard (2013), who also tried to measure regional resilience.

With regard to a diversified economy, it is meant here to refer to externalities as theorized by Jacobs (1969) and Arthur (1994, 1996), who saw in sectorial heterogeneity an important factor of local development and growth. Martin (2012) identified diversity of regional economic structure as a factor influencing adaptive resilience, but did not have data to measure this effect. In our work, a general entropy index, calculated by concentration measurements, will be used as a proxy to capture this aspect. We claim that a diversified economy offers multiple opportunities to recover from a crisis, because, for instance, some industries may be less affected than others from the external shocks, or there can be a higher probability for an employee to move from one industry to another, within the same workplace position, jumping from an industry with low productivity (or mainly physical) to an industry with high productivity (or mainly cognitive/intangible) by recombination or hybridization processes between them. Accordingly, machineries, logistical infrastructures, technologies and intangible assets can be converted from one function to another, without the need to dismiss them, within a re-use perspective. 'Diversity creates a greater variety in the knowledge base and thus a greater source of cross-subsector knowledge spillovers and opportunity for the emergence of new activities' (Holm and Østergaard, 2013, 5), through cross-fertilization mechanisms (such as in the case of laser technologies for conservation in Florence – see Lazzeretti et al., 2011). In a similar vein, Cooke and Eriksson (2012) argued that innovations emerge through pre-adaptations and 'white spaces' between clusters. Specialization enhances vulnerability to external shocks (Frenken et al., 2007). In the analysis of cluster life cycles, Menzel and Fornhal (2010) show that as the cluster grows, there is a risk that it becomes more technologically specialized and knowledge heterogeneity shrinks. This impedes the cluster renewal. Therefore, Hyp. 1 is formulated as follows:

Hyp. 1: A highly diversified economy is positively associated to the resilience of a local production system.

An important note must be introduced when considering the diversification of a regional economy. Cognitive distance (Noteboom, 2000) and cognitive proximity (Boschma, 2005) might facilitate inter-firm knowledge spillovers and knowledge re-use. This is the main reason why some authors distinguished between related and unrelated variety. As regards the distinction between related and unrelated variety, we consider the contributions of Frenken et al. (2007) and Boschma and Frenken (2007), which, stemming from the seminal work of Jacobs (1961, 1969), propose to focus on the positive effects of the related variety on local economic development. By introducing the concept of cognitive proximity, they argue that the added value of the variety lies in its ability to generate cross-sectorial knowledge spillovers. These are more easily activated when the cognitive distance between the actors involved is low. The resulting theory has been supported by empirical evidence from numerous studies carried out in different countries (among others: Frenken et al., 2007 for the Netherlands; Boschma and Iammarino, 2009 for Italy; Hartog, Boschma and Sotarauta, 2012 for Finland; Boschma, Minondo and Navarro, 2012 for Spain). Holm and Østergaard (2013) proved that related variety influenced the resilience of the ICT sector in Denmark after the shock following the burst of the dot.com bubble and economic recession of 2000-2001. Similarly, the analysis proposed by Østergaard and Park (2013) revealed that technological 'lock-in' was the major force that hampered the resilience of the wireless communication cluster in Denmark. 'Innovation (renewal of technological competence) and new firm formation (including spinoffs) are identified as the factors that increase the cluster's ability to overcome threats' (Østergaard and Park, 2013, 3). Spin-offs are certainly more likely to occur within the same industries, where the related variety is high. In this case, we have a highly codified cultural context dependence, prevalently transferred by business relationships and market mechanisms.
We therefore put forward the following hypothesis:

Hyp. 2: The related variety of the industrial structure is positively associated to the resilience of a local production system.

With regard to the differentiated knowledge base argument, this refers to the interpretation provided by Asheim and Gertler (2005) and Asheim et al. (2007), offering not only to look at the variety of sectors within a regional context, but also to identify the prevalent knowledge base. The authors consider the fact that production activities can be broken down based on their knowledge base, which may be analytical, synthetic or symbolic. In this case, we have a highly embedded, non-codified cultural context of dependence, prevalently transferred by personal relationships and non-market mechanisms.

A variety of knowledge sources and inputs are normally used by firms and organizations to support creative innovation processes. In regional systems, distributed knowledge networks have to transcend industries and sectors to better sustain firms' absorptive, explorative and exploitative capacities (Asheim et al., 2011). Smith (2000) detected that the relevant knowledge base is not always internal to an industry, but can be distributed across a larger range of actors and industries.

Even if related variety plays a crucial role in defining regional competitiveness (Asheim et al., 2011; Boshma and Iammarino, 2009; Cooke, 2007; Frenken et al., 2007), policy arrangements to support firms' processes of creating, transferring and absorbing knowledge cannot be generalized but depend on specific regional needs, available resources and on the most relevant type of knowledge bases.

By explaining the impact of related variety, Asheim et al. (2011) suggested an alternative conceptualization of types of knowledge bases versus the more classical distinction between tacit and codified knowledge. They identified three relevant types: analytic, synthetic and symbolic knowledge. The analytical knowledge base characterizes those productive contexts in which scientific knowledge is a critical component for innovation (which often is of a break-through/radical type). The university assumes a role as knowledge broker, being able to transfer scientific knowledge to the industry, as in the case of the biotechnology sector, following a linear process. The discovery of a new molecule as part of a research laboratory, for example, generates a process of experimentation that will lead to the realization of a drug. During this period (with an average duration of 10-12 years), the pharmaceutical industry will evaluate the potential market applications of the new discovery, and will decide whether or not to proceed with its commercialization. The synthetic knowledge base regards those contexts in which the innovation process (which generates mainly incremental innovations) depends on the ability to apply new combinations of existing knowledge to create new products. The knowledge flows occur mainly in the direction of industry-academia, as the processes of production and circulation of knowledge require possessing know-how and technical expertise. These processes therefore require a mechanism for interactive learning between customers and suppliers (that is developed in the industrial field, as in the case of engineering sectors), rather than a mere application of a scientific discovery. In these areas, the needs expressed by industry stimulate scientific research, which often focuses on the creation of a customized solution. The symbolic knowledge basis is about the aesthetic attributes of products, the creation of design elements and, in general, the use for economic purposes of various cultural products. The creative industries such as cinema, publishing, music, advertising, design and fashion are characterized by high-intensity activities of design and innovation, where the mere physical product is not as important as the attribution to it of an aesthetic and emotional value. In these areas, the prevailing knowledge base is the symbolic one, and the symbolic value, rather than the technical-scientific, is crucial for

determining the economic value of the final product. The innovations in sectors dominated by the symbolic knowledge base are often incremental in nature, and they preferably occur in contexts of social interaction, which promote the exchange of knowledge, know-how and meanings.

