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Network dynamics in spatial clusters. Focus on Industrial Districts of the Campania Region, Italy

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1. *Introduction*

Historically, the theme of economic growth has generated two macro-strands of research characterized by different considerations of spatial value. Firstly, the *neoclassical theory*, which has never taken into consideration how territorial factors correlate in their development with exogenous factors, and secondly, the most recent approaches of *New Theory of Growth* and the *New Economic Geography*.

The Neoclassical approach to economic growth hypothesizes a perfect diffusion of knowledge, as well as a constant return to scale that precludes any possibility of explaining persistent growth differentials over time. This approach constitutes a datum of experience that may be considered economically backward when referencing the problems of specific local areas.

The models of endogenous growth and the New Economic Geography (NGE) were developed at the end of the last millennium. From the microeconomic point of view, they aim for a more precise analysis of the dissemination of knowledge and can give an account of the persistent variations in the development of different economies (Gualerzi, 2001). In particular, the NGE has been characterized as «having given a unifying expression, with respect to the mainstream of exponents of space and non-space economics, of the tendency of productive activities to concentrate in physically restricted spaces according to the concept of agglomeration» (Dileo, Losurgo, 2011, p. 455). It represents

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the research field that deals with the *causes* - the why - and of the *modalities* - the how – of economic activity that interacts with space. This is according to the Marshal concept of externality as a concentration of regional economic activity capable of generating external economies locally (Basile *et alii*, 2012).

The focus on the two main factors of endogenous growth (increasing returns and the mechanisms of diffusion of knowledge), «implies a greater attention towards cumulative dynamic processes dependent on initial conditions, and lock-in phenomena that open the way to the recognition of importance of local paths and strategic variables in the definition of intervention policies aimed at modifying these paths» (Lodde, 1999). This importance, perhaps even without a precise awareness, was captured in the transition from theory to practice by industrial districts, which was first theorized in the early 1990s by Becattini (1991).

Industrial districts can be understood as agglomerations of companies that are geographically close to each other and which, unlike clusters of Porterian conception (Porter, 1990), tend to value the relationships and bonds that exist in the area in terms of community. As Sforzi says (2009), «industrial districts are not merely agglomerations of firms, but organisms in which a local community mirrors an industrial specialization and the way it (the community) is organizing the production» (Sforzi, 2009, p. 333).

If the relationships assume this value, then it makes sense to investigate the value of industrial districts present in a territory as catalyzed by geographical proximity and their reticular configuration in clusters. In this work, these relations reference the industrial districts of the Campania Region, Italy, which has stood out for a high degree of activity innovation.

Innovation is particularly crucial for technology-based businesses. A company's ability to create new knowledge and exploit it is a determining factor for its long-term success. Although resources and skills are determining factors, relationships with other companies can become more influential in the learning and innovation process. Since learning is a key mechanism for the accumulation of resources in the field of knowledge, a company's ability to exploit resources through network relationships is crucial for its survival, especially in high-tech sectors (Latorre *et alii,* 2017). In fact, despite the diffusion of remote communication technologies, companies look for explicit or non-explicit alliances with other organizations according to geographic proximity. Whether this is consciously done or not, these alliances enhance a company's intangible assets linked to human capital: through learned experiences, best practices, access to new information, and knowledge. All of these points can help turn ideas into business opportunities (Tsai, 2000).

In the industrial field, and especially in the creative and high technology sectors, the acquisition of external knowledge that is based on network relationships is crucial for a company's success (Pittaway *et alii*, 2004).

2. *Evaluation metrics of industrial clusters*

Innovation studies (Boschma, 2004, 2015; Boschma, Iammarino, 2007) often argue that innovative cluster-based enterprises benefit from externalities that are generated by co-localized organizations. These create local spillovers of knowledge (Jaffe *et alii*, 1993; Audretsch, Stephan, 1996a, b; Caniels, 2000; Varga, 1999). Informal networks of knowledge reveal themselves to be strategic factors in the competitiveness of a territory (Saxenian, 1996; Keeble, 2000). However, field research is necessary due to the complexity of territorial systems. Studies of the role and nature of intra-cluster knowledge flows could clarify the nature of the relationships (Giuliani, 2007; Moodysson, 2008).

As Evangelista states (2014), in any geographic area, the «semantic diatribe on the main meso-economic structures (districts, clusters, local production systems, milieux innovateurs, local territorial systems) is still open». In this context, a cluster is an agglomeration of geographically interconnected companies, specialized suppliers, service companies, companies in related sectors, and associated organizations that are all operating in a particular field. Each of these clusters is characterized by the simultaneous presence of competition and cooperation between companies (Porter, 1990). Technology districts represent a policy tool for structural change in regions with a critical mass of innovative actors and specific competencies (Bellandi, Caloffi, 2013).

The efficiency of a cluster may be evaluated by different metrics (Table 1). The clustering coefficient is a macro-metric related to its general characteristics. For example, an area in which companies from an industrial district are located is considered G=V(E). In this graph, «V» represents a set of nodes (the cluster companies) in a reference territory, and «E» represents the set of relations between them.

Thus, (vi; vj) ϵ E with vi, vj ϵ V, is a branch[1] in G. G represents any relationship between the nodes vi and vj, which are classified as research collaborators[2] (the agreement for a call of project financing, consortiums, research orders, Laboratory's tests, and Licensing).

The clustering coefficient is defined as:

$$Cl^{vi} = \frac{\#(vj,vk) \in E|vj \neq vk,\ vj \in Nvi,\ vk \in Nvi}{\frac{1}{2} \cdot d(vi) \cdot (d(vi)-1)} \qquad (1)$$

In it, d(vi) represents the number of connections of the node vi, with the Nvi set of nodes closed to vi; «k» refers to Nvi's cardinality.

[1] A non-oriented network graph is considered as a working hypothesis, assuming the bidirectionality of the search relationship.

[2] This work was involved in the study of network relationships between companies in industrial districts, and not focused on the direct supply chain. Therefore, sub-supply collaborations were not evaluated.

Figure 2 represents a possible spatial cluster. In it, node A has three direct connections (respectively with the nodes B, C and D). Node A has two indirect connections in BC and CD:

Cl^A==2/3=0,66; Cl^B=1; Cl^E=0; Cl^C=2/6=0,33 e Cl^D=1.

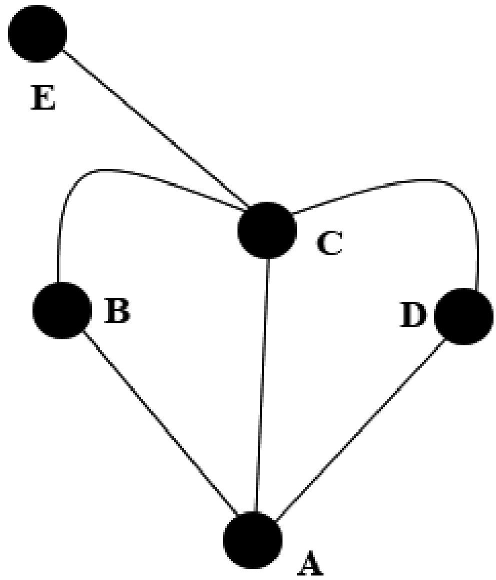

Fig. 1 – Example of a clustering coefficient.
Source: author's elaboration.

