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## **Production Networks in Local Labour Market Areas**

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### **Introduction**

Network analysis finds its origin in social research. In the 1930s, Jacob Moreno developed what he called “sociometrics” to study social relations. From the 1970s on, after a dark period in which network analysis was rarely mentioned (Freeman 2004), its use was progressively extended to other fields: economy, biology, ITC, political sciences etc.

From the original social focus, attention later shifted to the explanatory ability of network analysis in diverse areas.

The number of different fields to which network analysis can be applied led to great progress in the visualization of networks, in the analysis of the relations established, and in the formulation of synthetic measures. These allow describing such networks in terms of relation and distance between nodes, which represent the actors or units of the analysis.

Over the years, in social sciences and other fields, experiments have been made that led to the discovery that, despite the fact that each actor tends to relate mainly with a few other actors, the nodes of a network are relatively “close” thanks to the presence of few intermediaries (Granovetter 1973)..

In 1998 Duncan Watts and Steven Strogatz generalized the so called “small world” theory<sup>1</sup> based on the realization that networks can be classified according to a clustering coefficient and the shortest path from one node to the other. They could also prove that the connections established in these network differ from random aggregations as imagined by Erdős-Rény (1959). A small world is characterized by a small average distance between nodes ( $Aspl$ ) but also by a degree of separation in the network ( $Cc$ ) significantly higher than that expected in a random graph.

In more recent years attention has been focused on the role played by hubs (Barabási-Albert 1999), highly connected nodes present in all kinds of networks.

In general, the use of network analysis was extended from social sciences to the study of complex systems in various fields.

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<sup>1</sup> This term derives from a famous experiment made in 1967 by the sociologist Stanley Milgram (1967) intended to describe the acquaintance networks in the United States by asking to a random sample of 160 persons living in Omaha (Nebraska) to find an (even indirect) way to send a package to a stockbroker living in Boston.

“Today the understanding of networks is a common goal of an unprecedented array of traditional disciplines: Cell biologists use networks to make sense of signal transduction cascades and metabolism, to name a few applications in this area; computer scientists are mapping the Internet and the WWW; epidemiologists follow transmission networks through which viruses spread; and brain researchers are after the connectome, a neural-level connectivity map of the brain. Although many fads have come and gone in complexity, one thing is increasingly clear: Interconnectivity is so fundamental to the behaviour of complex systems that networks are here to stay” (Barabasi, 2009, p.413).

In this paper the complex system we want to study with the help of the concepts discussed above is that of multilocalized enterprises in Italy, with reference to the territorial frame represented by local labour market areas.

Local labour market areas (see below) are relatively closed as to the external mobility of the labour factor (this feature is intrinsic in their construction), but they are potentially open to possible connections between enterprises and their local units (establishments or branches). As is well known, the development “model” based on clusters of small and very small sized enterprises, especially in manufacturing, is considered by most observers a weak spot of the Italian economic system. Through multilocalization, enterprises put different (more or less dynamic) areas in contact. How does this contact take place? How does the network created this way work? Does it show “small world” features? Is endogenous entrepreneurship more or less successful than the one shaped by branches of multilocalized enterprises?

These are not just theoretical questions, because the answers have immediate policy implications, in the promotion of endogenous entrepreneurship versus the support to the expansion of multilocalized enterprises in different territories.

### **Definitions and data sources**

Information collected by Istat on enterprises (Istat 2008b) and local units (Istat 2009) allow to perform this analysis on 686 local labour market areas, with 2006 as the reference year.

Local labour market areas (LLMAs – Istat 2005) are functional aggregations of contiguous municipalities (not necessarily belonging to the same administrative region or province), formulated according to an analysis of the daily journeys of the population to reach and return from their place of work. These movements are surveyed by population Censuses. This study is based on the 686 local labour market areas identified from data recorded in the Census of 2001. A local labour market area is a functional region that is defined as a “self-containing”

commuter flow area and indicates a set of municipalities linked by a high level of interdependence. This territorial reference grid makes it possible to analyze the economic and social geography in greater detail than that allowed by traditional administrative subdivisions (regions and provinces) and also to use a partition of the territory that derives from the self-organization of relationship dynamics encompassing the main socio-economic dimensions of daily life, with particular reference to residence and place of work.