Differentiated knowledge bases involve different knowledge inputs, different ways to use and develop knowledge (Aslesen and Freel, 2012), different criteria of success, different interplays between actors and different sensitivity to geographical distance and spatial proximity (Asheim, 2007). In other words, they can explain differences in performance between local labour systems and thus in their resilience rates.

> *Hyp. 3: Differentiated knowledge bases affect the rate of resilience of a local production system.*

As mentioned above, these aspects have been considered so far only in partial form. There are no contributions that integrate these important drivers of regional growth in an overall theoretical framework and offer reliable empirical evidence. Our work fills this significant gap in theoretical and empirical studies currently published in Italy and abroad.

3. Methodology

3.1 Research design

Many studies on Italian industrial districts use data from the Istat census of enterprises, with reference to the decade 1991-2001. However, these data contextualize the role of industrial districts in an economic environment that is overall positive and tending to grow. This research study points to evaluating the competitiveness of the LPSs in a context stressed by economic depression. Negative economic features emphasize inefficiencies and allow identification of the factors really influencing the competitive gap between LPSs.

This section defines the research design. Multivariate statistical models are implemented to analyse the effect of regional diversity and complementarity, the impact of knowledge bases and creativity and the level of international involvement, over the period relative to the economic crisis (from 2007 to 2011).

3.2 Unit of analysis: Local labour systems

In this study, the local production system concept is analysed by referring to the Italian National Institute of Statistics's definition of *local labour systems* (LLSs) because they are relevant to exploring the structural and socio-economic evolution of local environments. LLSs are aggregations of neighbouring municipalities characterized by a greater demographic

density.[5] Each LLS is identified with the name of its most populous municipality, which usually has a greater availability of productive, commercial and administrative resources and, therefore, is likely focus of the local labour market. LLSs are defined and geographically identified by analysing the flows of workers between the Italian municipalities. At least 75% of the population lives and works inside each LLS. Because career choices have a strong influence on localization decisions of families, workers' flows bring out a characterization of national territory depending on local economic and social features and overcoming provincial and regional administrative boundaries. Therefore, 167 LLSs are multi-provincial, and 49 of them are multi-regional as well (Istat, 2005). Moreover, it is important to point out LLS classification is also used to identify the 156 Italian industrial districts, which are particular local systems sharing historic, cultural and productive features (Becattini, 1979).

However, political boundaries are not fixed in time, and LLS classification evolves with economic and social changes. Since 1981, in fact, the number of LLSs decreased from 955 to 784 in 1991 and further reduced to 686 as of the population census of 2001 (data concerning the Italian population census of 2011 is not available yet).

Re-processing of data according to LLS classification by Istat usually requires a very long time, which makes the lack of data greater than for provincial or regional aggregations. In spite of this criticality, the use of LLS classification is conceptually more suitable because it better explains local socio-economic dissimilarities.

For the sectorial breakdown, employment data by Istat are based on a standard intermediate-level aggregation of 38 ISIC (International Standard Industrial Classification of All Economic Activities) categories for internationally comparable SNA data reporting (Vicari et al., 2009). Overall, SNA/ISIC aggregation includes 21 macro-categories (1-digit classes) and 38 sub-categories (2-digit classes), but data by Istat exclude macro-categories T (Activities of households as employers; undifferentiated goods and services producing activities of households for own use) and U (Activities of extraterritorial organizations and bodies). The applied classification is set out in *Appendix A.*

3.3 Variables

Dependent variables

The aim of the analysis concerns the assessment of LLSs' capacity to be resilient in face of an external shock. For this assessment, a performance variable must be applied. The value added (Boschma et al., 2012) and the level of employment (Frenken et al., 2007; Boschma and Iammarino, 2009; Mameli et al., 2012) are the two most commonly used variables to measure the competitiveness of firms in a region at the aggregate level. However, this research focuses

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[5]Methodology of LLSs' identification is developed by Fabio Sforzi in *I sistemi locali del lavoro 1991*, Collana Argomenti n. 10, Istat, Roma, 1997.

only on employment level, because data on value added based on LLSs classifications are available by Istat only until 2005. The level of employment is measured in two ways: as a logarithm of employment rate ($LabRate_{\text{sll}}$) in 2007, to evaluate the factors determining the employment capacity of an LLS at a fixed point; and as growth of the employment rate ($LabGrowth_{\text{sll}}$) over the period 2007 to 2011, to assess the resiliency factors able to reduce the negative effects of the crisis or to anticipate the economic recovery of local firms.

Independent variables

Diversified economy. The entropy of the local system is an indicator of the systemic variety. It is usually implemented by using concentration measurements. Mariotti et al. (2006) suggest the Herfindhal index – see Eq. (1). A high index value means employment within the SLL is concentrated in a few industries, and suggests low entropy and a greater specialization of territory. Conversely, lower values relate to greater cognitive heterogeneity and higher levels of entropy.

$$Var_{lls} = \sum_{ind=1}^{N} N_{ind} \left(\frac{E_{ind}/N_{ind}}{E_{lls}} \right)^2 \qquad (1)$$

where A_{sll} is the total number of employees of each LLS, while N_{ind} and E_{ind} are, respectively, the local units of enterprises and the number of employees in local businesses, grouped by sub-categories of intermediate SNA/ISIC sectorial classification.

Related and unrelated variety. Based on the concept of 'related variety' suggested by Asheim et al. (2011), in industries with different but related and complementary knowledge bases, transfer processes of knowledge, resources and competences tend to produce more value and innovation than in too homogeneous or too heterogeneous industries (Frenken et al., 2007). A minimal degree of cognitive proximity (Noteboom, 2000) is necessary to support effective communication and interactive learning processes without producing situations of lock-in (Boschma and Iammarino, 2009), so that excessive distance between cognitive assets generally entails greater difficulties in undertaking effective relationships with other actors. However, excessive proximity creates redundant ties that make radical innovation and new knowledge creation processes less likely and profitable (Nooteboom, 2006).