The influence of a node on the nodes next to it may be evaluated using the clustering coefficient. For example, the emergence of a new connection between the enterprises C and E (as seen in Figure 1) could reasonably come to be due to the influential presence of A rather than other circumstances. Another central feature of a cluster is its centrality, where a company may be defined by its position within a network in purely relational terms. The centrality of a node can be expressed at least in three different ways: on its degree, on its interposition (as an intermediate node between others), and its proximity to other nodes in the graph (this includes the efficiency with which it can reach all other nodes in the network).

Tab. 1 – Metrics for the evaluation of the network: properties of the industrial district.

Cluster Evaluation Metrics	Brief Description
Density	Density is often used as the leading indicator for the degree of network cohesion in descriptive statistics. The coefficient calculated by the study's software varies between 0 (a disconnected network) to 1 (a fully connected network) and expresses the percentage of links that are present on the possible totals.
Distance	This metric includes three necessary cohesion measures: the average of the geodetic distances (Average Distance) between the companies of the district, the distance-based cohesion index, and the distance-based measure of fragmentation (Distance-weighted Fragmentation). The values contained in the distance matrix represent the shortest path connecting each pair of companies in the district.
Connectivity	Connectivity is based on the number of nodes that must be removed to disconnect the district network.
Centrality	The degree of centrality in general.
Closeness Centrality	The closeness centrality expresses the geographical proximity between the companies of the district.
Betweenness Centrality	The betweenness centrality indicates the frequency with which every node-enterprise of the district is in the shortest path (geodetic) connecting other pair of nodes. The betweenness centrality indicates how much a company is an intermediary between two other companies within a group.

Source: author's elaboration.

3. *Industrial districts in the Campania region*

Industrial districts have long been a privileged object in studies on local development processes, imposing themselves, especially in the Italian context, as an alternative to the vertical industry. This is thanks to the high dynamism, flexibility, and competitiveness characterizing the companies present there. Industrial districts have recorded high levels of progress since the 1970s and 1980s, a period that coincides with the first signs of a slowdown in the Italian economic system. Successful districts are marked by an active co-presence between a community of people and a principal industry. The industry, in this case, may consist of a grouping of small independent companies, each specialized in different phases of the same production process. Today, networks and knowledge represent the main barriers in the paradigm shift to the fourth industrial revolution for industrial districts. Material and immaterial networks in the country's system have not yet been sufficiently integrated. This is due to a lack of investment from national stakeholders, as well as a lack of coordination about commercial guidelines between nodes. Rather than coordinate, these nodes compete with each other (*ibidem*). Therefore, a study concerning the micro-dynamics of knowledge exchange at the local level may be of great value.

The productive structure of the Campania Region is characterized by a robust territorial concentration of companies in the area of the province of Naples, where 51% of the local units are settled; followed by the provinces of Salerno (21%), Caserta (14%), Avellino (8%), and Benevento (5%). Considering employee numbers, the relative weight of the province of Naples represents about 55% of the regional total. Furthermore, considering the manufacturing industry alone, 50% of companies operating in the strict sense (with 50% of industry employees) are based in Naples (ATSIC, 2015).

The regional strategy for innovation is an ex-ante conditionality for the programming of the European funds FESR and EAFRD 2014-2020 called «RIS3 Campania»[3] (Research and Innovation Strategies for Smart Specialization for the Campania Region). Its aim is a regional development through the integration of the Campania innovation system in technical-scientific, economic-productive, and socio-institutional dimensions. This strategy is based on the choice of concrete policy priorities linked to the strengthening and development of technological-productive domains. These domains are particularly promising for industrial districts, concerning their distinctive factors and skills as well as their growth paths. They represent specialized areas that concentrate available resources in order to create sustainable and inclusive growth of the regional system.

Following desk analysis and qualified sharing with innovation stakeholders, the Region chose the following technological-productive domains to consider: Aerospace; Surface transports and Logistics; Biotechnologies, Agrofood Human Health; Energy and Environment; Cultural Heritage, Tourism, and Sustainable Construction; Advanced Materials and Nanotechnologies. The following parameters were examined: the critical mass of adequate resources; the pursuit of defensible competitive advantages at a supra-regional level, and their levels of differentiation; the development of critical success factors that are complementarity with international value chains; social and economic long-research networks. Table 2 shows the districts that were taken into consideration within this study.

[3] http://ris3.regione.campania.it/

Tab. 2 – Brief descriptions of Campania's industrial districts.

District	Brief Description
Aereospace	Approximately 140 subjects are involved in the Aereospace District: 8 large companies (including Alenia Aermacchi, MBDA, Magnaghi, Atitech, DEMA, Telespazio), 11 research centers (including CIRA, CNR, ENEA, and five University of Campania centers), and 125 SMEs (considering those that adhere to the eight-member consortia). The district has a strategic plan based on an innovative governance model and 12 research programs for a total investment value of over 100 million EUR. Through these research programs, the district brings together all sectors of the Campania aerospace industry: Commercial Aviation (for the development of new regional aircraft); General Aviation (for the development of production techniques, and the assembly of light aircraft); Space and Carriers (for the development of microsatellites and dual technologies linked to vectors and systems for autonomous flight); Maintenance and Transformation (for the development of dynamic maintenance processes). The district has implemented the following transversal actions: project management, training, technology transfer, duality, and the presence of Campania aerospace in international networks.
Bioscience	The Bioscience District represents a territorial aggregation of 47 companies, including leading companies operating in the pharmaceutical and diagnostics sector. The intervention has been planned in 3 thematic lines: Development and production of nutraceuticals and cosmeceuticals; Diagnostics, biosensors, and innovative technologies for the biomedical industry; Development and testing of new therapies. Two «system» intervention lines have been planned as well: Technology Transfer Services, Internationalization, Dissemination, and Networking; High formation. The Bioscience District is a network of technological platforms capable of the following: supporting drug discovery and development of new molecules especially for drugs and diagnostics and phase 1 clinical trials (with a focus on therapeutic areas of significant social impact such as tumors, neurodegenerative, and cardiovascular diseases); developing pilot-scale production processes for drugs (both new molecules and biogenerics), and diagnostics; developing processes for the production of molecules with nutraceutical and cosmeceutical actions that enhance waste biomass from the food industry; support the nutraceutical and food industry in the design, development, and clinical validation of food supplements and functionally «enriched» foods.
Transportation	The Transportation District operates in the field of surface transport (automotive, railway, and logistics). It aims to do the following: increase the competitiveness of companies; attract new investments to the Campania Region; increase industry scientific and technological skills; support the growth of Campania's SMEs through the development of high added value products; create «network excellence»; attract human resources. The industrial area includes prominent industrial companies and research centers.