From an operational point of view we define:

- Multilocalized enterprises those that deploy their activities in different locations, each of them being a local unit.
- Local unit (establishment or branch)<sup>2</sup> an enterprise or a portion of an enterprise located in a topographically identified area where one or more persons deploy economic activities for the same enterprise, full or part-time.

The source employed is the statistical registry of local units of enterprises (ASIA-local units) with reference year 2006.

In 2006 multilocalized enterprises were 263,930 and represented 6.0% of all enterprises included in the registry of active enterprises. These enterprises were organized in 678,995 local units and thus had on average 2.6 local units per enterprise. As can be expected they show features that are different in part from the total population of enterprises in manufacturing industry and services: in general they are large enterprises, even if they tend to become quite widespread starting from the threshold of 20 employed persons and become the absolute majority above the 50 employed persons limit. In addition they are more frequent in manufacturing and are more structured, as evidenced when we use their legal status as a proxy of their organizational complexity.

On the other hand, from the perspective of local units, those which are branches of multilocalized enterprises are 14.1% of the total and comprise 37.7% of employed persons.

### **Endogenous enterprises and local units of external enterprises**

Apparently most Italian enterprises do not pursue a strategy aimed at offsetting the drawbacks of small size through formalized relations. Groups of enterprises involve only about 3 per cent of all active enterprises, even if their weight in terms of employed persons and turnover is much higher, thus evidencing that this phenomenon concerns mainly relatively large

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<sup>2</sup> Local units are for example the following ones, provided they are performed by at least one person: agency, hotel, consulting room, bar, quarry, storage room, garage, laboratory, depot, mine, shop, workshop, hospital, restaurant, school, factory, office, etc.

enterprises. The relations built on the basis of contract and subcontract agreements or other forms of formalized partnership (co-operation in production, marketing or technological or organizational innovation) are relatively more widespread, but not enough to counterbalance the drawbacks of small size through a flexible organization strategy. According to various research papers, locally one frequently finds other, often informal, forms of co-operation between enterprises, but their very nature does not allow an adequate statistical representation.

