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How do related variety and differentiated knowledge bases influence the resilience of local production systems?

Silvia Rita Sedita , Ivan de Noni and Luciano Pilotti

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 2013, focusing on the role played by diversified economy, related and unrelated variety and differentiated knowledge bases, as drivers for territorial resilience. 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 codes: R11, R12, O18

Keywords: Regional economic growth, industrial districts, sustainability, creative capacity of culture, resilience

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? New evolutionary economic geographers have been recently trying to answer this question, focusing on the identification of drivers for regional resilience, which is defined by Boschma (2009) as the ability of a system to overcome the tension between adaptation (through path-dependent growth paths) and adaptability (through new growth paths creation). Some authors focus on the study of business ecosystems[4] (Moore, 1993; Weeks et al., 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

[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).

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 development policies, are no longer sufficient to ensure competitiveness within the eco-system. The risk of an excess of path-dependent growth paths in industrial districts might undermine their ability to overcome external shocks. 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), 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 and overcome path dependent growth trajectories. 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 2007-2013, 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 (2012a), 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 recovering 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, 2012a: 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? These are our main research questions.

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 recent research often focuses on single 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. 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 (2012a), 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 (2012a) identified diversity of regional economic structure as a factor influencing adaptive resilience, but did not have data to measure this effect. As well put by Boschma (2014: 6) 'industrial variety in a region spreads risks and can better accommodate idiosyncratic sector-specific shocks'. Research work by Dissart (2003), Essletzbichler (2013), Davies and Tonts (2010), Desrochers and Leppala (2011) go in this direction. 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. Moreover, as suggested by Boschma (2014), diversified economies should show higher adaptability, which is considered a necessary condition for regional resilience. 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 Frenken and Boschma (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 highly

codified cultural context dependence, prevalently transferred by business relationships and market mechanisms. Moreover, as proposed by Boschma (2014), related variety should enhance the adaptability of regions, and therefore the resilience.
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.

Firms and organizations normally use a variety of knowledge sources and inputs 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 base.

By explaining the impact of related variety, Asheim et al. (2011) suggested an alternative conceptualization of types of knowledge base versus the more classical distinction between tacit and codified knowledge. They identified three relevant types: analytical, 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 base is about the aesthetic attributes of products, the creation of design elements and the use for economic purposes of various cultural products. 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.

Regions dominated by one or the other knowledge base are characterized by 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; Asheim and Hansen, 2009). Existing work on the importance of differentiated knowledge bases is largely grounded on in-depth case studies. Martin (2012b) and Aslesen and Freel (2012) are among the few trying to operationalize the concept of differentiated knowledge bases in a more systematic manner. Martin (2012b) measures the knowledge base in Swedish regions, mapping regions by the dominating knowledge base. His very interesting work leaves open questions on how the knowledge base structure of regions impacts on innovation and economic growth. Aslesen and Freel (2012) provide the first empirical work that quantitatively measures the impact of the dominating knowledge base on the innovation strategies of Norwegian firms. We suggest that the dominating knowledge base can explain differences in performance and resilience rates between local production systems.

Hyp. 3: The dominating knowledge base has an influence on the 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 resilience 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 actual economic crisis (from 2007 to 2013).

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' 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 the focus of the local labour market. LLSs are defined and geographically identified by analysing the flows of workers between 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).

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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.

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 only on employment level, because data on value added based on LLSs classifications are available from Istat only until 2005. The level of employment is measured in two ways: as a logarithm of employment rate ($LabRate_{lls}$) in 2007, to evaluate the factors determining the employment capacity of an LLS at a fixed point; and as growth of the employment rate ($LabGrowth_{lls}$) over the period 2007 to 2013, to assess the factors able to reduce the negative effects of the crisis or to anticipate the economic recovery of local firms (resilience).