Energy	The Energy District operates in the network of advanced technology for the generation and accumulation of energy in a distributed form according to the «Smart Grid» paradigm. It aims at renewable energies, the analysis of and intervention on the entire electricity supply chain, starting from the generation of non-fossil fuels (solar, wind, geothermal, biogas, and hydroelectric) and their integration into the network (through the paradigm of a microgrid) to transport and use energy efficiently. The purpose of the Energy District is represented, in particular, by the pursuit of 7 areas of intervention: • Smart Grid • Energy Enhancement • Renewables • Micro Grid • Fuel Cells • Energy-saving and Environmental Sustainability • Geothermal Prominent industrial companies and universities participate in the Energy District.

Source: author's elaboration on a Campania Region report.

The development of the RIS3 Campania has required precise objectives in order to strengthen the Region competitively. The participatory governance of regional policies in both the implementation phase and intervention-monitoring phase allows for possible synergies between districts to be found. A regional governance model for RIS3 should: offer a strategic analysis and elaboration framework for thematic areas, and district specializations and based on roadmaps; create permanent collaborations between districts in the research and innovation system; monitor indicators and targets in order to guarantee follow-up results; assess the effectiveness of strategic actions through the review of district strategies. The Campania Region has adopted the following levels of governance: a high level of governance for the strategic coordination of the districts that are able to favor a synthesis between political orientation and administrative action; an intermediate level of governance between the territory and the regional administration, so that authoritative interlocutors may be systematically involved in the planning of the regional district strategies; an operational level of governance aimed at ensuring (through open innovation environments) that institutional subjects and innovation firms participate.

Companies operating in the industrial sector are generally located in the eastern and north-eastern areas of the city of Naples. The eastern area is an example of how innovation can constitute not only a driving force for development but also an opportunity for redevelopment in peripheral areas, characterized by the divestment of activities and a need to reconvert land. Industry in the eastern area represents the developmental engine of the Neapolitan city, following the effects of the first and second industrialization of the nineteenth century (lasting until the 1990s). Planning and trends that are common to several Mediterranean cities, such as polycentric development, have affected the eastern suburbs of Naples. Mediterranean cities have undergone enormous transformations over the last thirty years, due to traditional compact models as well as discontinuous and dispersed morphologies (Kasanko, Barredo, Lavalle, 2006; Longhi, Musolesi, 2007; Schneider, Woodcock, 2008). These changes were accompanied by the rapid and sometimes disorderly development of rural areas on the outskirts of big cities (Salvati, Gargiulo, Morelli, Rontos, 2013). At the same time, the decline of the urban core has accompanied these phenomena, characterized by a latent change in the consolidated economic functions within the city nucleus (Hall, 1997) and by the emergence of new satellite cities, can be well explained by the birth of a polycentric spatial asset (Bruegmann, 2012).

The development of Naples' suburban areas has always been a part of the Campania's regional strategies, and this development highlights the positive drivers of the complex interaction between territorial, social, and economic factors that jointly influence urban structure and functions (Rosi, 2004). The Municipality of Naples, working with the Region, has begun a series of revitalization projects in the eastern area of the city. These projects favor the establishment of new businesses in a no-tax regime through the implementation of a Special Economic Zone (SEZ). Simultaneously, the University of Naples Federico II has created a university campus for the provision of teaching and research services by creating a research center called CeSMA. The suburban redevelopment in eastern Naples has been driven by the will of local authorities that are supported by regional strategy. Alongside the university's strategy of select suburbanization, a series of high-value settlements have been triggered, such as several multinational academies (Apple's iOS academy in 2016; Digita of Deloitte in 2018). These additions were front-page news in both national and international press.

According to the national report of the Chambers of Commerce updated to the second quarter of 2018, Campania ranks first in Southern Italy in terms of its number of startups (it is fifth at national level), while the province of Naples is fourth among the Italian provinces with the most startups (Naples counts 313, and the more industrialized Turin counts 329). This is a very profitable scenario for the compelling performances of regional districts.

4. *Methodology*

Four industrial districts of the Campania Region were analyzed in Table 1 with the companies surveyed and geographically located (figure 2).[4] The nodes vi; vj of the formula (1) and the connections have been analyzed (noting the branches (Vi; Vj) of the formula (1)), corresponding to possible relationship exchange.

[4] Seventytwo companies were analyzed according to the following classifications: Aerospace (23); Bioscience (19); Transportation (14); Energy (16). Except for a few cases, the industrial fabric has been homogeneous in terms of the number of employees. There has been no criticality related to a possible uncertainty induced by a dimensional gradient.

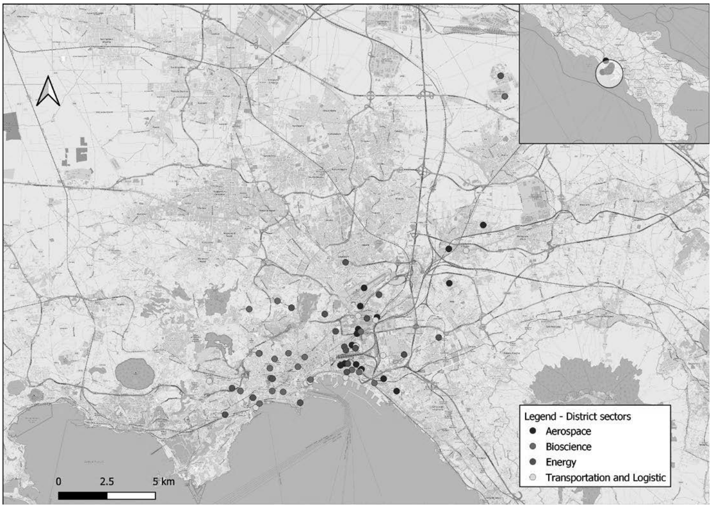

Fig. 2 – Geographical distribution of companies of districts of Campania Region – area of Naples.
Source: author's elaboration.

All network metrics of Table 1 have been calculated and evaluated for three flow dimensions: the nature of the exchanged knowledge; the relationship between companies; the type of exchanged relationship[5].

The denominator of the clustering coefficient is the number of connections that a node has with other local nodes. The results may be interpreted through the guiding criterion of Table 3. Hub-nodes, or nodes that develop many relationships, are characterized by low clustering coefficients that could mistakenly suggest a low networking capacity.

Tab. 3 - Clustering coefficient evaluation criteria. (Clu Clustering coefficient of central hub node; Cli-u Clustering coefficient of company «i» linked to central hub node.)

	Low Clustering Effect	High Clustering Effect
Low Fluxes	High Clu Low Cli-u	High Clu High Cli-u
High Fluxes	Low Clu Low Cli-u	Low Clu High Cli-u

Source: author's elaboration.

[5] Several audits were carried out on the companies within the project. Each attribute and reference company was evaluated according to a numerical scale: 0 (absence of relationship); 1 (poor activity); 2 (mild activity); 3 (moderate activity); 4 (discrete activity); 5 (intense activity). Formal, contracted relationships and in activity has been taken into account equally, as the objective of the research was to evaluate the nature and intensity of the relationships and the degree of formalization that would lead to different results.

