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Abstract

The traditional district literature tends to assume that: (1) the competitiveness of firms depends on external sources of knowledge; (2) all firms in a district benefit from knowledge externalities; (3) relying on external knowledge relationships necessarily means these are confined to the district area. Our case study of the Barletta footwear district in the South of Italy suggests otherwise. Based on social network analysis, we demonstrate that the local knowledge network is quite weak and unevenly distributed among the local firms. A strong local network position of a firm tended to increase their innovative performance, and so did their connectivity to extra-local firms. So, it mattered being connected either locally or non-locally: being co-located was surely not enough. Having a high absorptive capacity seemed to raise only indirectly, through non-local relationships, the innovative performance of firms.

1. Introduction

Concepts like innovative milieux (Camagni, 1991), industrial districts (Becattini, 1979), regional innovation systems (Cooke, 2001) and learning regions (Asheim, 1996) have underlined the importance of regions as key drivers of innovation. This body of literature stresses that key technological advances (and R&D activities) take place in only a limited number of regions world-wide. The general claim is that geographical proximity facilitates knowledge sharing and, thus, interactive learning and innovation. In doing so, it states that knowledge externalities in a district are 'in the air', as Marshall called it, available to firms located inside, but not to those outside the district. In addition, this body of literature often suggests that all firms in the district benefit from these knowledge spillovers, because they are part of extensive local networks and belong to the same cultural environment.

There is increasing awareness that this traditional view on districts tends to overemphasise, and often even assumes, the role of geographical proximity in the transfer of knowledge between firms (Boschma, 2005a; Boschma and Kloosterman, 2005). In doing so, it tends to ignore the importance of knowledge creation within the firm, while it overestimates (local) external relations as key sources of knowledge (see special issue *Economic Geography*, 2001). Firms are often treated as being one and the same, overlooking the fact that firms widely differ in terms of absorptive capacity and economic power (Cohen and Levinthal, 1990; Boschma and Lambooy, 2002). Recent studies have demonstrated that leading firms or district groups affect or even dominate the degree and nature of knowledge transfer between local firms in districts (e.g. Lissoni, 2001; Giuliani and Bell, 2005; Malipiero et al., 2005). In addition, non-local relationships are considered to play a key role in avoiding lock-in both at the firm and the district level (Camagni, 1991; Bathelt et al. 2004). What can be learned from recent studies is that it would be wrong to assume that: (1) firms only depend on external sources of knowledge; (2) all firms in a district benefit from knowledge externalities; (3) relying on external relationships necessarily means these are confined to the district area (Breschi and Lissoni, 2001).

In the paper, we account for these shortcomings when analysing knowledge relationships between firms in the footwear district of Barletta in the South of Italy. The objective of the paper is twofold. First, we conduct a social network analysis to draw the configuration of the knowledge network of the footwear district of Barletta, and we make use of non-parametric techniques to determine which factors (like the absorptive capacity of firms) may be held responsible for a firm's position in the knowledge network. Second, we aim to assess which factors may have contributed to the innovative performance of footwear firms in the Barletta district. We explore the extent to which firm-specific features (such as the size and the absorptive capacity of firms), network positions of firms (horizontal and vertical relationships) and their location (local versus non-local relationships) contribute to the innovativeness of footwear firms in the Barletta district. So, despite the fact that a spatial clustering of footwear production is observed, we do not take the role of geographical proximity for granted, but test its impact on firm's performance empirically, controlling for the effects of firm-specific features and external non-local linkages.

The paper is structured as follows. In Section 2, we describe in a brief way the main shortcomings of the traditional view on industrial districts. In doing so, we bring together and build on insights from a range of disciplines, that is, cognitive science, social network theory, innovation

studies, the organisation literature (gatekeepers) and regional studies. In Section 3, the footwear district in the Barletta region is introduced, including a description of the nature and structure of the knowledge network. Section 4 presents the empirical results, and Section 5 draws some conclusions.

2. Firms, networks and places

In economic geography, there is a fundamental debate about whether places are still relevant for the competitiveness of firms, or whether networks matter more (Castells, 1996). This debate may also be linked to the geography of innovation. Whereas the concept of space of places expresses the idea that the place or location matters for learning and innovation (being in the right place is what counts), the concept of space of flows focuses more on the idea that networks are key vehicles of knowledge transfer and diffusion (meaning that being in the right network is of utmost importance).