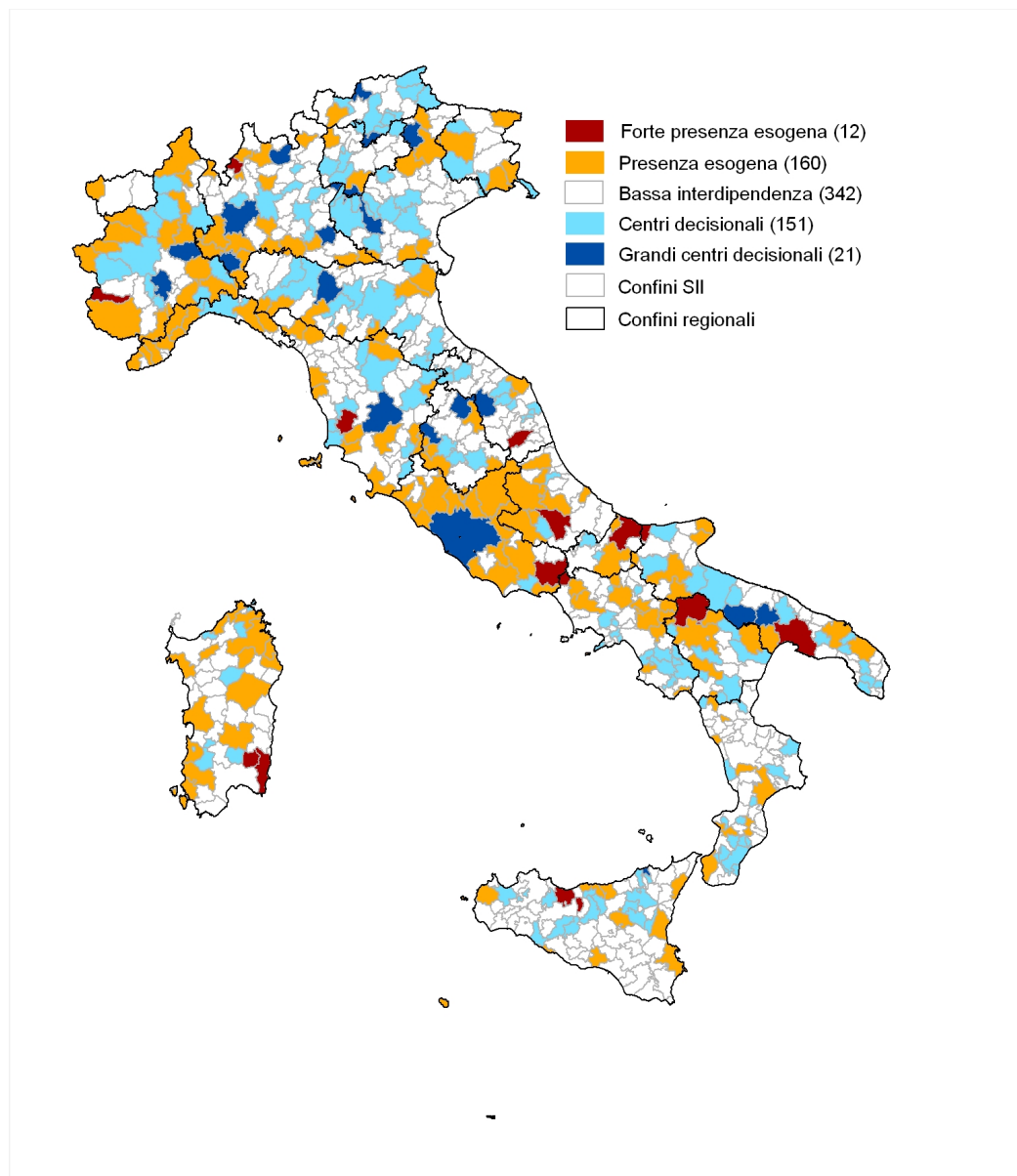
A different, but closely related, aspect concerns the control of the production units active in a local labour market area: unlike the labour factor, endogenous by definition, production units can be the expression of enterprises in the same area (and generally they coincide with them) or can be controlled by companies whose headquarters are in a different area. This analysis provides some interesting information: firstly it allows to try and confirm the hypothesis that Italian development, at least from the 1970s on, has taken place by contagion and diffusion from one or more poles (Istat 2008a, pp.163-173); secondly, it allows to understand if, in the competition between territories, greater success is achieved by systems where endogenous entrepreneurship is more lively or by those where external enterprises set up their local units (and this question entails serious consequences in terms of development policies – Istat 2007, pp.162-167); thirdly, it provides the opportunity to analyze the networks created by these relations between enterprises and local units.

In a space-based perspective, a first indicator – the ratio of employed persons in enterprises included in a given local labour market area to all employed persons working for local units of enterprises in the same area – measures the presence of local units managed by an external entity. Values lower than one identify local labour market areas where a portion of all employed persons work for external enterprises, while values higher than one define local labour market areas where enterprises have employed persons active in enterprises located in other areas. This ratio ranges from 0.661 (Pomarance, Pisa, where one employee out of three works for units of external enterprises) to a maximum of 1.419 (Ala, Trento, where nearly one third of employed persons of local enterprises operates in units located in other areas). In most local labour market areas, however, production units (measured in terms of number of employed persons) belong to enterprises located in the same area, consistently with the fact that in Italy most enterprises have only one unit (4.8 million local units versus 4.4 million enterprises).

The distribution of values in this indicator is symmetrical, but shows high concentration near the average, where multilocalized enterprises are most frequent. If we consider the 172 local

labour market areas at both ends of the distribution (below called *decisional centres* and *exogenously affected areas*) we can see that the former are most frequent in the North-East, that confirms its ability to direct the production decisions of the Italian economy (Figure 1, Table 1).

Figure 1 - Local labour market areas by intensity of presence of external enterprises – Year 2006



Source: Istat elaboration of Istat data, Registry of local units

Table 1 - Presence of employed persons in branches of external enterprises by location and type of local labour market areas – Year 2006 (localization ratios)

Type of Local labour market area	Territorial area				Italy
	North-West	North-East	Centre	South & Islands	
Exogenously affected	1,539	0,603	1,153	0,896	1,000
- of which highly affected	1,003	-	1,340	1,231	1,000
Low interdependence	0,792	0,994	0,987	1,080	1,000
Decisional centres	0,875	1,408	0,872	0,945	1,000
- of which large centres	2,006	1,647	1,276	0,302	1,000
Total	1,000	1,000	1,000	1,000	1,000