The dimension of knowledge has been evaluated through Polany's 1996 classification (Table 4), which identifies a series of constituent components similar to what happens in physics with the spectral analysis of a signal. Current literature is now unanimous in considering geographical proximity as a variable of influence in local development processes in this telematic era (Uyarra, 2010; Addie, 2016; Acs *et alii*, 2010; Anderson, Larsson, 2016; Breschi, Lissoni, 2001a, b). What is transferred to «zero time» through broadband networks is only the so-called «raw date», or the «raw data» (Zikopoulos *et alii*, 2012). Conversely, structured knowledge in its constituent components is spread by interactive geographical proximity mechanisms.

Tab. 4 - *Sub dimensions of knowledge.*

Type of Knowledge	***Definition***	***Examples***
Tacit	Knowledge of a strictly personal matrix that is difficult to formalize, and is linked to the reference context	Skills; tricks of the trade; mental models; ideals; values; personal beliefs
Esplicit	Quickly codable, transmissible, and usable knowledge in contexts different from the one in which the knowledge was generated	Behavioral rules
Individual	The knowledge that is created and owned by individuals	Personal vocations; skills
Collective	The knowledge that is created by a group's collective actions.	Typical business knowledge
Declarative	Know-what	To know which solution is appropriate for a specific problem
Procedural	Know-how	Know how the solution should be applied
Conditional	Know-when	Typical knowledge of the marketing and communication phase
Causal	Know-why	Knowledge of the cause-effect relationship of the applied solution; modeling
Relational	Know-with	Know the interactions between the various solutions
Pragmatic	Applicable knowledge	Knowledge of products, processes, and technologies related to specific cases

Source: author's elaboration on Polany's theory (1996).

The particular nature of the involvement of the current research and collaboration activities between the companies of the districts, considered as territorial nodes, was evaluated. The Cooper model (Cooper, Smith, 1992) was employed, based on the following process phases: concept, design, implementation, testing, and marketing. In the model, these phases are associated with added value, characterizing them according to a so-called «bath curve» trend. The first phases relating to the design and planning of the research activity, together with the marketing and communication last phases, are associated with a high added value. The intermediate phases characterize more standardized production activities such as production and tests and have lower added value.

The types of research collaboration between companies were investigated in the following terms:

-*Agreements for project financing*: this item means a relationship between companies generated in correspondence with an opportunity to participate jointly in calls for tenders financing (mainly that of the European Community, but also national and regional tenders);

-*Consortiums*: this macro-word means the activities carried out in the context of industrial sector associations, or groupings in private consortia with the same common dominant theme;

-*Research orders*: this element refers to any relations that may have arisen following a search order commissioned by a third party, and executable only jointly through different competences of the same sector. Therefore, it is a horizontal collaboration and not a sub-supply;

-*Laboratory tests*: this refers to tests performed concerning the sharing between several companies, and the use of test equipment by one company at another company;

-*Licensing*: this element concerns any formal and non-formal business combination aimed at protecting industrial property.

4.1. *Results* – Table 5 shows a summary of the clustering coefficient values and the main metrics analyzed for each industrial district. In Figure 3, the graphs relating to the network analysis are shown.

The analysis has demonstrated that the Aerospace and Bioscience Districts are characterized by greater network cohesion, while a higher capacity for clustering distinguishes the Aerospace and Transport Districts. The values contained in the distance matrix represent the shortest paths that connect each pair of nodes. The values of the Aerospace and Bioscience districts are lower than in the other districts. This means that the company pairs are close to each other and that the districts are well connected.

A third measurement, Distance Weighted Fragmentation, analyzed the distance-based measure of fragmentation. This indicated the proportion of business pairs in the District that cannot reach one another. The Distance Weighted Fragmentation index varies between «0» and «1»: if all companies can reach one another (as in the case of a single company) then the index value is equal to 0; if all companies are isolated then the value of the metric is equal to 1. All four analyzed districts had an index very close to 0. The Aerospace and Bioscience Districts had the lowest index values, indicating that the District's companies were in close proximity to one another. The Aerospace District had the most connectivity, with a large number of companies in the network that were fundamental to the continuation of the District's activities. This scenario is common in the aeronautical sector, where clustering has particular characteristics, such as modularity in production and the complexity of the final product. In these situations, it is almost impossible for a single enterprise to carry out all the phases of production (Frigant, Talbot, 2005). The Aerospace and Bioscience Districts were most prevalent in terms of centrality (i.e., the number of flows that appear from each company in each District). These may be considered the two most responsive Districts to the forms of enterprise clustering relative to an industrial district.

Figure 4 shows the cases from the knowledge dimension (summarized in Table 6). Figure 5 shows those relating to the Cooper phase (summarized in Table 7). Figure 6 shows those relating to the types of collaboration that the companies engaged in (summarized in Table 8).

The Aerospace and Bioscience Districts have the most relationship exchanges, of a high-level nature. There is an almost perfect trend of isomorphism regarding the sub-dimensions of the exchanged knowledge. Excepting the Energy District, which also favors a relational component, the other Districts all move homogeneously on the causal and procedural components. This scenario denotes a structured nature of the relationship-activities concerning modeling and the high-level of know-how that is necessary to face complex problems.

The Bioscience district is also characterized by a very significant involvement of lower-level phases, such as testing and dissemination. This can be explained through the shared use of laboratory equipment, but it also reflects the sector's tendency to disseminate the results of its work. The Bioscience district alone stands out for its licensing activities, and the Aerospace District is unique in its call for fund collaborations.

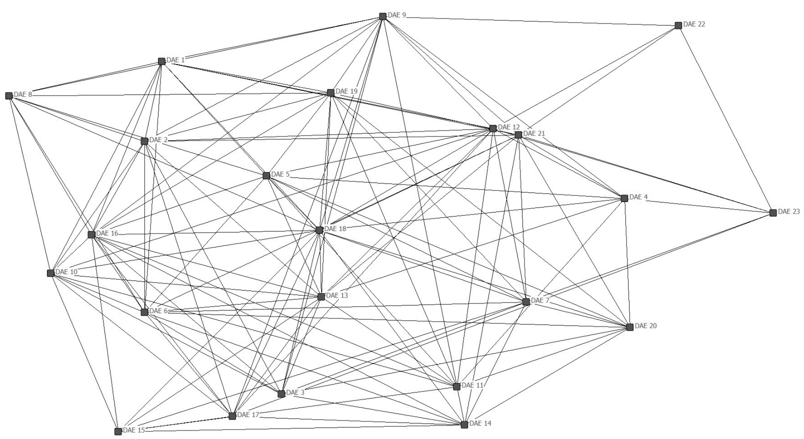

Fig. 3a - *Aerospace District Elements*.
Source: author's elaboration with Ucinet®.