In the traditional industrial district literature, the space of places and the space of flows greatly overlap. Knowledge externalities were assumed to be readily available for district firms, because, among other things, knowledge networks were assumed to be geographically localised, encompassing all district firms, with no significant extra-regional linkages (Boschma and Lambooy, 2002). Effective knowledge sharing was enhanced by social and cultural proximity between agents in the district. Local firms were assumed to be more willing to share knowledge and establish research partnerships with other local agents because common norms and values prevented cheating and opportunistic behaviour (Harrison, 1992). In other words, because geographical and cultural proximity facilitated interactive learning, district borders were conceived to enclose knowledge networks, and collective learning processes were tied to the place of the district (Crevoisier, 2004).

As a consequence, little attention was paid to the fact that district firms might differ¹. Broadly speaking, district firms were characterised as small and medium-sized, having equal access to local knowledge being 'in the air'. They were conceived to be connected to the local network of input-output linkages, and they shared similar levels of absorptive capacity unknown to non-local firms. Being in the right firm, the right place and the right network meant more or less the same. When conceptualising a district like that, knowledge was a public and a club good at the same time, though spatially bounded. In those circumstances, there was no need to disentangle analytically the effects of firm-specific features, network positions and place on the performance of district firms. Below, we argue why such a position does not hold any longer.

2.1 Heterogeneous firms

As stated above, the district literature tends to overemphasise the role of external linkages in the acquisition and creation of knowledge, at the expense of intra-firm processes of knowledge creation. This may partly be attributed to the fact that districts were composed merely of small and medium-sized firms lacking the resources for expensive R&D efforts. By contrast, empirical studies often show that firms value internal knowledge creation as a more important source of knowledge for innovation than external relationships (e.g. Sternberg & Arndt, 2001; Weterings, 2005). In addition, there is

growing awareness that the two go together, meaning that the ability of a firm to understand and absorb external knowledge is dependent on its own competence base.

Consequently, it would be wrong to represent district firms as homogeneous agents (Boschma and Lambooy, 2002). This awareness is expressed most strongly in literature on Italian industrial districts that presented clear evidence of the emergence of powerful leading firms and business groups through local mergers/acquisitions and direct investments / takeovers by foreign corporations (Dei Ottati, 1996, Boari and Lipparini, 1999; Whitford, 2001; Cainelli et al. 2005). Leading firms (like Benetton) often control the supply chain through their market power, coordinating activities of suppliers and subcontractors in the district. In addition, they perform R&D and other search activities, which means that knowledge creation is increasingly taking place within the confines of the leading firms. Leading firms are also well integrated in the world economy, having access to international knowledge networks, and possessing a capability to identify, understand and absorb external knowledge.

Firms are also heterogeneous in their knowledge and competence bases (Nelson and Winter, 1982). They are subject to cognitive constraints, which depend to a large extent on the knowledge and experience they have acquired in the past. Firms have different levels of absorptive capacity, meaning that they have different abilities to absorb, understand and exploit external knowledge (Cohen and Levinthal, 1990). Knowledge accumulates in the structure of firms, embodied in routines and human resources, which provide opportunities but also set constraints for firms to learn. Consequently, the absorptive capacity of a firm is a function of its stock of prior knowledge. Inter-firm learning is only possible when the cognitive distance between firms is not too great. For that reason, different levels of knowledge bases may result in different roles firms can perform in knowledge networks: leading firms will function as hubs in the district network, while weak firms will operate quite isolated from the district network because they have no capabilities that might be attractive to other firms nor do they have a capacity to understand and exploit knowledge coming from other firms (Giuliani and Bell, 2005).

Recently, the literature has focussed on the role of leading firms as gatekeepers of knowledge, who search for and absorb non-local knowledge, and transmit it into the district (Morrison, 2004; Owen-Smith and Powell, 2004). In that respect, technological gatekeepers may act as 'bridging enterprises' linking the district to the outside world. As Malipiero et al. (2005) explain, leading firms have well-established contacts crossing the border of their own district. Since they have a superior knowledge base (as compared to other district firms), they are better equipped to identify and incorporate new external knowledge. In addition, gatekeepers are able to process and decode the external knowledge for local firms, favouring the dissemination of external knowledge into the district (Morrison, 2004). Having said that, local firms require a sufficient amount of absorptive capacity to enable such interactive learning to take place effectively. When leading firms share and exchange knowledge only with a few selected local partners, and other district firms lack the competences for effective knowledge transfer, knowledge will not spread widely among all district firms.