Independent variables

Diversified economy. The entropy of the local system is an indicator of the systemic variety. It is usually implemented by using concentration measures. Industrial diversification is measured by Herfindhal index adopted by Mariotti et al. (2006) - see Eq. (1).

$$Herfindahl_{lls} = \sum_{i=1}^{n} N_i \left(\frac{E_i/N_i}{E_{lls}}\right)^2 \qquad (1)$$

E_{lls} is the total number of employees of each LLS, while N_i and E_i are, respectively, the local units of enterprises and the number of employees in local businesses, grouped by sub-categories i (where $i=1...n$) of intermediate SNA/ISIC sectorial classification.

Since we are interested to measure diversity effect more than concentration, fractionalization index (Alesina et al., 2003), based on Herfindahl index, is introduced in order to make the interpretation easier.

$$DivEcon_{lls} = 1 - Herfindahl_{lls}$$

A low index value means employment within the LLS is concentrated in a few industries, and suggests low entropy and a greater regional specialization. Conversely, higher values relate to greater cognitive heterogeneity and higher levels of entropy.

Related and unrelated variety. 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). Excessive cognitive distance generally entails greater difficulties in undertaking effective relationships with other actors. However, excessive cognitive 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. 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 one-digit sector *j* level (macro-categories in *Table 1*) – see Eq. (3):

$$RelVar_{lls} = \sum_{j=1}^{k} P_j \sum_{i=1}^{n} \frac{p_{ij}}{P_j} log_2 \left(\frac{1}{p_{ij}/P_j} \right) \qquad (2)$$

where $P_j = E_{j,lls}/E_{lls}$ is the share of employment in each industrial category *j* (where $j=1...k$) and $p_{ij} = E_{ij,lls}/E_{lls}$ is the share of all industrial sub-category *i* (where $i=1...n$) belonging to a one-digit sector *j*.

$$UnrelVar_{lls} = \sum_{j=1}^{k} P_j log_2 \left(\frac{1}{P_j} \right) \qquad (3)$$

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 analytical, synthetic and symbolic knowledge bases in the determination of the resilience of local production systems. The three knowledge bases need to be intended as abstracted ideal types because, in practice, no local economy structure is characterized by just one of the knowledge bases. Moreover, the degree to which a specific knowledge base dominates varies and depends on firms, industries and activities' features (Asheim and Hansen, 2009). Actually, some of the knowledge specializations are overlapping and this influences the empirical results.

In literature, both occupation data (Asheim and Hansen, 2009; Martin, 2012b) and industry sector data (Aslesen and Freel, 2012) are used to identify the dominating knowledge base of a local economy. Even though it might be useful and interesting matching both occupational and industrial categorizations, we are forced to use employment data in industries that are associated to different knowledge bases. This association is adapted (to make it comparable with above mentioned SNA/ISIC aggregation) from Aslesen and Freel (2012). According to this approach, analytical 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 for local systems (Lazzeretti et al., 2008). *Table 1* reports only industries matched respectively to analytical, synthetic and symbolic knowledge bases.

INSERT TABLE 1 ABOUT HERE

A location quotient (LQ) is operationalized to define the knowledge specializations for each LLS. The adoption of LQ as a geographical concentration measure is a classical technique used in economic geography to compare the presence of certain industries in a local economy with respect to a reference economy (Martin, 2012b). It is measured as the ratio of the share of employment in industries grouped by differentiated knowledge bases at local and national level – see Eq. (4):

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

where $E_{ind,lls}$ is the number of an LLS's employees in industries belonging to each type of knowledge base; E_{sll} is the total number of an LLS's employees; E_{ind} 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 above 1 specifies that the share of employment in a specific knowledge based industry is higher at local than national level. Conversely, a value of less than 1 suggests a low concentration in a specific knowledge based industry.

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 that 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 are more likely to 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. Moreover the dummy might be considered as a proxy for institutional structure, which is an important and often neglected variable in the resilience literature, as suggested by Boschma (2014). The Northern institutional structure is expected to be more coherent, supportive and favourable to change and thus able to foster adaptation and adaptability. Conversely, the Southern institutional lock-in is expected to negatively influence the development of new growth paths.