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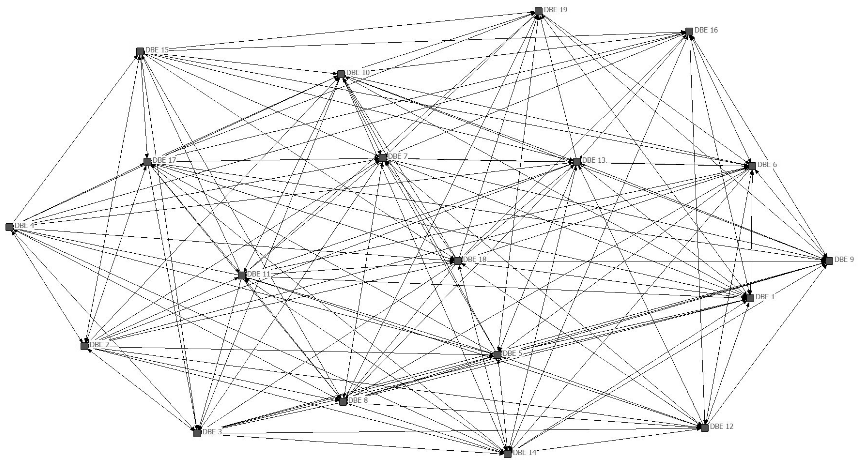

Fig. 3b - *Bioscience District Elements.*
Source: author's elaboration with Ucinet®.

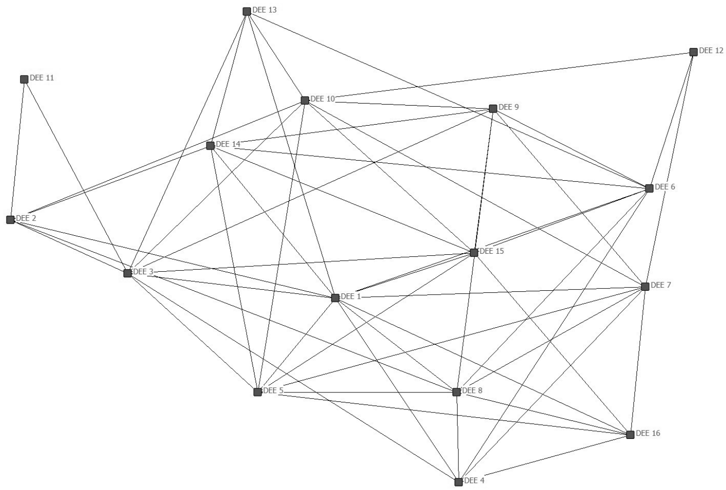

Fig. 3c - *Energy District Elements.*
Source: author's elaboration with Ucinet®.

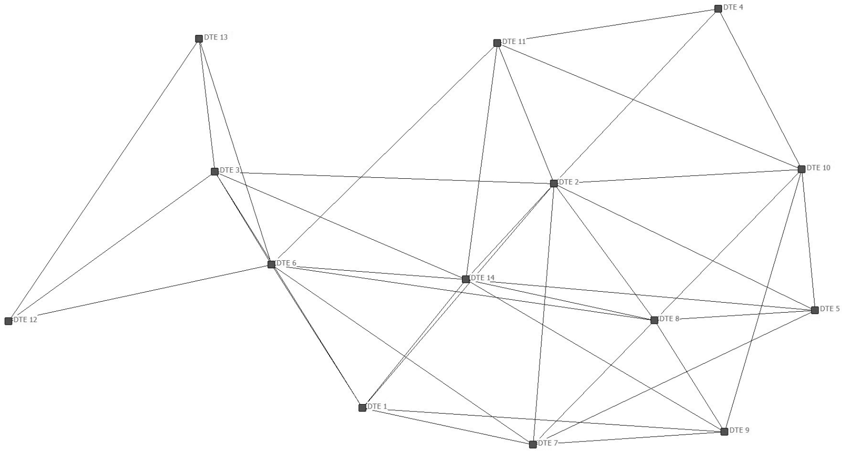

Fig. 3d - *Transportation and Logistic District Elements*.
Source: author's elaboration with Ucinet®.

Tab. 5 - Summary of the network metrics of each district.

	Districts			
Metrics	**Aerospace**	**Bioscience**	**Transportation**	**Energy**
Clustering coefficient	0.567	0.535	0.617	0.502
Density	0.502	0.532	0.458	0.440
Average Distance	1.506	1.474	1.648	1.575
Distance-based Cohesion	0.750	0.765	0.705	0.724
Distance-weighted Fragmentation	0.250	0.235	0.295	0.276
Connectivity	High (see Appendix a)	Medium (see Appendix b)	Low (see Appendix c)	Low (see Appendix d)
Centrality - Network Centralization	23.20%	21.24%	29.49%	31.43%
Closeness Centrality	31.09%	21.50%	32.68	32.28
Betweenness Centrality	3.49%	4.25%	15.33	8.25%

Source: author's elaboration with Ucinet®.

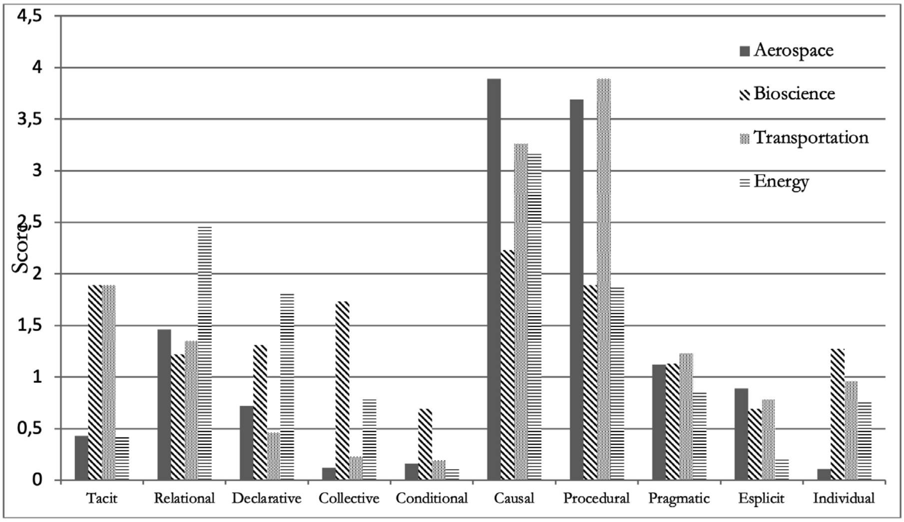

Fig. 4 - Knowledge sub-dimensions for each district.
Source: author's elaboration.

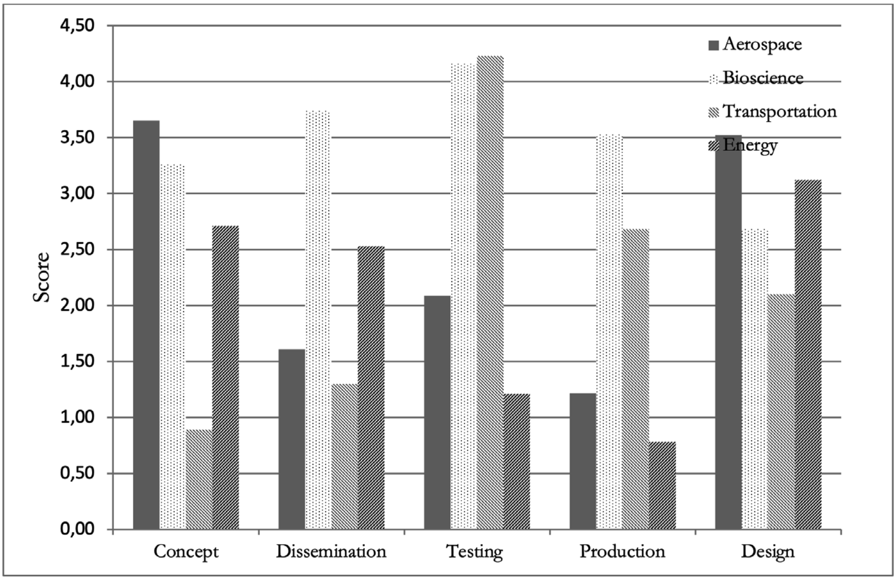

Fig. 5 - Cooper phase for each district.
Source: author's elaboration.