Related and unrelated variety are computed following Frenken et al. (2007) and Mameli et al. (2012), but with a change to the depth of the used digit-level, due to the structure of available data by Istat. Thus, the first is measured as a weighted sum of entropy at the 2-digit level (sub-categories in *Table 1*) within each 1-digit class (macro-categories in *Table 1*) – see Eq. (2); the second, as entropy at the 1-digit level (macro-categories in *Table 1*) – see Eq. (3):

$$RelVar_{lls} = \sum_{ind=1}^{N} \frac{p_{ind_{sub.cat}}}{p_{ind_{macro.cat}}} log_2 \left(\frac{1}{p_{ind_{sub.cat}} / p_{ind_{macro.cat}}} \right) \quad (2)$$

where $p_{ind} = E_{ind,lls}/E_{lls}$ is the share of employment in each industry of an LLS (measured by using macro- and sub-category aggregation) on the total employment of an LLS (Table 7-2 in Istat, 2007).

$$UnrelVar_{lls} = \sum_{ind=1}^{N} p_{ind_{macro.cat}} log_2 \left(\frac{1}{p_{ind_{macro.cat}}} \right) \quad (3)$$

Differentiated knowledge bases. Through the association of each sector to a specific prevailing knowledge base, we are able to grasp with sufficient quantitative rigor the role of differentiated knowledge bases in the determination of the resilience of local production systems. *Table 1* reports only industries matched respectively to analytic, synthetic and symbolic knowledge bases. Analytic knowledge is more typical of high and medium-high technological industries and research and development services. Synthetic knowledge is more associated with low- and medium-technological manufacturing industries and mainly to knowledge-intensive market and financial services. Activities with a highly symbolic component characterize knowledge-intensive high-tech services and creative industries (Florida et al., 2008) that positively affect 'regional creative climate' (Dziembowska-Kowalska and Funck, 2000) and are an important source of competitiveness and economic development of local systems (Lazzeretti et al., 2008). The classification in *Table 1* is adapted from Aslesen and Freel (2012).

INSERT TABLE 1 ABOUT HERE

Secondly, a concentration index is built to define the levels of differentiated knowledge bases for each LLS. It is measured as the ratio between local and national levels of the concentration of employment in industries grouped by differentiated knowledge bases – see Eq. (4).

$$KnowledgeBases_{ind,lls} = \frac{E_{ind,lls}}{E_{lls}} \bigg/ \frac{E_{ind}}{E_{tot}} \quad (4)$$

where $E_{ind,lls}$ is the number of an LLS's employees in industries with some prevailing knowledge base; E_{sll} is the total number of an LLS's employees; E_{set} is the total national number of employees in the same particular industries; and E_{tot} is the total national number of employees.

A value of the index over 1 specifies a higher concentration level of some knowledge bases in an LLS than the national average. Conversely, a value of less than 1 suggests a low

concentration in a particular knowledge base.

Control Variables

Population density (PopDensity). Population density is used to measure the size of local labour systems. Moreover, following Mameli et al. (2012), it is often considered a proxy for externalities related to the process of urbanization. It is supposed more populous systems are also more likely to house universities, industry research laboratories, trade associations and other knowledge-generating organizations (Frenken et al., 2007). Thus, urbanization economies likely better support knowledge production, absorption and transfer.

Macro geographical area (North). Due to economic and structural features that match spatial heterogeneity, a dummy is used to distinguish LLSs localized in Northern Italy. They are usually more industrialized, internationalized and structurally organized.

Industrial districts (IndDistrict). A dummy is used for district LLSs. The definition of LLS is a restricted geographical area that integrates a community of people, workers and local firms; however, just 156 of 686 LLSs are officially recognized by Istat (Sforzi and Lorenzini, 2002) as industrial districts, *á la* Becattini (1998, 2000). The matching between LLS and industrial district, in fact, depends on several criteria such as degree of industrialization, rate of SMEs, productive specialization and so on. Industrial districts are historically some of the most productive areas of Italy (Becattini, 1998).

External linkages. The external linkages are captured through an indicator of the degree of internationalization (*DOI*). The literature has generally shown the positive effects that the process of internationalization has on company performance (Bausch & Krist, 2007; Ruigrok & Wagner, 2004). A higher international involvement encourages reorganization processes of organizational practices (Teece, 2007), supports experiential learning processes (Johanson and Valhne, 2003), facilitates access to new knowledge by exploiting the global expansion of relational networks (Jansson and Sandberg, 2008) and increases the cognitive assets of directly and indirectly internationalized local firms (Rullani, 2004). Rullani (2004) suggested local firms indirectly involved in internationalization process – because they are included in global networks by internationalized firms embedded in the same territorial system – benefit from positive externalities. Internationalization processes are becoming crucial for industrial districts, capturing the attention of a number of theoretical and empirical contributions (among the others: Rabellotti et al., 2009; Belussi and Sedita, 2008; Chiarvesio et al, 2010; Belussi and Sammarra, 2010).

In this study, the international involvement of the local system is measured by the ratio between employees of exporting local units (A_{exp}) and total employees of the local system (A_{lls}) – see Eq. (5).

$$DOI_{lls} = \frac{A_{exp}}{A_{lls}} \quad (5)$$

Although a complete analysis should take into account other internationalization modes, such as foreign direct investment (of which, however, no data are available at the level of LLS), the Italian entrepreneurial structure, consisting of 98% SMEs, makes export capacity a good indicator of the international involvement of local systems. Based on Basile et al. (2003), who showed that firms that adopt more complex forms of internationalization do not stop exporting, and, similarly, on Head and Ries (2004), who argued that a substitution effect between exports and other forms of global expansion is not relevant, we suppose a greater propensity to export is likely related to a higher predisposition to use other forms of internationalization.

3.4 Descriptive statistics

Descriptive statistics and the correlation matrix of dependent and predictor variables are reported in *Table 2*.