Industrial districts (IndDistrict). A dummy is used for identifying LLSs that can be considered as industrial districts. Industrial districts *á la* Becattini (1998, 2000) are LLSs that, in a restricted geographical area, integrate a community of people, workers and local firms. However, Istat recognizes as industrial districts only 156 out of the overall 686 LLSs (see Sforzi and Lorenzini, 2002). 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 exposure of a 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 use of export capacity qualifies as a good indicator of the international exposure of local systems, which are mainly composed by SMEs (98% of the Italian entrepreneurial structure). 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 claim that a greater propensity to export is related to a higher predisposition to use also 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 2013 is largely negative; just about 5.5% of LLSs registered a positive growth.

The distribution in *Figure 1* places LLSs with higher employment rates in Northern Italy, thus justifying the implementation of a geographical area dummy as a control variable. The distribution of the growth of the employment rate is a bit more heterogeneous, but again suggesting a more diffused prevalence of positive values in 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 related variety show also high levels of unrelated variety. Nevertheless, there are local systems reporting contrasting results, such as LLSs in North-eastern Italy, where at high levels of related variety correspond low levels of unrelated variety. The partial matching between related and unrelated variety is further supported by a positive correlation (0.48 – see *Table 2*).

INSERT FIGURE 2 ABOUT HERE

About differentiated knowledge bases, the synthetic knowledge base index ranges between 0.22 and 1.62, showing an even distribution across LLSs, while the other two indexes (relative to symbolic and analytical knowledge bases) are more unevenly distributed. *Figure 3* shows maps of the distribution of the LLSs according to their knowledge base specialization. Maps come from plotting a dummy (location quotient of differentiated knowledge bases above or below 1, which represents the national average) with respect to each knowledge base specialization. The distribution by knowledge bases is heterogeneous and, as it appears in Table 2, there is a very low correlation between the various knowledge base specialization levels, in particular between synthetic and symbolic knowledge bases. More than 25% of the LLSs are synthetic-specialized. Analytical- and symbolic-specialized LLSs (with an index value higher than the national one) are fewer in number and more unevenly distributed (*Table 2* and *Figure 3*).

INSERT FIGURE 3 ABOUT HERE

Statistics concerning the degree of internationalization show values close to zero for strongly localized LLSs and value over .5 (when half of the total local workforce is employed in exporting local units) for the most internationalized LLSs (*Table 2*). On average, 17% of the employment is concentrated within exporting firms. Finally, internationalization processes are more likely to occur in LLSs specialized in synthetic knowledge base (and thus traditional) activities (the correlation index is .80).

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 levels in Italian LLSs. *Table 3* refers to employment levels in 2007, while *Table 4* analyses growth of employment rates from 2007 to 2013. Indicators related to different types of agglomeration economies are sequentially introduced into the models: 1) diversified economy (*DivEcon*), to test the effect of sectorial variety; 2) related (*RelVar*) and unrelated (*UnrelVar*) variety, to test different types of intra- and inter-industry diversification; and 3) differentiated knowledge bases (*AnalyticalKB, SyntheticKB, SymbolicKB*), to test different types of knowledge specializations and their quadratic effects on employment levels and employment growth rates.

Results for employment rate

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

Coming to the interpretation of the control variables coefficients, we can observe the following. Firstly, Northern local systems have higher employment rates. This is partially due to path-dependent evolutionary trajectories, which historically reinforced more dynamic areas (both in terms of entrepreneurial orientation and institutional settings). Moreover, results seem also supporting the idea that this advantage is 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 on the dependent variable. 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, industrial districts show average employment levels higher than other LLSs (as it also happens in the other four models presented in Table 3), likely due to productive structure and specialization. This suggests that industrial districts still play a relatively crucial role on national employment capacity.

In model 2 related and unrelated variety indicators replaced the entropy index (which captures to what extent an economy is diversified). Results point out that related and unrelated variety statistically and positively affect local employment levels. Here the unrelated variety coefficient is slightly higher than the related variety one.