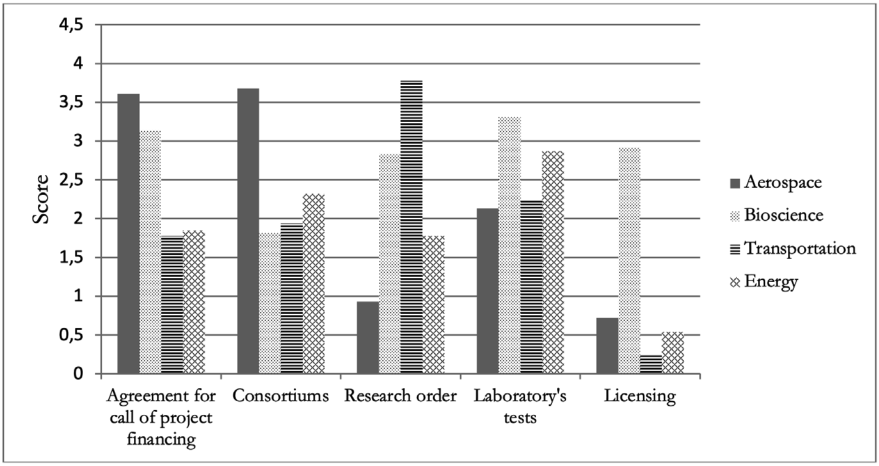

Fig. 6 -Type of collaboration exchanged for each district.
Source: author's elaboration.

Tab. 4 - Knowledge sub-dimensions for each district – major occurrences.

	Knowledge sub-dimensions									
Districts	*Tacit*	*Explicit*	*Individual*	*Collective*	*Declarative*	*Procedural*	*Conditional*	*Causal*	*Relational*	*Pragmatic*
Aerospace						▲		▲		
Bioscience						▲		▲		
Transportation						▲		▲		
Energy								▲	▲	

Source: author's elaboration.

Tab. 5 - Cooper phase for each district – major occurrences.

	Cooper's phases				
District	*Concept*	*Design*	*Production*	*Testing*	*Dissemination*
Aerospace District	▲	▲			
Bioscience District				▲	▲
Transportation District			▲	▲	
Energy District	▲	▲			

Source: author's elaboration.

Tab. 6 - Types of collaboration for each district – major occurrences.

	Relationship Typology				
District	*Agreement for call of project financing*	*Consortiums*	*Research order*	*Laboratory's tests*	*Licensing*
Aerospace District	▲	▲			
Bioscience District	▲			▲	
Transportation and L. District			▲	▲	
Energy District		▲		▲	

Source: author's elaboration.

4.2 *Geographical implications* – The empirical case dealt shows that the concept of space enters decisively into economic analysis, bringing with it the constant attempt to obtain empirical methods for increasingly precise and accurate measurements of phenomena. The conceptual leap took place, therefore, with the paradigm shift that concerned the interpretation of space as «territory»: «space becomes territory when the regional growth model considers it as an economic resource and an independent productive factor, a generator of static and dynamic advantages for companies located in an area or, in other words, an element of fundamental importance in determining the competitiveness of a local production system» (Capello, Frattesi, 2009, p. 21). Growth, as a territorialized process is, therefore, «the consequence of complex mechanisms made of relational or social capital of a particular geographical space, a system of governance and institutions, a system of values that concentrate activities and create externalities giving rise to an increase , territorialized, of factor productivity» (Borri, Ferlaino, 2009, p. 11).

Therefore, once the spatial role of the innovative phenomenon has been clarified, greater support from local institutions in relation to two factors would be necessary. First of all, in order to collaborate in the development and maintenance of the network dynamics that arose independently from the various industrial sectors. The case analyzed, for example, shows a certain predominance of the aerospace district as it is characterized by a lower technological distance between its actors which increases its capacity to absorb the exchange of knowledge. With reference to this first aspect, the Campania Region, through its Department of Innovation, has moved precisely in this direction by launching the RIS3 strategy (Research and Innovation Strategies for Smart Specialisation) based on the strengthening of strategic alliances. The second aspect relates to urban planning which must increasingly include actions to support the convergence between urban geography and geography of companies in order to maximize the competitive advantage deriving from informal and cooperative relationships induced by network dynamics. In this sense, institutions, understood as shared game rules, play a non-secondary role in the district economy (Becattini, 1991).

As shown in Figure 2, industrial districts are increasingly urban district and urbanization economies - as opposed to localization economies that act separately within each sector - act transversely on all production activities, although they may have an intensity different in relation to the various economic sectors.

5. *Conclusions*

The intensive use of knowledge in production and the increase in interdependencies between local and global markets are radically transforming the global economic landscape. These are epochal trends which are today described by two key terms: globalization and innovation. The two phenomena reinforce each other, in a circle, often virtuous other times vicious, which perpetually changes the industrial structure. Therefore, if on one hand innovation seemed to need a global perspective, on the other the initial local and global oxymoronic dilemma was then resolved by reasoning the terms of binomial and not of dualism. The dynamics, especially those of the network, at the local level haven been revealed themselves as absolutely necessary. Indeed, the concept of a regional innovation system was owed to Asheim and Isaksen (1997), then redefined by Cappellin and Orsenigo (2000, p. 174) «as a system in which the firms and the other organizations are systematically engaged in an interactive learning process through an institutional environment characterized by local embeddedness». Regional innovation systems therefore represent a subnational concentration of actors characterized by local roots and involvement in a collective learning process (Evangelista, 2015).

The organizational form that best expressed the potential of the local industrial agglomeration was that of the industrial districts. Since the 1970s, this type of industrial development has found ideal conditions in Italy to develop and expand simultaneously with the first signs of the crisis of large companies. Today, Italian legislation recognizes and protects about 200 industrial districts, distributed in a leopard spot across the entire national territory. They have grown despite the disinterest of economic policy and early theories relegating them to something between traditional and pre-modern activities. This growth has been surprising in part because the real driver of district development is still unclear.

District development is based on mobility and the multiplication of propagated knowledge. There should not be too many barriers, new or pre-existing, between people and between geographically close companies.

Big businesses try to obtain growth through a complex hierarchy of powers and programs, and yet this growth may arise spontaneously in some Districts, based on voluntary, involuntary, and contracted interpersonal exchange.