INSERT TABLE 2 ABOUT HERE

The labour rates in 2007 ranged between 26% and 61%, with an average value close to 43%. The growth of the employment rate over the period 2007 to 2011 is largely negative; just over 25% of LLSs registered an increase.

The distribution in *Figure 1* places LLSs with a higher employment rate in Northern Italy and justifies the implementation of a geographical area dummy as a control variable. In terms of the growth of the employment rate, distribution is more heterogeneous, but again suggests a more positive prevalence in the northern local systems.

INSERT FIGURE 1 ABOUT HERE

The maps of related and unrelated variety provided in *Figure 2* present two partially different contexts. Some LLSs with high levels of aggregation show high levels of unrelated variety, as well. There are local systems that evidence contrasting results, such as LLSs in North-eastern Italy. The partial matching between related and unrelated variety is further supported by a positive correlation (0.476).

INSERT FIGURE 2 ABOUT HERE

About differentiated knowledge bases, synthetic ones range between 0.21 and 1.68, shifting more homogeneously across LLSs. Analytic- and symbolic-based LLSs (with an index value higher than the national one) represent just over 25% (*Table 2*). *Figure 3* shows highly concentrated LLSs by plotting a dummy (differentiated knowledge base index over or under

1, which represents the national average) with respect to each differentiated knowledge base. The distribution by knowledge base is very different, and the evidence confirms very low correlation levels, mainly between synthetic and symbolic knowledge bases.

INSERT FIGURE 3 ABOUT HERE

Statistics concerning the degree of internationalization show low global LLSs with values close to zero and, contrastingly, more international LLSs where half of the total local workforce is employed in exporting local units (*Table 2*). Interestingly, international involvement is highly related to synthetic specialization, and, conversely, no relationship is observed with symbolic specialization.

3.5 Analysis and results

Hierarchical multivariate regression models are implemented to assess the effect of diversified economy, related and unrelated variety and types of knowledge bases on static and dynamic employment capacities of LLSs. *Table 3* refers to employment levels in 2007, while *Table 4* analyses growth of employment rates from 2007 to 2011. Indicators related to different types of agglomeration economies are sequentially introduced into the models: general entropy (*Var*) to test the effect of sectorial variety; related (*RelVar*) and unrelated variety (*UnrelVar*) to test different types of intra- and inter-industry diversification; and differentiated knowledge bases (*AnalyticKB, SyntheticKB, SymbolicKB*) to test different types of knowledge specializations and their quadratic effects.

Results for employment rate

Table 3 provides results for the employment rate fixed to 2007. Since a high Herfindhal index value means high sectorial concentration, model 1 specifies the negative effect of excessive concentration, and so the positive influence of systemic entropy on LLSs' employment capacities. Systemic variety positively and statistically explains employment differentials between local systems. Larger inter-industry heterogeneity, in fact, implies a more dynamic and competitive environment producing positive externalities on systemic competitiveness (Mariotti et al., 2006; Jansen et al., 2006) by diffuse hybridization and contamination between different competences across industries.

Furthermore, control variables need to be primarily interpreted. Firstly, Northern local systems have higher employment rates, likely related to the greater logistic integration and geographical proximity to other industrialized European countries, which supports economic development by facilitating internationalization processes. This latter finding is confirmed by a statistically positive effect of international linkages. Secondly, population density, used as urbanization economies' proxy, adversely affects employment rate. Likely, urbanized cities catch labour force exceeding their real employment capacity, producing a negative effect on employment rates. This attraction power is probably influenced by highly porous frontiers between urban and non-urban spaces and by a high mobility between different urban areas. Finally, local district systems show average employment levels higher than traditional LLSs

in all models, likely due to productive structure and specialization. That suggests the still relatively crucial role of industrial districts on national employment capacity.

Using model 1, the entropy index was replaced by related and unrelated variety. In model 2, results point out that related and unrelated variety statistically and positively affects local employment levels. Even if the unrelated variety coefficient is slightly higher than the related variety one, the latter becomes prevalent since, in model 5, knowledge bases are introduced, as well.

In model 3, differentiated knowledge bases are introduced in a linear shape. LLSs with symbolic specialization result in the most performance. A focus on synthetic knowledge bases negatively affects employment capacity. Analytic ones are statistically insignificant.

In model 4, differentiated knowledge bases are tested by assessing quadratic shape. Firstly, findings confirm the irrelevance of analytic knowledge. Secondly, synthetic knowledge base shows a U-shaped effect on employment rate; just as extensive synthetic specialization positively affects LLSs' employment capacity. Thirdly, symbolic knowledge base shows an inverted U-shape. That suggests symbolic based industries are very important to supporting local employment, but excessive specialization is self-defeating.

Such findings are confirmed in model 5 by introducing related and unrelated variety.

INSERT TABLE 3 ABOUT HERE

The robustness of hierarchical models was also tested by measuring R2, adjusted R2 and F-stat of models. In particular, the positive change in R2 by including predictor variables suggests the goodness of the models. To test for potential multicollinearity, variance inflation factor (VIF) is further computed for each explanatory variable. The highest VIF value for each model is reported in *Table 3*. VIF values do not show serious multicollinearity. The highest values in model 3, 4 and 5, due to correlation between DOI and synthetic knowledge, are still significantly below the threshold value of 10, which is generally considered as critical.

In conclusion, results suggest that a diversified economy plays an important role in LLSs' employment capacity, independent of related or unrelated variety (variety is important regardless of type); analytic knowledge base is not important, a synthetic one requires a strong specialization to positively affect local employment; and symbolic and creative knowledge bases can be stimulating drivers but with decreasing effects.

Results for employment growth

Table 4 provides results for employment growth over the period 2007-2011. This complementary analysis aims to identify crucial factors favouring local employment dynamics and local resilience to globally recessive economic conditions.

Firstly, the significance and negative sign of systemic entropy (a lower value means higher heterogeneity) suggest the global crisis mainly affects LLSs characterized by excessive industrial concentration, and, conversely, a larger sectorial diversification allows an LLS to more effectively face adverse economic conditions. The positive effect of regional diversity is confirmed in all tested models.