In model 3, differentiated knowledge bases indicators are introduced considering a linear relationship between them and the dependent variable. LLSs with prevalent symbolic specialization result the best performing. The synthetic knowledge base specialization of the LLSs negatively affects its employment capacity. The analytical knowledge base specialization does not affect significantly the LLSs' employment capacity.

In model 4, differentiated knowledge bases indicators are introduced considering a quadratic relationship between them and the dependent variable. Firstly, findings confirm the irrelevance of analytical knowledge base specialization. Secondly, the synthetic knowledge base specialization shows a U-shaped effect on employment rate: only an extensive synthetic specialization positively affects LLSs' employment capacity. Thirdly, symbolic knowledge base specialization shows an inverted U-shaped effect on employment rate. This suggests that symbolic knowledge based industries are very important to supporting local employment, but an excessive specialization is self-defeating.

Such findings are confirmed in model 5 by introducing related and unrelated variety together with differentiated knowledge bases. The main difference is that the introduction of knowledge base specialization indicators makes the effect of the unrelated variety on the employment rate not significant. Model 5, which includes related (and unrelated) variety and differentiated knowledge bases as drivers for regional competitiveness, better fits our data and thus confirms the need of adopting a combined framework of analysis.

INSERT TABLE 3 ABOUT HERE

The robustness of hierarchical models was tested by measuring their R^2, adjusted R^2 and F-stat. In particular, the positive change in R^2 obtained by including more variables as predictors confirms the goodness of the models. In order 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 base, 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); analytical knowledge base specialization is not relevant, a strong synthetic knowledge base specialization positively affects local employment rates; and, finally, symbolic knowledge base specialization might configures as a stimulating driver for employment, but with decreasing effects.

Results for employment growth

Table 4 provides results for employment growth over the period 2007-2013. This analysis aims to identify crucial factors favouring local employment dynamics and local resilience to globally recessive economic conditions.

Firstly, the significance and positive sign of systemic entropy – or diversified economy, suggests that the global crisis mainly affects LLSs characterized by extreme industrial concentration. Conversely, a larger sectorial fractionalization allows a LLS to face more effectively adverse economic conditions. 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 when variables related to knowledge base specialization are introduced as explanatory ones. 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 result aligns with the fact that the majority of Italian local systems is characterized by a high level of context-based specialization and consequently by an over-representation of related variety activities with respect to unrelated ones.

Thirdly, LLSs principally based on symbolic knowledge base show employment growth rates higher than local systems focusing on synthetic and analytical types of knowledge (model 3). In particular, analytical specialization does not affect employment growth, while synthetic specialization has a negative effect. By studying the quadratic effect of knowledge bases (model 4), findings suggest, on the one hand, a statistical insignificance of analytical and synthetic specialization, and, on the other hand, an inverted U-shaped relationship between symbolic knowledge base and employment growth. The decreasing effect of symbolic knowledge base specialization on employment growth might also be explained by the emergence of a substitution effect between immaterial and material labour (with an overall labour saving effect).

Finally, model 5 summarizes the main results. Supporting local resilience requires pushing towards industrial activities characterized by related variety more than unrelated; moderately investing in activities based on symbolic knowledge base (since the effect on employment growth is positive - but decreasing); and disinvesting in activities based on synthetic specialization alone, since they reduce regional resilience. The analytical knowledge based specialization is not impacting significantly on employment growth and thus resilience.

INSERT TABLE 4 ABOUT HERE

By analyzing the control variables, we observe that degree of internationalization (*DOI*) plays a crucial role in supporting employment dynamics, given that the coefficient estimate shows a robust significance and positive sign across all tested models. On the contrary, population density (*PopDensity*) coefficient estimate displays a negative sign, showing that regions characterized by urbanization economies are less able to face an external shock. 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 that the effects on employment growth are not due to urbanization per se. The authors asserted: 'related variety is responsible for job creation, which is often, but not necessarily, highest in cities' (Frenken et al., 2007: 693). The analysis of the geographical heterogeneity (*North*) shows that Northern LLSs are usually better performing than Central and Southern macro-regions in terms of resilience capability. This is likely due to a general higher industrialization capacity of Northern areas, which also show a higher proximity to European regions, therefore sustaining the importance of an international exposure in order to increase regional resilience. 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. In other words, the presence of more supportive and favourable institutions fosters adaptation and adaptability (Boschma, 2014) and thus the resilience capacity of the local systems.