Source: Istat elaboration of Istat data, Registry of local unit

The North-West has lost its traditional primacy, although when we consider the *large decisional centres* (the 21 areas with the highest indicator – higher than 1.088) a third of these is still located in the North-West. At the other end of the range, *exogenously affected areas* are relatively more frequent in the North-West and Centre, with a relatively lower presence in the North-East. Local labour market areas with low interdependence, less affected by the interchange between headquarters and production sites, are relatively more frequent in the South (while the North-West is the most interdependent area). In the South however we find seven of the twelve *highly exogenously affected areas*, i.e. those with the lowest indicator (lower than 0.785): the most prominent are the establishments of Fiat (Cassino, Termini Imerese, Termoli and Melfi) and other enterprises born from the special intervention for the South (Taranto and Sulmona).

A reference to the classification of local labour market areas according to their specialization (Istat 2006) provides further insights (Table 2).

The *highly exogenously affected areas* are relatively more frequent in the segment “Other manufacturing industry”, which includes heavy industry and in general large enterprises. It is mainly the manufacture of motor vehicles, chemicals and oil that contribute to this result. Areas without specialization are excluded from the relations established between the headquarters and local units; on the other hand these enterprises are mostly located in the South, thus confirming the “autarchic” isolation typical of Southern enterprises. *Decisional centres*, and *large decisional centres*, instead, are located mainly in urban areas, especially those with high specialization. This is not surprising because the rank of a city is defined also by the presence of the headquarters of large enterprises. But the presence of decisional centres is as high, when not higher, in the areas of light manufacturing industry. The ability of enterprises in these areas to expand outside their original location, developing and delocalizing their structures – frequently determining a “contagion” towards nearby local labour market areas – is relatively less frequent in the “made in Italy” areas specializing in traditional sectors (textiles, leather and clothing) than in other “made in Italy” areas where

different light manufacturing industries prevail (wood and furniture, eyewear, machinery and food industry). The latter are characterized also by a greater ability to interact with different local labour market areas belonging to the same specialization group. Thus, the contagion happens not only through geographic proximity, but also through affinity in specialization. As concerns interdependence between decisional centres and highly exogenously affected areas (measured as the sum of the localization ratios referred to the two extremes of distribution), the higher values are found in highly specialized urban areas (chemicals, oil and textiles). At the opposite end (low interdependence) we find shoes and clothing, in addition to agricultural areas, whose relative isolation however depends on localization constraints.

Table 2 - Local labour market areas by intensity of presence of external enterprises – Year 2006 (localization ratios)

Local labour market area by specialization	Type of local labour market area					Total
	Exogenously affected	- of which highly affected	Low interdependence	Decisional centres	- of which large centres	
NON SPECIALIZED AREAS	0,780	0,260	1,094	1,033	0,148	1,000
NON MANUFACTURING AREA	1,255	0,642	0,947	0,851	1,101	1,000
Cities	1,219	-	0,836	1,108	1,815	1,000
Highly specialized cities	-	-	-	3,988	16,333	1,000
Poorly specialized cities	0,963	-	1,107	0,825	2,253	1,000
Non specialized cities	0,307	-	0,617	2,454	-	1,000
Mostly harbours	2,148	-	0,771	0,307	-	1,000
Other non manufacturing areas	1,279	1,079	1,022	0,677	0,616	1,000
Tourist areas	1,411	1,394	0,881	0,827	0,797	1,000
Agriculturally bent areas	0,831	-	1,504	0,166	-	1,000
"MADE IN ITALY" AREAS	0,739	0,493	1,038	1,186	1,971	1,000
Textiles, leather and clothing	0,518	0,572	1,183	1,117	0,327	1,000
Integrated leather and leather goods	-	-	0,729	2,538	-	1,000
Shoes	0,181	2,598	1,641	0,544	-	1,000
Textiles	1,108	-	0,557	1,773	1,815	1,000
Clothing and apparel	0,570	-	1,310	0,814	-	1,000
Other "made in Italy"	0,906	0,433	0,927	1,239	3,217	1,000
Wood and furniture	0,570	2,042	0,931	1,567	2,333	1,000
Eyewear	0,997	-	0,752	1,496	4,083	1,000
Manufacture of machines	0,912	-	0,917	1,253	3,733	1,000
Agro-food industry	1,046	-	0,954	1,046	3,213	1,000
HEAVY MANUFACTURING	2,137	7,146	0,645	0,570	-	1,000
Production and processing of metals	1,424	4,083	0,860	0,855	-	1,000
Motor vehicles	2,493	17,865	0,627	0,249	-	1,000
Construction materials	1,140	-	0,860	1,140	-	1,000
Chemicals and oil	2,729	3,009	0,422	0,420	-	1,000
Total	1,000	1,000	1,000	1,000	1,000	1,000