Secondly, the analysis of related and unrelated variety highlights more specific results (models 2). While related variety is significant and positive across all tested models (2 and 5), unrelated variety seems to have no effects on employment growth. In other words, job creation depends mainly on local related diversification of activities and services. Related variety is likely the most important factor supporting LLSs' resilience capacity. This main result aligns with the fact that main local clusters in Italy are characterized by a high level of (context) specialization and consequently an over-representation of the role of related variety with respect to unrelated variety.

Thirdly, LLSs principally based on a symbolic knowledge base show employment growth rates higher than local systems focusing on synthetic and analytic types of knowledge (model 3). In particular, analytic specialization does not affect employment rate, while synthetic specialization is negatively related. By studying the quadratic effect of knowledge bases (model 4), findings confirm, on one hand, the statistical insignificance of analytic specialization and negative linear effect of synthetic specialization, and suggest on the other hand, an inverted U-shaped relationship between symbolic knowledge base and employment growth. This is a trajectory probably also explained by some substitution effects between symbolic knowledge and labour forces, or in other words between technology and labour also in the case of highly specialized craftsman activities.

Finally, model 5 summarizes the main results. Supporting local resilience requires related variety more than unrelated; a symbolic knowledge base produces positive but decreasing effects; synthetic specialization reduces local performance; and analytic specialization is insignificant.

However, the including of internationalization involvement in models 6 and 7 emphasizes that none of the specific industrial settings is positively related to employment growth and local resilience. In crisis times, specialization in a synthetic knowledge base seems to negatively affect local performance. This is probably explained by a very slow transition between cost performances (tangible productivity) with respect to quality performances (intangible productivity), or in other words between a quantity-focused industrial economics towards a quality-focused industrial economics.

INSERT TABLE 4 ABOUT HERE

By analysing the control variables, the robust significance and positive sign across tested models suggests that degree of internationalization plays a crucial role in supporting

employment dynamics. Population density is irrelevant or displays a negative coefficient sign. According to Mameli et al. (2012, 11), '*urbanization economies are offset by diseconomies arising, for instance, from congestion or high land rents*'. In addition, Frenken et al. (2007), in their study, argued the effects on employment growth are not due to urbanization per se. The authors assert, '*related variety is responsible for job creation, which is often, but not necessarily, highest in cities*'. Geographical heterogeneity analysis shows Northern LLSs are usually better performing than Central and Southern macro-regions. This is likely due to a general higher industrialization capacity of Northern areas, experienced by a higher proximity to European regions, which confirms the importance of international involvement. This result is also due to better inter-connections (logistics, infrastructures, education networks and commercial networks) between urban and non-urban areas in Northern Italy with respect to Southern and Central Italy.

Interestingly, the role of industrial districts still seems to be relevant in supporting employment growth, even if some recent studies question the capabilities of industrial districts to successfully face global competition (Rabellotti et al., 2009; Nardozzi, 2004). Such a finding suggests the importance of supporting the evolution of traditional industrial districts by supporting a more active internationalization process (Zucchella, 2006; Onetti and Zucchella, 2012), through sharing innovation processes through more locally and globally integrated networks (Asheim & Isaksen, 2002), by process, product and functional upgrading (Humphrey & Schmitz, 2002) to face competition from low cost producers in emerging countries.

4. Discussion

Evidence suggests that regional systems' employment capacity and growth depend, on the one hand, on variety and particularly on related variety, and on the other hand, on accurate integration of differentiated knowledge bases.

Related variety enhances employment growth and regional resilience by promoting interaction processes and virtuous paths for creativity and innovation, which are more stable and replicable over time than the ones coming from unrelated businesses. Therefore, regional systems need to identify prevalent competitive industries and support the development of complementary more than unrelated knowledge. This is probably explained by three main aspects, firstly because of the presence of industries with a low level of interdependences between them – inherently harder in the Northern than in Southern Italy; secondly, because of the predominantly very small size of the firms (95% under 10 workers on average); and thirdly, because of the prevalent nature of innovation, which is mainly incremental and due to intangible or informal practices.

Moreover, the concept of related variety refers to the paradigm of 'collaborative innovation', in a context where few companies actually have the resources to support a stable and

continuous innovation path. Even large companies struggle alone to guard the frontier of innovation (Onetti and Zucchella, 2008). An effectively distributed innovation process depends on firms' cooperation, which typically is positively affected by sharing languages and knowledge bases, and consequently related to spatial, cultural and cognitive proximity. However, several authors advocate proximity as able to produce incremental innovations, whereas value creation is usually higher when knowledge bases are reinterpreted and matched to produce radically more than incremental innovation, by fostering organizational discontinuities (Teece, 2007) and 'disruptive innovation' (Chrinstensen, 1997) or to exploit development opportunities of a firm's core business (through, for instance, exaptation processes). In this sense, local firms' internationalization does not mean just new markets and new opportunities for business expansion, but allows introducing new actors in a firm's business and social networks, therefore multiplying the opportunities for social interaction and knowledge exchange, supporting a reallocation of knowledge on global level, identifying new application fields (exaptation) or increasing chances for distributed and collaborative innovation processes. A large body of literature (Johanson and Valhne, 2003; Bolmstermo and Sharma, 2003; Hsu and Pereira, 2008; Jansson and Sandberg, 2008) has argued the positive influence of internationalization on learning process by accessing new relationships and new knowledge, which increases the cognitive diversity of the territorial system, promoting conditions of entropy and related variety and affecting growth and value creation. Rullani (2004) argued global firms in a local network are hubs that favour the access of local firms to global networks (see also Belussi et al., 2011). Such firms benefit from the positive externalities derived from firms involved in international markets. Therefore, internationally embedded regional systems have more resources and are more able to support entrepreneurial growth. Global openness creates the conditions for channelling knowledge flows, supporting systemic variety and making local systems more flexible and resilient.

Concerning the role played by differentiated knowledge bases, regression analysis highlights the inefficiency of an analytical knowledge base in supporting an LLS's employment and resilience. Differently, local industrial structure based on synthetic knowledge specialization shows conflicting findings. On the one hand, it tends to support a higher local employment capacity, but, on the other hand, it is unable to effectively affect the rate of resilience of a local production system. However, since synthetic knowledge bases evidence a U-shaped trend, the former finding suggests that a minimum structural capacity is required. On the contrary, the latter finding, which emphasizes that resilience capacity does not depend on synthetic knowledge specialization, suggests policies supporting industrial reconfiguration in order to increase local employment need to adequately match the differentiated knowledge bases. Supporting specialization focused on synthetic knowledge-based industries can be useful in the short term, but is unable to guarantee long-term resilience capacity.