Although bottom-up development has many possibilities, it also has significant limitations; it can only work when the individual company has innovations and investments for growth within reach. Anything requiring concentrations of means and skills, as well as long-term investments, is not compatible with bottom-up growth; this growth arises gradually without any overall design to act as a guide (Rullani, 2006).

The Italian economy has been well integrated into this framework. The Campania Region, in particular, has developed organizational forms of production that are based on small business capitalism as well as on territorial capitalism. Production systems have taken root within the companies established in each territory, and, thanks to the mediation of close local networks, this situation has favored the dissemination of knowledge and skills, incubated the growth of many new companies, organized specialized production chains, fostered the development of professionalism in the workplace and related industries, and encouraged the formation of services and institutional policies consistent with the needs of local production activities.

Most micro-businesses that are active in the production circuit could not survive in the absence of strong ties with the territory, and the networks of relations present therein. These networks create economies of specialization and scale and allow businesses to organize modern production processes, access skills, and access a vast outlet market alongside local SMEs.

The Italian Ministry of Economic Development funded this multi-year project in order to reach the following objective: to debate the analysis of territorial relationship phenomena of the companies present in the Districts of the Campania Region with a focus on research activities and innovation.

The analysis found a strong network dynamism among the companies of all four Districts (Aerospace, Bioscience, Transportation, and Energy). Districts had strong identities as well, confirming the objectives of the regional strategy. This result is compatible with the work of authors who have underlined the active role of institutions in the development of industrial districts (Aranguren *at alii*, 2014; Aragón *et alii*, 2012a; 2012b).

There is an almost perfect trend of isomorphism in the sub-dimensions of the exchanged knowledge, which denotes the structured nature of the high-level relationship activities related to modeling and the know-how that is necessary to deal with complex problems.

This analysis shows that a long life-cycle of the Districts may be hypothesized, particularly those within the Campania Region's productive strategies.

The results of the research, although referring to a particular case, are useful in an inductive approach to suggest dynamics and models that govern similar district scenarios in many other parts of the world.

APPENDIX

APPENDIX A) AEREOSPACE DISTRICT - CONNECTIVITY

		1 DA	2 DA	3 DA	4 DA	5 DA	6 DA	7 DA	8 DA	9 DA	10 DA	11 DA	12 DA	13 DA	14 DA	15 DA	16 DA	17 DA	18 DA	19 DA	20 DA	21 DA	22 DA	23 DA
1	DAE 1	0	11	10	9	11	11	10	9	11	11	9	10	10	10	8	11	10	11	11	10	10	4	6
2	DAE 2	11	0	10	9	12	12	11	9	12	12	9	12	12	10	8	12	11	12	12	10	12	4	6
3	DAE 3	10	10	0	9	10	10	10	9	10	10	9	10	10	10	8	10	10	10	10	10	10	4	6
4	DAE 4	9	9	9	0	9	9	9	9	9	9	9	9	9	9	8	9	9	9	9	9	9	4	6
5	DAE 5	11	12	10	9	0	12	11	9	12	12	9	12	12	10	8	12	11	12	12	10	12	4	6
6	DAE 6	11	12	10	9	12	0	11	9	13	12	9	12	13	10	8	13	11	13	12	10	13	4	6
7	DAE 7	10	11	10	9	11	11	0	9	11	11	9	11	11	10	8	11	11	11	11	10	11	4	6
8	DAE 8	9	9	9	9	9	9	9	0	9	9	9	9	9	9	8	9	9	9	9	9	9	4	6
9	DAE 9	11	12	10	9	12	13	11	9	0	12	9	13	13	10	8	13	11	13	12	10	13	4	6
10	DAE 10	11	12	10	9	12	12	11	9	12	0	9	12	12	10	8	12	11	12	12	10	12	4	6
11	DAE 11	9	9	9	9	9	9	9	9	9	9	0	9	9	9	8	9	9	9	9	9	9	4	6
12	DAE 12	10	12	10	9	12	12	11	9	13	12	9	0	12	10	8	12	11	12	12	10	13	4	6
13	DAE 13	10	12	10	9	12	13	11	9	13	12	9	12	0	10	8	14	11	14	12	10	13	4	6
14	DAE 14	10	10	10	9	10	10	10	9	10	10	9	10	10	0	8	10	10	10	10	10	10	4	6
15	DAE 15	8	8	8	8	8	8	8	8	8	8	8	8	8	8	0	8	8	8	8	8	8	4	6
16	DAE 16	11	12	10	9	12	13	11	9	13	12	9	12	14	10	8	0	11	15	12	10	13	4	6
17	DAE 17	10	11	10	9	11	11	11	9	11	11	9	11	11	10	8	11	0	11	11	10	11	4	6
18	DAE 18	11	12	10	9	12	13	11	9	13	12	9	12	14	10	8	15	11	0	12	10	13	4	6
19	DAE 19	11	12	10	9	12	12	11	9	12	12	9	12	12	10	8	12	11	12	0	10	12	4	6
20	DAE 20	10	10	10	9	10	10	10	9	10	10	9	10	10	10	8	10	10	10	10	0	10	4	6
21	DAE 21	10	12	10	9	12	13	11	9	13	12	9	13	13	10	8	13	11	13	12	10	0	4	6
22	DAE 22	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4
23	DAE 23	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	4	0

Output actor-by-actor point connectivity matrix saved as dataset PointConnectivity

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Running time: 00:00:01
Output generated: 16 dic 19 10:30:44
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APPENDIX B) BIOSCIENCE DISTRICT - CONNECTIVITY

		1 DB	2 DB	3 DB	4 DB	5 DB	6 DB	7 DB	8 DB	9 DB	10 DB	11 DB	12 DB	13 DB	14 DB	15 DB	16 DB	17 DB	18 DB	19 DB
1	DBE 1	0	10	4	8	8	10	8	10	9	10	10	8	8	10	10	8	10	10	8
2	DBE 2	10	0	4	8	8	11	8	12	9	12	10	8	8	12	10	8	11	12	8
3	DBE 3	4	4	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
4	DBE 4	8	8	4	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
5	DBE 5	8	8	4	8	0	8	8	8	8	8	8	8	8	8	8	8	8	8	8
6	DBE 6	10	11	4	8	8	0	8	11	9	11	10	8	8	11	10	8	11	11	8
7	DBE 7	8	8	4	8	8	8	0	8	8	8	8	8	8	8	8	8	8	8	8
8	DBE 8	10	12	4	8	8	11	8	0	9	12	10	8	8	12	10	8	11	12	8
9	DBE 9	9	9	4	8	8	9	8	9	0	9	9	8	8	9	9	8	9	9	8
10	DBE 10	10	12	4	8	8	11	8	12	9	0	10	8	8	11	10	8	11	12	8
11	DBE 11	10	10	4	8	8	10	8	10	9	10	0	8	8	10	10	8	10	10	8
12	DBE 12	8	8	4	8	8	8	8	8	8	8	8	0	8	8	8	8	8	8	8
13	DBE 13	8	8	4	8	8	8	8	8	8	8	8	8	0	8	8	8	8	8	8
14	DBE 14	10	12	4	8	8	11	8	12	9	11	10	8	8	0	10	8	11	12	8
15	DBE 15	10	10	4	8	8	10	8	10	9	10	10	8	8	10	0	8	10	10	8
16	DBE 16	8	8	4	8	8	8	8	8	8	8	8	8	8	8	8	0	8	8	8
17	DBE 17	10	11	4	8	8	11	8	11	9	11	10	8	8	11	10	8	0	11	8
18	DBE 18	10	12	4	8	8	11	8	12	9	12	10	8	8	12	10	8	11	0	8
19	DBE 19	8	8	4	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	0