Source: Istat elaboration of Istat data, Registry of local u

## The configuration of production links among enterprises

If we limit our analysis to multilocalized enterprises, we can use the tools of network analysis for describing the network, intensity and features of the interrelations between the headquarters of an enterprise and its local units. In all multilocalized enterprises, in fact, local units have operational connections with headquarters (which perform management and decision making functions). These connections are oriented by the same managerial functions and have an evident geographical aspect related to the different location of headquarters and local units. The intensity of such connections can be measured by the number of employees of each local unit governed by headquarters.

The application of network analysis to the connections between headquarters and local units allows to identify their patterns of relation and interaction. These techniques, and their



graphical representation, show synthetically the existence of networks of enterprises on the territory, providing a picture that goes beyond the biunivocal relation between origin and destination, and allowing to identify types of networks that can be ascribed to the various socio-economic features of the areas in question.

When read in the territorial dimension, the relationships between headquarters and local units describe the pattern and the intensity of the relationships between local labour market areas.

To provide more details on this aspect, our network analysis has been performed with reference to local labour market areas and we considered only the relations between headquarters and branches located in different labour market areas. These connections confirm the existence of a producing relationship between the two areas.

Overall, if we keep into account the relatively low frequency of multilocalized enterprises included in the registry, the network built by headquarters and local units is quite dense<sup>3</sup>: in fact it activates 5.8% of all possible connections (all those connecting two areas, i.e. nearly 240,000).

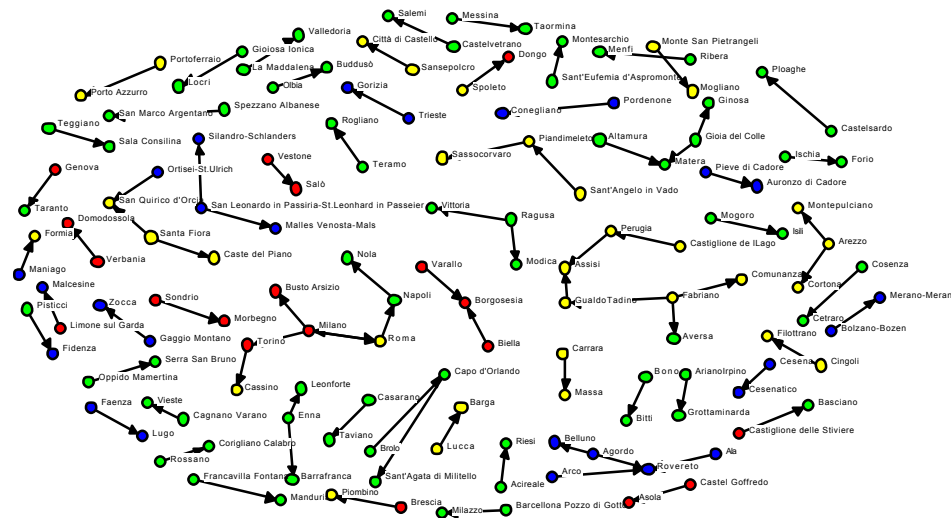
In the corresponding graph (Figure 2), the connections (nodes) between areas are represented as oriented arrows connecting headquarters to local units. The thickness of each vector is proportional to the intensity of the effect (i.e. the number of employed persons in the first area governed by headquarters from the second area), adequately weighted with the geometric average of employed persons in the two areas.

In order to appreciate the number of “active” connections that each area establishes with other areas (through headquarters controlling local units in other areas) and the number of “passive” connections (employed persons active in areas controlled by headquarters located in other areas) we used two measures of centrality: out-degree and in-degree, respectively. The highest out-degree is found in Rome, where enterprises control local units in all other local labour market areas, while the highest in-degree is found in Milan, where we find local units of enterprises located in 343 local labour market areas. If we look at these indicators jointly, as a synthetic measure of the interconnectedness of each area with the rest of the network, we see that the local labour market areas of large to medium sized cities take the first ten ranks (in addition to Rome and Milan we have Bologna, Turin, Padua, Florence, Bergamo, Verona and Genoa).