Our study of the Barletta district accounts for the fact that firms differ in economic power, competences and organisational strategies, and we expect this to be reflected in the specific

¹ In that traditional view, it was acknowledged though that an extensive division of labour between specialised firms was a key feature of industrial districts. However, this view did not say much about

configuration of the knowledge networks. In doing so, we explore whether gatekeepers exclude local firms from reaping knowledge spillovers, or whether they enhance processes of knowledge transfer, providing local firms access to external sources of information. In addition, we account for firm-specific features (e.g. absorptive capacity) when assessing their impact on the innovative performance of footwear firms in the Barletta district.

2.2 Local and non-local networks

As described in the introduction, the view of regions as key drivers of innovation is very strong and well established in economic geography. It builds on the fact that geographical proximity facilitates knowledge sharing and, thus, interactive learning and innovation. In doing so, it assumes that knowledge does not spill over large distances: district firms can benefit from knowledge externalities that are 'in the air', but that are not available to firms located outside the district. In addition, this body of literature stresses that all firms in the district can benefit from these knowledge spillovers, because they belong to the same cultural environment (Malmberg and Maskell, 2002).

Next to simple co-location, networks may also function as key vehicles of knowledge transfer and knowledge diffusion. Since networks are demarcated in a non-territorial way, it would be wrong to assume that knowledge networks are geographically localised (Bunnell and Coe, 2001). Breschi and Lissoni (2002) have suggested that not geography causes tacit knowledge to spillover between firms, but social connectedness of people in networks does. This implies that knowledge is unlikely to diffuse evenly in a district, and that knowledge networks may cross the boundaries of the district. Knowledge circulates and flows through networks (or 'epistemic communities') that consist of agents sharing cognitive capabilities and trust, but not necessarily the same location. In other words, networks do not require permanent co-location for interactive learning to take place (Torre and Rallet, 2005). This implies that district firms are excluded from essential knowledge sharing when they are not part of knowledge networks (Lissoni, 2001; Graf, 2005). Accordingly, interactive learning and innovation is not a matter of being in the right place, but more about being member of the right network. In other words, it makes a difference whether the performance of district firms may be attributed to their network position (being in the right network), or to their geographical position (being in the right location).

There is growing awareness that geographical openness (being connected to extra-local knowledge networks) is a precondition for district firms to survive. Too much reliance on local knowledge sources may be harmful for interactive learning and innovation: when district firms become too much inward looking, their learning ability may be weakened to such an extent that they lose their innovative capacity and are unable to respond to new developments. This problem of lock-in may be solved or avoided by establishing non-local networks, providing access to the outside world (Camagni, 1991; Asheim and Isaksen, 2002). Empirical studies show that both local and non-local relationships are important sources for interactive learning (Kaufmann and Tödtling, 2002). Local relations may even be more beneficial when they are supplemented by non-local relations that bring new ideas into the district (Bathelt et al., 2004). As stated earlier, technological gatekeepers may fulfil this task in districts.

the way specialisation of firms might have hindered knowledge transfer between firms.

Giuliani (2005) suggests that one should make a clear distinction between business networks and knowledge networks in districts. The co-location of firms in districts tends to provide equal opportunities for each firm to interact with other firms. This is in line with the traditional view on industrial districts that emphasises the existence of local pervasive networks in districts. By contrast, knowledge networks are expected to be more unevenly distributed in the district, depending on the level of the knowledge bases of the district firms. That is, the structure of knowledge networks tends to follow a power law distribution, shaped by a preferential attachment rule. According to Giuliani (2005), it is not geographical and relational proximity of firms per se (as reflected in local networks of interaction) that affects the innovative performance of district firms, but their absorptive capacity, because this determines their degree of centrality in the knowledge network.

In sum, knowledge creation and innovation may take place within the boundaries of a firm, within a network and within the confines of a district. So, district firms are expected to perform better when they have a higher absorptive capacity (or stronger knowledge base), when they are better connected, and when they participate in local networks. This will be tested in our case study, in which we assess the impact of firm-specific features, network position and geography on the innovative performance of firms separately. Our study aims to determine the effects of each of them at the firm level, instead of assuming them at the regional level.

3. Knowledge relationships in the Barletta district

In this section, the Barletta footwear case is introduced. First, we provide some general information on the main characteristics of the footwear sector in the Barletta district. Then, we draw the main configuration of the knowledge network of the Barletta district by employing social network analysis (Wasserman and Faust, 1994).