Interestingly enough, industrial districts seem to play still a relevant role in supporting employment growth, even if some recent studies questioned the capacity of industrial districts to successfully face global competition (Rabellotti et al., 2009; Nardozzi, 2004) – see for another perspective on the topic the work of Belussi and Sedita (2012).

Finally, multicollinearity between variables and robustness of hierarchical regression model are further verified. The increasing R^2, the significance of F-statistic and maximum VIF value below threshold are all factors that highlight the goodness of the analysis. Again, model 5 better fits our data and shows the importance of keeping an integrated approach to regional resilience, which combine the related variety and the differentiated knowledge base approaches.

4. Discussion

In this study we focus on factors that support the resilience of local production systems and an integrated approach is introduced in order to explore the effects of variety and differentiated knowledge bases on employment rate and growth.

The findings suggest that diversified economies are generally better performing than concentrated economies, thus confirming Hyp.1. However diversification per se does not take into consideration the cognitive distance between sectors (Nooteboom, 2000) and related effects on regional performance. If, on the one side, too much cognitive proximity may result in regional lock-in (Crespo et al. 2013) and scarce contribution to the increase of existing knowledge (Mameli et al., 2012), on the other side, an excessive unrelated diversification may preclude fertile linkages and spillovers between actors and cross-fertilization processes. Related variety is argued to better support employment growth 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. However, even though several studies argued that related variety positively affects regional economic growth rates (Frenken et al., 2007; Boshma et al., 2012), empirical analyses are usually limited to positive economic cycles. This research contributes over the issue by displaying the positive effects of related variety also on regional adaptability as response to shocks, thus confirming Hyp.2.

We then further explore whether local specialization into differentiated knowledge bases, as compared to national level, is able to foster adaptation and resilience capacity of LLSs. The research findings highlight the inefficiency of an analytical knowledge base specialization in supporting LPSs' employment and resilience. Differently, local industrial structures based on synthetic knowledge base specialization show conflicting findings. On the one hand, the U-shaped trend on the level of employment rate suggests that a minimum dimension of synthetic specialization is required to support local employment capacity. On the other hand, findings concerning employment growth emphasizes that resilience capacity negatively depends on synthetic knowledge base specialization. This may suggest that policies supporting specialization focused on synthetic knowledge-based industries can be useful in the short term, but are unable to guarantee long-term resilience capacity.

Finally, local systems with a significant symbolic knowledge base specialization are to be likely considered the most resilient. However, the positive decreasing effects displayed by the inverted U-shaped relationship with both employment rate and employment growth suggest that an optimal level of symbolic specialization needs to be identified. Since local economies are not necessarily dominated by one single knowledge base (Martin, 2012b), a balanced mix needs to be adequately configured within local industrial composition. In other words, the symbolic knowledge base is not required to be dominating but should be combined with other knowledge bases in order to explore new application fields by fostering the inter-sectorial exchange of knowledge, know-how and meanings between differently specialized industrial settings. A heterogeneous impact of different knowledge base specialization is therefore confirmed, as proposed by Hyp.3.

Finally, some further considerations need to be highlighted. First, the effects of shocks on employment are stronger within urbanization economies and ask for supportive policies to be reasonably balanced. Second, the best performances of northern production systems likely suggest institutional completeness is able to better support employment rate and growth. An institutional structure, which is coherent, supportive and favourable to change, is able to enhance the interactions between knowledge bases and industries in the local system (Boschma, 2014). Third, internationally embedded local systems are expected to better support resources appropriability, adaptability and employment development. Global openness creates the conditions for channelling knowledge flows, supporting systemic variety and making local systems more flexible and resilient. Fourth, even though some traditional industrial districts have recently experienced poor performance, the positive influence on local resilience suggests the importance of supporting their evolution and competitiveness. In this regard, policy makers should likely foster districts' internationalization (Zucchella, 2006; Onetti and Zucchella, 2012) by promoting the creation of locally and globally integrated networks (Asheim & Isaksen, 2002; Iammarino and MacCann, 2013; Belussi and Sammarra, 2010) to enhance sharing innovation processes and productive and functional upgrading (Humphrey & Schmitz, 2002).