Finally, LLSs with a significant symbolic knowledge base are the most positively performing. Concerning the effect on employment rates, the U-shaped relation of symbolic knowledge

bases compared to the inverted U-shaped relation of synthetic ones confirms they need to be adequately integrated. Similarly, an inverted U-shaped relationship between symbolic specialization and employment growth suggests symbolic knowledge is not required to be prevalent but should be balanced with other knowledge bases. In other words, creativity (symbolic knowledge base) is likely able to promote the spread of analytic and synthetic knowledge and to explore new application fields.

5. Conclusions

This work aimed to investigate the factors affecting the resilience of LPSs. Rooted in the evolutionary economic geography literature, the authors offered an original contribution where the concept of diversified economy, related variety and differentiated knowledge bases were considered as complementary in shaping the rate of resilience of an LPS. The capacity to positively face an external shock is due to the characteristics of economic systems that mark heterogeneously different geographical and institutional areas. Our empirical evidence, based on an accurate descriptive and multivariate analysis of data coming from Istat, reveals the main features of Italian resilient ecosystems. Related variety and symbolic knowledge base appear to be drivers of regional resilience. Italian LPSs are not all the same, and the variety in the economic structures of systems affects their performance heterogeneously. This is coherent with a multiple path-dependent evolutionary trajectory, also posed by Belussi and Sedita (2009). Therefore, this work provides support to the approach proposed by Asheim, Boschma and Cooke (2011), who stressed the importance of a platform policy approach to regional development, where related variety and differentiated knowledge bases are the two main components that differentiate regional economies. Our most challenging research result concerns the poor resilience of regional systems characterised by the prevalence of industries with an analytical knowledge base. This evidence suggests that the competitiveness of Italian firms is not centred on the most high-tech activities, but is sustained by more complex innovation dynamics, which are not reflected by official investments in R&D. The positive impact of symbolic knowledge base activities gives further support to this interpretation, leaving room for the idea that core resources for the sustainability of Italian economies have to be found not, or not predominantly, in technology-intensive fields, but in more creativity-intensive fields, whose outputs may become inputs for renewing more traditional manufacturing activities (such as in the case of design, illustrated by Bettiol and Micelli, 2014). Country-specific factors affect regional resilience, alongside with a variety of capitalism approaches (Hall and Soskice, 2001). This work has the limitation of basing the empirical evidence on analysis of a single country. Further research is needed to capture cross-country drivers of resilience, where our framework may be applied.

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Table 1 – Differentiated knowledge bases depending on SNA/ISIC classification

SNA class.	*Industries' description*	*Isic code*	*Cognitive base*
CE	Manufacture of chemicals and chemical products	20	Analytic
CF	Manufacture of basic pharmaceutical products and pharmaceutical preparations	21	
CI	Manufacture of computer, electronic and optical products	26	
MB	Scientific research and development	72	
JA	Publishing, audiovisual and broadcasting activities	58 to 60	Symbolic
JB	Telecommunications	61	
JC	IT and other information services	62 + 63	
R	Arts, entertainment and recreation	90 to 93	
CA	Manufacture of food products, beverages and tobacco products	10 to 12	Synthetic
CB	Manufacture of textiles, wearing apparel, leather and related products	13 to 15	
CC	Manufacture of wood and paper products; printing and reproduction of recorded media	16 to 18	
CD	Manufacture of coke and refined petroleum products	19	
CG	Manufacture of rubber and plastics products, and other non-metallic mineral products	22 + 23	
CH	Manufacture of basic metals and fabricated metal products, except machinery and equipment	24 + 25	
CJ	Manufacture of electrical equipment	27	
CK	Manufacture of machinery and equipment n.e.c.	28	
CL	Manufacture of transport equipment	29 + 30	
CM	Other manufacturing; repair and installation of machinery and equipment	31	
D	Electricity, gas, steam and air conditioning supply	35	
E	Water supply; sewerage, waste management and remediation	36 to 39	
K	Financial and insurance activities	64 to 66	
L	Real estate activities	68	
MA	Legal, accounting, management, architecture, engineering, technical testing and analysis activities	69 to 71	
MC	Other professional, scientific and technical activities	73 to 75	
N	Administrative and support service activities	77 to 82	
O	Public administration and defence; compulsory social security	84	
P	Education	85	
QA	Human health activities	86	
QB	Residential care and social work activities	87 + 88	

Source: Our elaboration from Aslen and Freel (2012)

Table 2 – Descriptive statistics and correlation matrix

							Correlation Matrix									
Variables	*Min.*	*1st Q.*	*Median*	*Mean*	*3rd Q.*	*Max.*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
1. LabRate	0,26	0,37	0,44	0,43	0,50	0,61	1,00									
2. LabGrowth	-0,22	-0,05	-0,01	-0,02	0,01	0,18	0,39	1,00								
3. Var	0,00	0,00	0,00	0,00	0,00	0,03	-0,12	-0,19	1,00							
4. RelVar	2,22	4,31	4,94	4,85	5,48	6,83	0,25	0,23	-0,44	1,00						
5. UnrelVar	1,82	2,85	3,01	2,99	3,16	3,57	-0,19	0,05	-0,27	0,48	1,00					
6. AnalyticKB	0,00	0,06	0,22	0,52	0,60	11,46	0,23	0,13	0,27	0,27	0,02	1,00				
7. SyntheticKB	0,22	0,69	0,85	0,87	1,06	1,62	0,45	0,05	-0,02	0,25	-0,34	0,19	1,00			
8. SymbolicKB	0,03	0,33	0,45	0,53	0,65	4,47	0,17	0,16	-0,21	0,39	0,50	0,11	-0,08	1,00		
9. External linkages	0,00	0,06	0,14	0,17	0,27	0,55	0,74	0,24	-0,03	0,25	-0,38	0,34	0,80	0,00	1,00	
10. PopDensity	0,01	0,05	0,10	0,19	0,20	3,96	0,02	-0,09	-0,23	0,29	0,20	0,08	0,11	0,29	0,12	1,00

Table 3 – Multivariate regression models. Dependent variable: employment rate (log) 2007.