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<sup>3</sup> The measure of density, one of the descriptive statistics included in network analysis, is calculated by relating the actual number of connections existing in a network to the maximum possible number of connections and allows to assess how interconnected the nodes in a network are and to rate their centrality.

Figure 2 - Network of multilocalized enterprises in industry and services in local labour market areas – Year 2006 (weighted values)



Source: Istat elaboration of Istat data, Registry of local units

The shape of the identified networks is also a useful element in the analysis. Small and relatively closed networks present some drawbacks as compared to more open networks, with “weak ties” (Granovetter 1973) with nodes external to the main network. These nodes in fact facilitate the circulation of information, innovative ideas, mobile production factors, explicit and implicit knowledge. From the point of view of each node, it is more rewarding to be connected also to the nodes of other networks, rather than having many connections all within the same network. Conversely, some nodes – those connecting networks or portions of different networks – play the strategic role of interconnecting networks that would otherwise remain separate. Thanks to these “weak ties” most nodes can be reached with a limited number of steps. Networks endowed with these features are called “small worlds”.

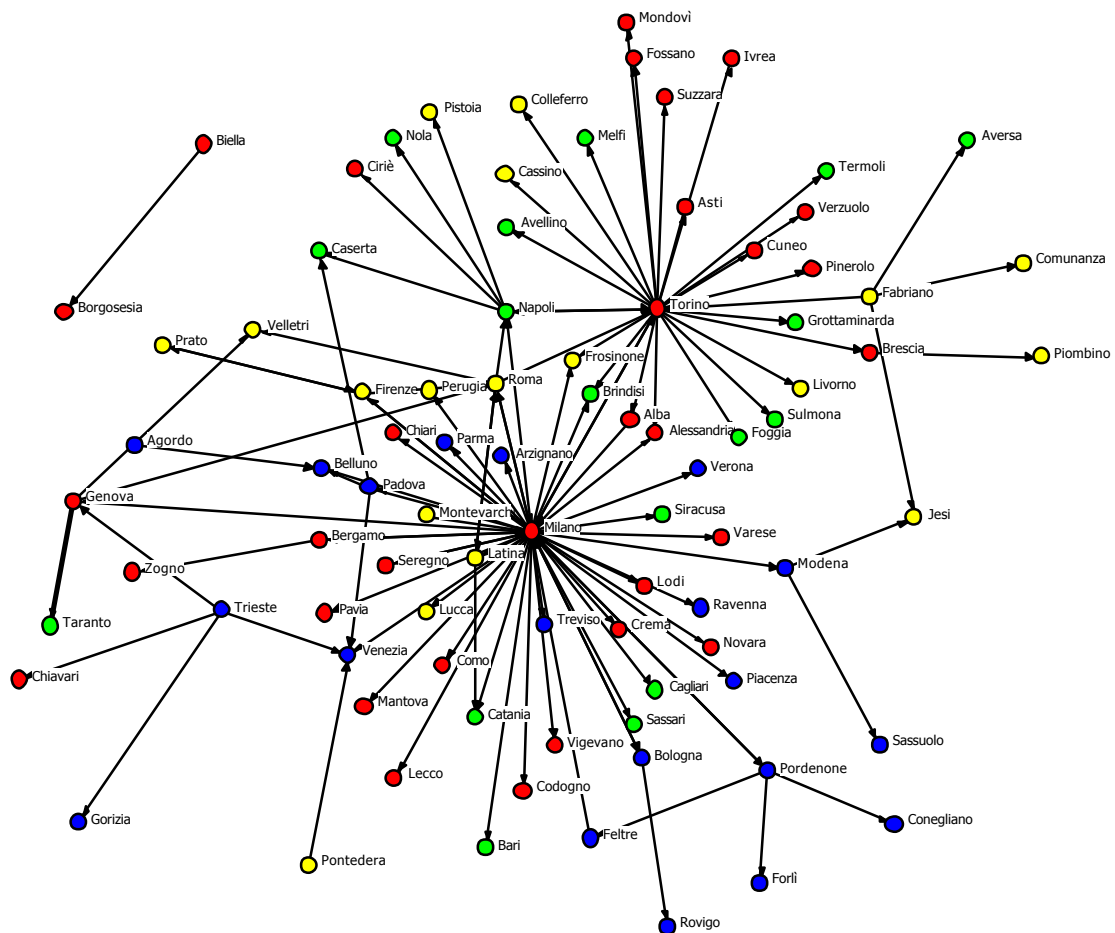
The network created in the geography of local labour market areas by relations between headquarters and local units shows the features of a “small world”: the average distance between local labour market areas is slightly higher than two (on average each area is connected to another area with less than two steps, the most distant<sup>4</sup> being Ales and Vilminore di Scalve with four degrees of separation) but the level of aggregation of the network is ten times higher than the value of a random graph (0.4515084 compared to 0.0441705).