To sum up, policy platforms for the constructing of localized advantages requires 'a strategy based on related variety, which is defined on the basis of shared and complementary knowledge bases and competences' (Asheim et al., 2011: 901). In other words, in order to increase regional resilience, policy makers need to promote industrial reconfiguration by supporting related diversified economies through a balanced matching of different knowledge bases, where symbolic knowledge is likely the spreading factor. Nevertheless, local systems have a tendency to diversify in related activities (Neffke et al., 2011) by exploiting their specialized knowledge base, without encouraging integrated and balanced approaches.

We need to acknowledge here that the discussion on political implications so far has been partial, as the study is limited to the resilience in terms of employment growth, whilst knowledge specialization could be differently associated with different types of growth or innovation performances.

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 a 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 characterized 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 and further verified.

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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	Analytical
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	-0,26	-0,11	-0,07	-0,08	-0,04	0,08	0,51	1,00								
3. DivEcon	0,97	0,99	0,99	0,99	0,99	1,00	-0,12	-0,03	1,00							
4. RelVar	2,22	4,31	4,94	4,85	5,48	6,83	0,25	0,17	0,44	1,00						
5. UnrelVar	1,82	2,85	3,01	2,99	3,16	3,57	-0,19	-0,07	0,27	0,48	1,00					
6. AnalyticalKB	0,00	0,06	0,22	0,52	0,60	11,46	0,23	0,18	-0,27	0,27	0,02	1,00				
7. SyntheticKB	0,22	0,69	0,85	0,87	1,06	1,62	0,45	0,22	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	0,10	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	0,39	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	-0,04	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	-0.312 (0.04)***	-0.334 (0.03)***	-0.312 (0.03)***	-0.304 (0.03)***	-0.306 (0.03)***
Predictor Variables					
Diversified economy	0.123 (0,02)***				
Related Variety		0.063 (0.03)*			0.061 (0.03)*
Unrelated Variety		0.116 (0.03)***			0.061 (0.04)
AnalyticalKB			-0.036 (0.02)	0.017 (0.03)	
AnalyticalKB^2				-0.051 (0.03)	
SyntheticKB			-0.214 (0.04)***	-0.181 (0.03)***	-0.181 (0.03)***
SyntheticKB^2				0.069 (0.02)**	0.116 (0.03)***
SymbolicKB			0.205 (0.02)***	0.381 (0.03)***	0.316 (0.04)***
SymbolicKB^2				-0.225 (0.03)***	-0.188 (0.03)***
Control Variables					
DOI	0.485 (0,03)***	0.499 (0,03)***	0.669 (0,05)***	0.619 (0,05)***	0.614 (0,05)***
PopDensity	-0,125 (0.03)***	-0,136 (0.03)***	-0,203 (0.02)***	-0,186 (0.02)***	-0,202 (0.02)***
IndDistrict	0.159 (0.06)*	0.273 (0.06)***	0.363 (0.06)***	0.361 (0.06)***	0.390 (0.06)***
North	0.812 (0.06)***	0.802 (0.06)***	0.676 (0.06)***	0.654 (0.06)***	0.640 (0.06)***
Statistics					
N	686	686	686	686	686
R2	0.652	0.658	0.691	0.720	0.723
Adj. R2	0.649	0.655	0.688	0.716	0.719
Max Vif	2.177	2.652	4.887	5.493	5.669

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

Table 4 – Multivariate regression models. Dependent variable: employment growth 2007-2013.