Output actor-by-actor point connectivity matrix saved as dataset PointConnectivity

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Running time: 00:00:01
Output generated: 16 dic 19 10:33:51
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APPENDIX C) TRANSPORTATION AND L. DISTRICT - CONNECTIVITY

		1 D	2 D	3 D	4 D	5 D	6 D	7 D	8 D	9 D	10 D	11 D	12 D	13 D	14 D
1	DTE 1	0	6	4	3	5	6	5	5	5	5	4	2	2	6
2	DTE 2	6	0	4	3	5	6	6	7	5	6	5	2	2	8
3	DTE 3	4	4	0	3	4	6	4	4	4	4	4	3	3	4
4	DTE 4	3	3	3	0	3	3	3	3	3	3	3	2	2	3
5	DTE 5	5	5	4	3	0	5	5	5	5	5	4	2	2	5
6	DTE 6	6	6	6	3	5	0	6	6	5	5	4	3	3	6
7	DTE 7	5	6	4	3	5	6	0	6	5	5	4	2	2	6
8	DTE 8	5	7	4	3	5	6	6	0	5	5	4	2	2	7
9	DTE 9	5	5	4	3	5	5	5	5	0	5	4	2	2	5
10	DTE 10	5	6	4	3	5	5	5	5	5	0	5	2	2	5
11	DTE 11	4	5	4	3	4	4	4	4	4	5	0	2	2	4
12	DTE 12	2	2	3	2	2	3	2	2	2	2	2	0	3	2
13	DTE 13	2	2	3	2	2	3	2	2	2	2	2	3	0	2
14	DTE 14	6	8	4	3	5	6	6	7	5	5	4	2	2	0

Output actor-by-actor point connectivity matrix saved as dataset PointConnectivity

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Running time: 00:00:01
Output generated: 16 dic 19 10:38:05
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APPENDIX D) ENERGY DISTRICT - CONNECTIVITY

		1 D	2 D	3 D	4 D	5 D	6 D	7 D	8 D	9 D	10 D	11 D	12 D	13 D	14 D	15 D	16 D
1	DEE 1	0	5	8	6	8	8	8	8	7	8	2	3	5	7	8	6
2	DEE 2	5	0	6	5	5	5	5	5	5	5	2	3	5	5	5	5
3	DEE 3	8	6	0	6	8	8	8	8	7	8	2	3	5	7	8	6
4	DEE 4	6	5	6	0	6	6	6	6	6	6	2	3	5	6	6	6
5	DEE 5	8	5	8	6	0	8	8	8	7	8	2	3	5	7	8	6
6	DEE 6	8	5	8	6	8	0	8	8	7	8	2	3	5	7	8	6
7	DEE 7	8	5	8	6	8	8	0	8	7	8	2	3	5	7	8	6
8	DEE 8	8	5	8	6	8	8	8	0	7	8	2	3	5	7	8	6
9	DEE 9	7	5	7	6	7	7	7	7	0	7	2	3	5	7	7	6
10	DEE 10	8	5	8	6	8	8	8	8	7	0	2	3	5	7	8	6
11	DEE 11	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2
12	DEE 12	3	3	3	3	3	3	3	3	3	3	2	0	3	3	3	3
13	DEE 13	5	5	5	5	5	5	5	5	5	5	2	3	0	5	5	5
14	DEE 14	7	5	7	6	7	7	7	7	7	7	2	3	5	0	7	6
15	DEE 15	8	5	8	6	8	8	8	8	7	8	2	3	5	7	0	6
16	DEE 16	6	5	6	6	6	6	6	6	6	6	2	3	5	6	6	0

Output actor-by-actor point connectivity matrix saved as dataset PointConnectivity

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Running time: 00:00:01
Output generated: 16 dic 19 10:40:46
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Dinamiche di rete in cluster spaziali. Focus sui distretti industriali della Regione Campania, Italia

L'alta dinamica caratterizzante i paradigmi della globalizzazione sta generando diversi impatti alla scala locale. In particolare, il mercato globale è diventato un formidabile concorrente degli agglomerati industriali, consentendo la divisione del lavoro tra aree con fattori differenti. Tuttavia, la dimensione locale sembra svolgere ancora un ruolo chiave che necessita di approfondimenti di ricerca soprattutto in relazione alle dinamiche di rete che la geografia della impresa a scala locale determina.

Il presente lavoro riporta una sintesi dei risultati di un progetto pluriennale (2015-2020) - finanziato dal Ministero dello Sviluppo Economico italiano - basato sull'individuazione dei flussi di relazione stabiliti tra nodi di cluster territoriali con particolare riferimento ai distretti industriali della Regione Campania, Italia.

La ricerca ha lo scopo di caratterizzare in termini di rilevanza, natura e intensità le dinamiche inter-distrettuali, nonché di rilevare le differenze intra-distrettuali, per capire se esse possono realmente costituire una risorsa anche in epoca globale.

I risultati della ricerca, sebbene riferiti a un caso particolare, sono utili in un approccio induttivo per suggerire dinamiche e modelli che governano scenari distrettuali simili in molte altre parti del mondo.

Dynamique des réseaux dans les clusters spatiaux. Focus sur les districts industriels de la région de Campanie, Italie

Les paradigmes hautement dynamiques de la mondialisation ont un effet accru aux échelles locales. En particulier, le marché mondial est devenu un redoutable concurrent des agglomérations industrielles, permettant la division du travail entre les zones avec différents facteurs. Cependant, la dimension locale semble encore jouer un rôle clé qui nécessite de nouvelles recherches, notamment en ce qui concerne la dynamique de réseau induite par la géographie des entreprises à l'échelle locale.

Ce travail rend compte d'un résumé d'un projet pluriannuel (2015-2020) - financé par le ministère italien du Développement économique - basé sur l'identification des menaces potentielles pour le localisme, ainsi que l'examen des relations des les flux établis entre les nœuds des clusters territoriaux. Cette dernière analyse concerne une étude spécifique des districts industriels de la région de Campanie, en Italie.

Cette recherche vise à caractériser la dynamique inter-district ainsi qu'à détecter les différences intra-district entre pour comprendre si elles peuvent réellement constituer une ressource même à l'ère mondiale.

Les résultats de la recherche, bien qu'ils se réfèrent à un cas particulier, sont utiles dans une approche inductive pour suggérer des dynamiques et des modèles qui régissent des scénarios de district similaires dans de nombreuses autres parties du monde.