<sup>4</sup> This distance, that measures the degrees of separation in the network, does not necessarily mean a geographical distance: Ales is in Sardinia, Vilminore di Scalve in Lombardy.



network) and in-coming (lower in this case: 23.9% vs. 46.7%). Also the average number of “active” and “passive” connections established by each manufacturing area with other areas is less than one fourth of that in the general observation field (9.7 vs. 40.2). In this case the local labour market area of Milan has the highest values both for the out-degree (its enterprises control other enterprises in 268 local labour market areas) and for the in-degree (in this area are present local units of enterprises located in 210 different areas). Considering the two indicators together we can see a confirmation of the role played by large to medium sized cities, but in this case Alba (the location of Ferrero Nutella headquarters) takes the place of Padua in the first 10 ranking local labour market areas.

Figure 4 - Network of multilocalized enterprises in manufacturing in local labour market areas – Year 2006 (weighted values)

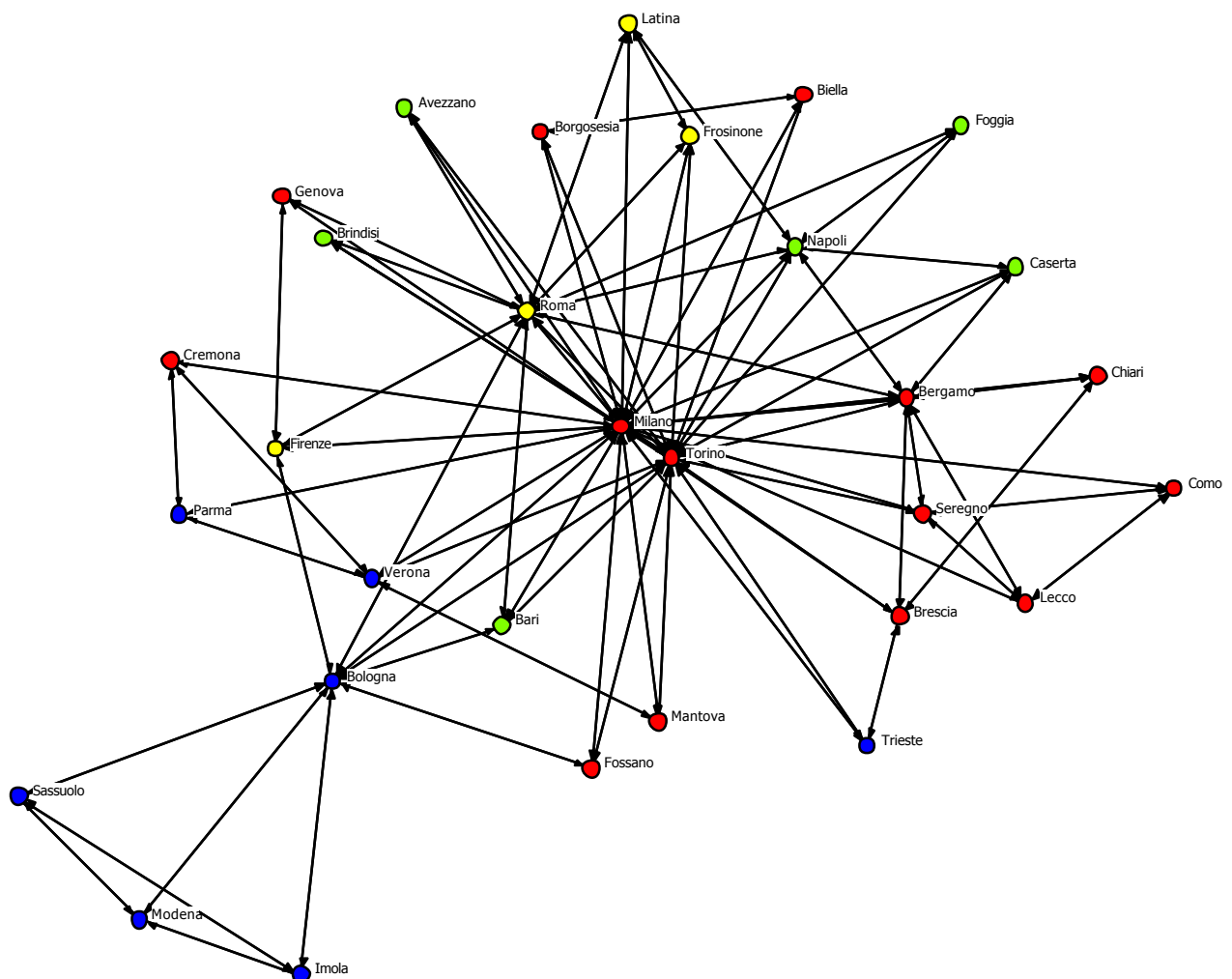


Source: Istat elaboration of Istat data, Registry of local units

The network's structure is quite different from the one analyzed above (Figure 4). Milan lies at the centre of a network that is interconnected but has a clear radial shape. The “small world” features are substantially confirmed. As compared to the network built on all economic activities recorded in the Asia registry, the average distance between local labour

market areas is slightly higher (on average each area belonging to the network is connected to other areas by a little less than three steps) but the couples of non connected areas are nearly 190,000 – among the connected areas the “farthest” are Locri (Calabria) and Corleto Perticara (Potenza) with eight degrees of separation. The network’s degree of aggregation is over fourteen times higher than what could be expected in a random graph (0.2528146 vs. 0.0178807). In the network of areas connected by the presence of multilocalized manufacturing enterprises we see also a widespread presence of cliques: there are in fact 19 cliques made up of 4 elements and 3 made up of 5 (Figure 5). Milan shows the highest centrality – as it is present in 20 cliques out of 22 – but also Turin (13), Rome (10), Bergamo (6) and Bologna and Naples (4) rank high.

Figure 5 - Cliques of multilocalized enterprises in manufacturing in local labour market areas – Year 2006 (weighted values)