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Intercept	-0.213 (0.05)***	-0.216 (0.05)***	-0.207 (0.05)***	-0.207 (0.05)***	-0.223 (0.05)***
Predictor Variables					
Diversified economy	0.140 (0,05)**				
Related Variety		0.093 (0.05)*			0.098 (0.05)*
Unrelated Variety		0.104 (0.05)*			-0.009 (0.06)
AnalyticalKB			0.058 (0.04)	0.094 (0.06).	
AnalyticalKB^2				-0.066 (0.05)	
SyntheticKB			-0.108 (0.06)*	-0.102 (0.06)	-0.128 (0.06)*
SyntheticKB^2				0.015 (0.04)	
SymbolicKB			0.146 (0.04)***	0.201 (0.05)***	0.206 (0.06)**
SymbolicKB^2				-0.095 (0.05)*	-0.363 (0.15)*
Control Variables					
DOI	0.240 (0,05)***	0.270 (0,05)***	0,315 (0.07)***	0.303 (0.08)***	0.336 (0.08)***
PopDensity	-0,176 (0.04)***	-0,194 (0.04)***	-0.178 (0.04)***	-0.195 (0.04)***	-0.218 (0.04)***
IndDistrict	0.080 (0.09)	0.171 (0.09).	0.197 (0.10)*	0.197 (0.10)*	0.214 (0.10)*
North	0.557 (0.09)***	0.509 (0.09)***	0.486 (0.10)***	0.478 (0.10)***	0.466 (0.10)***
Statistics					
N	686	686	686	686	686
R2	0.228	0.242	0.244	0.249	0.258
Adj. R2	0.223	0.235	0.236	0.238	0.247
Max Vif	2.171	0.268	0.485	0.541	5.171

*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 with respect to national level

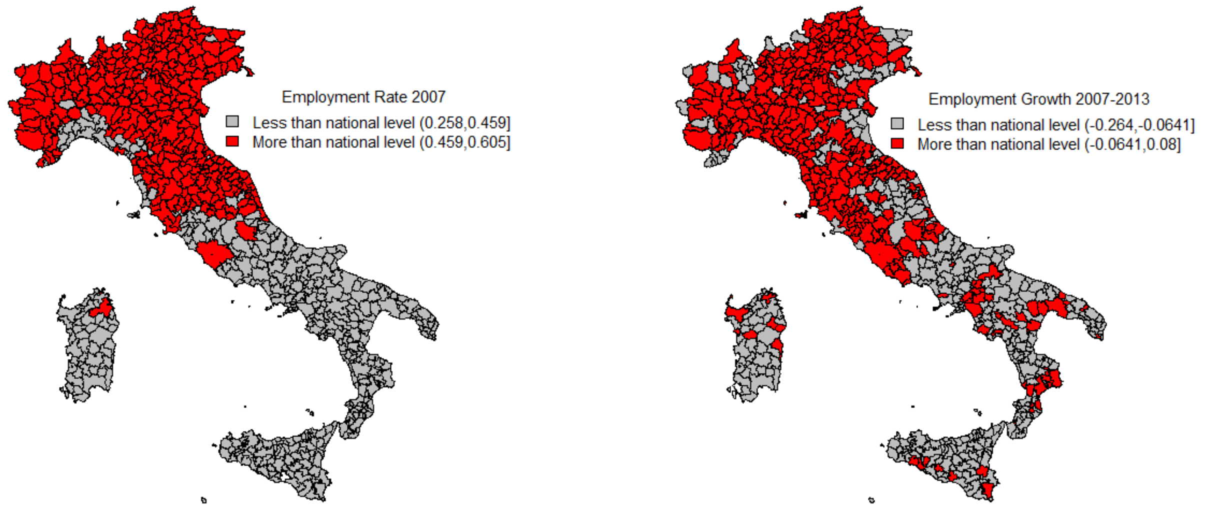


Figure 2 – Maps of related (on the left) and unrelated variety (on the right) distribution grouped for quartile.