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Intercept	-0.902 (0.00)***	-0.902 (0.00)***	-0.902 (0.00)***	-0.902 (0.00)***	-0.108 (0.05)*
Predictor Variables					
Diversified economy	-0,021 (0,00)***				
Related Variety		0.011 (0.00)*			0.011 (0.00)*
Unrelated Variety		0.020 (0.00)***			0.011 (0.00)
AnalyticKB			-0.006 (0.00)	-0.003 (0.00)	
AnalyticKB^2				-0.001 (0.00)	
SyntheticKB			-0.037 (0.00)***	-0.032 (0.00)***	-0.032 (0.00)***
SyntheticKB^2				0.009 (0.00)**	0.016 (0.00)***
SymbolicKB			0.036 (0.00)***	0.067 (0.00)***	0.055 (0.00)***
SymbolicKB^2				-0.007 (0.00)***	-0.005 (0.00)***
Control Variables					
DOI	0.085 (0,00)***	0.087 (0,00)***	0.117 (0,00)***	0.109 (0,00)***	0.108 (0,00)***
PopDensity	-0,022 (0.00)***	-0,024 (0.00)***	-0,024 (0.00)***	-0,032 (0.00)***	-0,036 (0.00)***
IndDistrict	0.027 (0.01)*	0.048 (0.01)***	0.064 (0.01)***	0.064 (0.01)***	0.068 (0.01)***
North	0.143 (0.01)***	0.141 (0.01)***	0.119 (0.01)***	0.115 (0.01)***	0.113 (0.01)***
Statistics					
N	686	686	686	686	686
R2	0,652	0,658	0,691	0,72	0,723
Adj. R2	0,649	0,655	0,688	0,716	0,719
Max Vif	2.176	2.652	4.887	5.408	5.149

*Signif. level: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Table 4 – Multivariate regression models. Dependent variable: employment growth 2007-2011.

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Intercept	-0.126 (0.05)*	-0.159 (0.05)**	-0.140 (0.05)*	-0.115 (0.06).	-0.109 (0.05)*
Predictor Variables					
Diversified economy	-0,223 (0,40)***				
Related Variety		0.180 (0.05)***			0.205 (0.05)***
Unrelated Variety		0.076 (0.05)			-0.010 (0.05)
AnalyticKB			0.011 (0.04)	0.010 (0.04).	
AnalyticKB^2				-0.015 (0.00).	
SyntheticKB			-0.327 (0.06)***	-0.317 (0.06)***	-0.368 (0.06)***
SyntheticKB^2				0.027 (0.03)	
SymbolicKB			0.149 (0.04)***	0.272 (0.05)***	0.181 (0.06)**
SymbolicKB^2				-0.029 (0.00)**	-0.019 (0.00)*
Control Variables					
DOI	0.156 (0,41)**	0.117 (0.06)*	0,388 (0.07)***	0.363 (0.08)***	0.396 (0.08)***
PopDensity	-0,107 (0.04)**	-0.111 (0.04)**	-0.047 (0.04)	-0.091 (0.04)*	-0.136 (0.04)**
IndDistrict	0.061 (0.09)	0.069 (0.10)	0.205 (0.10)*	0.206 (0.10)*	0.252 (0.10)*
North	0.412 (0.09)***	0.423 (0.09)***	0.277 (0.10)**	0.253 (0.10)*	0.210 (0.10)*
Statistics					
N	686	686	686	686	686
R2	0.134	0.135	0.149	0.168	0.189
Adj. R2	0.128	0.128	0.141	0.156	0.178
Max Vif	2.176	2.652	4.887	5.408	5.142

*Signif. level: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1*

Figure 1 – Maps of employment rate (on the left) and employment growth (on the right) distribution grouped for quartile

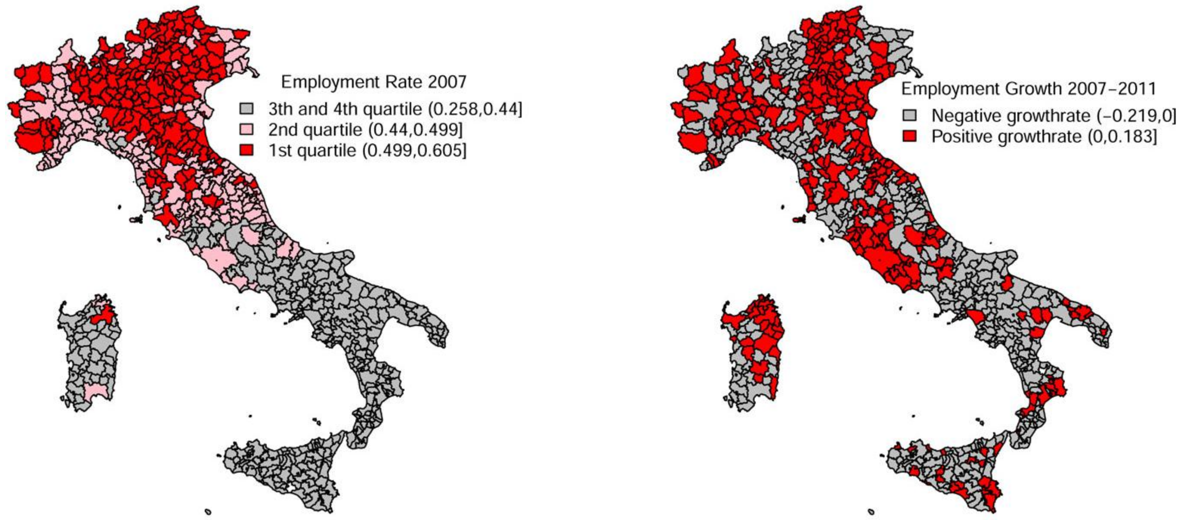


Figure 2 – Maps of related (on the left) and unrelated variety (on the right) distribution grouped for quartile.