Source: Istat elaboration of Istat data, Registry of local units

The network of areas connected by the presence of multilocalized manufacturing enterprises – even more than the one made up of economic activities in industry and services – is characterized by the role played by some nodes with high centrality, in particular Milan.

## Conclusions

From the above analysis we can draw a few conclusions.

First of all, the structure of the network created among Italian local labour market areas by the functional connections between multilocalized enterprises and their local units – characterized by the simultaneous presence of “weak ties” and high clustering levels – seems capable of favouring the transmission of innovation, the circulation of knowledge, and the mobility of production factors. This result confirms that the interaction of enterprises and of territories is a factor of growth: the concurrence of local labour market areas capable of expanding outside their original location by creating new units in different areas and of local labour market areas open to the contribution of external enterprises, also in terms of technological and organizational innovation, is a factor of success.

The analysis confirms also the propulsive role played by the decisional centres that takes place mostly “by contagion”, not only due to geographic proximity but also to affinity in the production mix. For this strategy to deploy these developmental effects it is also necessary that the expansion strategy of decisional centres find a welcoming environment in the local labour market areas chosen (exogenously affected areas – Istat 2007, p. 166).

The presence of these hubs<sup>6</sup> – especially with reference to the manufacturing industry – is at the same time a strong and a weak point in the network. The network’s structure is strong in case of occasional crisis or exogenous shocks (most of the nodes are relatively poorly connected and the problem concerns only a limited portion of the network), but its hubs are extremely vulnerable. Despite the diffuse features of Italian local development, the dependence from a limited number of decisional centres makes the Italian economic system more fragile in case of downturns affecting the most important decisional centres.

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<sup>6</sup> In mathematical terms this is a “scale free” network (Barabási e Albert 1999).

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