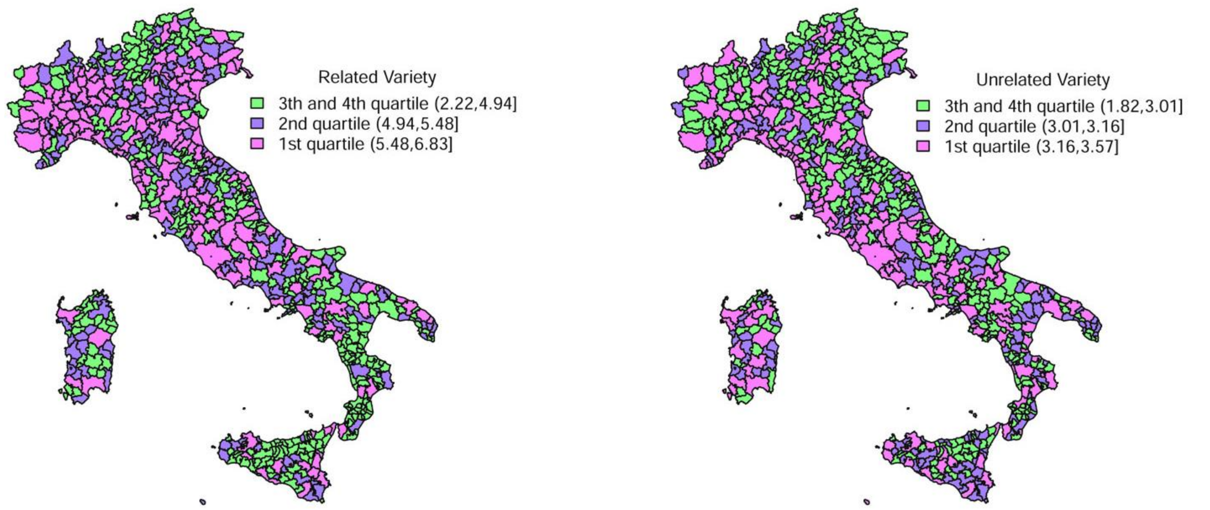
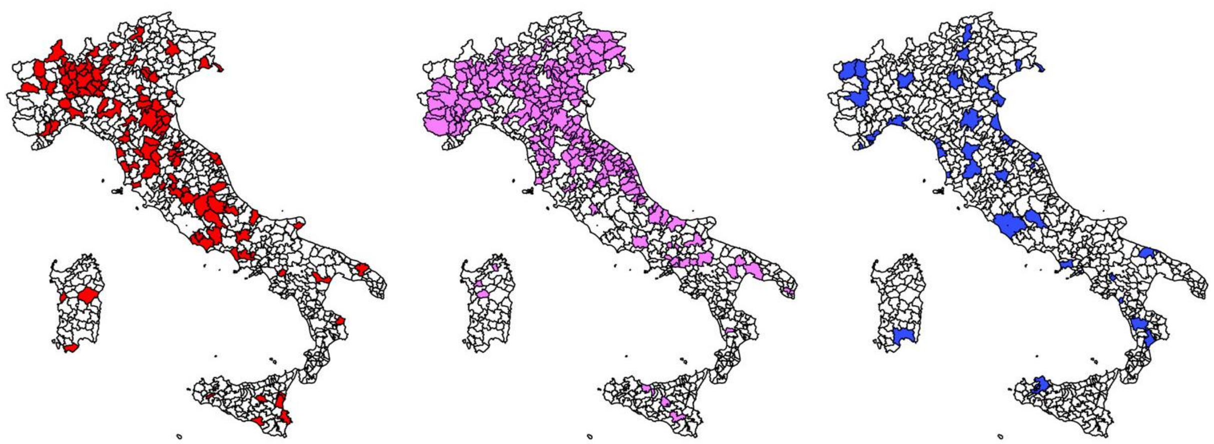


Figure 3 – Map of differentiated knowledge bases. From left to right, LLSs based respectively on analytical (left) synthetic (centre) and symbolic (right) knowledge are displayed.



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