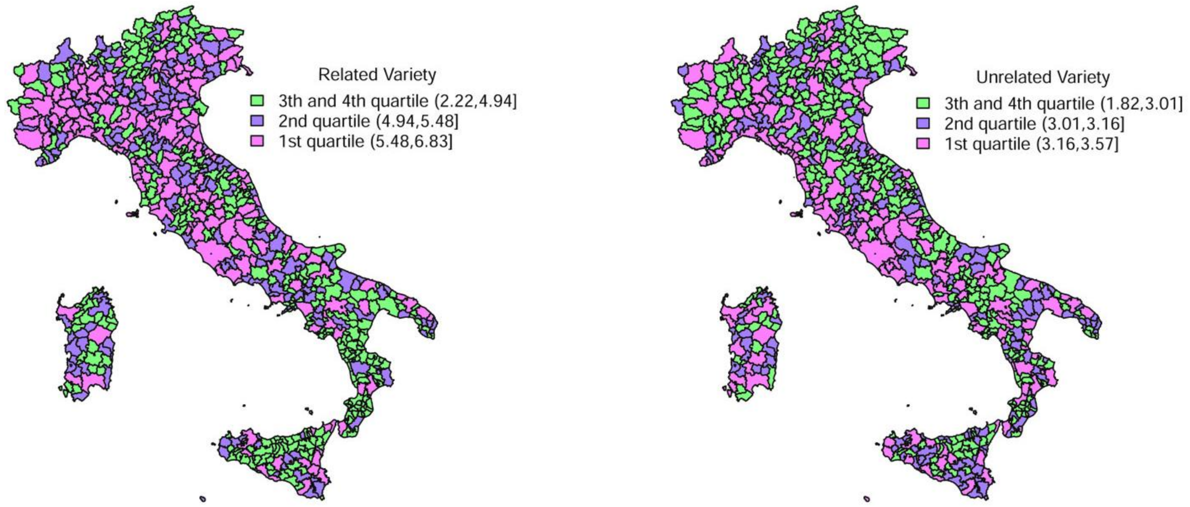
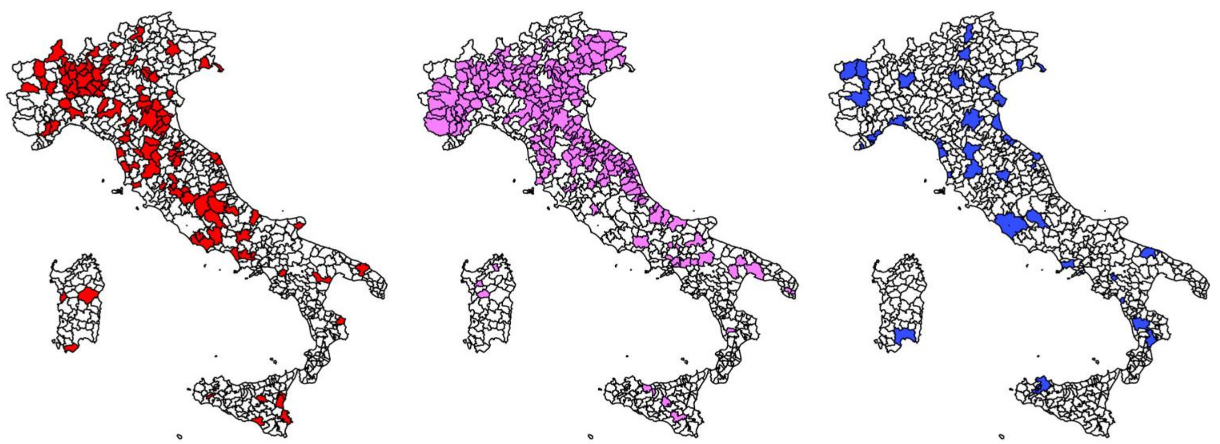


Figure 3 – Map of differentiated knowledge bases. From left to right, LLSs based respectively on analytic (left) synthetic (centre) and symbolic (right) knowledge are displayed.



APPENDIX A

SNA/ISIC classification

Macro	*Sub*	*Industries' description*	*Isic code*
A	A	Agriculture, forestry and fishing	01 to 03
B	B	Mining and quarrying	05 to 09
C	CA	Manufacture of food products, beverages and tobacco products	10 to 12
	CB	Manufacture of textiles, wearing apparel, leather and related products	13 to 15
	CC	Manufacture of wood and paper products; printing and reproduction of recorded media	16 to 18
	CD	Manufacture of coke and refined petroleum products	19
	CE	Manufacture of chemicals and chemical products	20
	CF	Manufacture of basic pharmaceutical products and pharmaceutical preparations	21
	CG	Manufacture of rubber and plastics products, and other non-metallic mineral products	22 + 23
	CH	Manufacture of basic metals and fabricated metal products, except machinery and equipment	24 + 25
	CI	Manufacture of computer, electronic and optical products	26
	CJ	Manufacture of electrical equipment	27
	CK	Manufacture of machinery and equipment n.e.c.	28
	CL	Manufacture of transport equipment	29 + 30
	CM	Other manufacturing; repair and installation of machinery and equipment	31
D	D	Electricity, gas, steam and air conditioning supply	35
E	E	Water supply; sewerage, waste management and remediation	36 to 39
F	F	Construction	41 to 43
G	G	Wholesale and retail trade; repair of motor vehicles and motorcycles	45 to 4
H	H	Transportation and storage	49 to 53
I	I	Accommodation and food service activities	55 + 56
J	JA	Publishing, audiovisual and broadcasting activities	58 to 60
	JB	Telecommunications	61
	JC	IT and other information services	62 + 63
K	K	Financial and insurance activities	64 to 66
L	L	Real estate activities	68
M	MA	Legal, accounting, management, architecture, engineering, technical testing and analysis activities	69 to 71
	MB	Scientific research and development	72
	MC	Other professional, scientific and technical activities	73 to 75
N	N	Administrative and support service activities	77 to 82
O	O	Public administration and defence; compulsory social security	84
P	P	Education	85
Q	QA	Human health activities	86
	QB	Residential care and social work activities	87 + 88
R	R	Arts, entertainment and recreation	90 to 93
S	S	Other service activities	94 to 96