3.1 The footwear district of Barletta

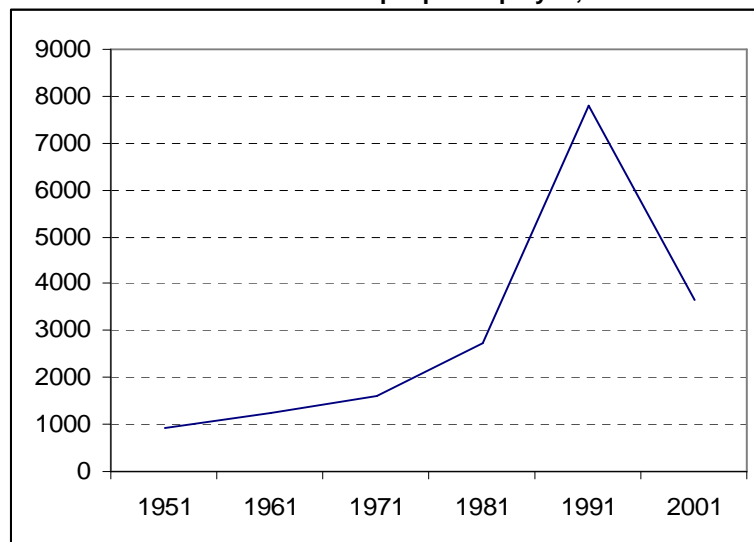
In Italy, footwear production is concentrated in a number of industrial districts, of which the Barletta district is the main one located in the South of Italy. It is situated in the region of Apulia, just north of the city of Bari. The concentration of small and medium-sized firms is focused on the production of casual shoes for lower market spheres, mostly provided with so-called injected soles. Some of the larger firms in the district are devoted to the production of the more advanced safety shoes that are developed for use in dangerous working circumstances.

As illustrated in Figure 1, the evolution of the Barletta footwear district in the post-war period may be characterised as follows. After the Second World War, some pioneers introduced the sophisticated technology of shoe production which they had acquired in a more advanced footwear district in Northern Italy. From the 1960s onwards, these pioneers' activities provoked massive imitation and the Barletta district took off. Due to a growing demand for cheap, trendy shoes the market size expanded greatly in the 1970s and 1980s and the number of footwear firms and the associated number of employees grew steadily (d'Ercole, 2000). From the beginning of the 1990s,

however, the first signs of a slowdown began to appear. This negative trend proceeded and made the district end up in a severe crisis with many closing and declining firms at the turn of the century. Due to a stronger orientation of consumer demand toward 'brand names' and increasing competition from low-cost countries, market space for the footwear from Barletta has shrunk considerably.

Only a limited number of enterprises made serious efforts to innovate by adapting their products to find new market niches or to modify the production process in order to decrease production costs. A considerable number of firms, however, from the beginning of the 1990s onwards shifted to the growing market for safety shoes. This market segment can be characterised by a relatively high innovation potential, less competition from low-cost countries and a growing consumer demand (due to new regulations on working conditions). Also the district's distinct leading firm produces safety shoes. Beside the fact that this is the only firm employing more than 100 persons, it is also leading in terms of its advanced technological knowledge base.

Figure 1. The evolution of the footwear district of Barletta, in terms of number of people employed, 1951-2001



Source: Viesti (2000), *Come nascono i distretti del Mezzogiorno* & ISTAT (2001) *Ottavo Censimento Generale dell'Industria e dei Servizi 2001*.

The most recent Census of Industry, carried out in 2001, made clear that the industrial district of Barletta officially consists of 369 firms in the footwear sector, with final firms and specialised suppliers both accounting for about 50 percent. These data however contain a very high number of firms that do not exist anymore. In reality the district consists of 58 existing and active final firms and a slightly higher number of specialised suppliers.

3.2 The knowledge networks of the Barletta district

We have investigated the structure of the knowledge relationships in the footwear sector of the Barletta district. With structure, we mean the intensity, the range, the type and the geographical range of knowledge relationships. That is, we have measured the depth of knowledge relationships (how important, how intensive), the breadth of knowledge relationships (how many, how diverse), and the

degree of geographical openness (the importance of local versus non-local knowledge sources of knowledge). In doing so, we not only determine the position of each individual firm in the local network of footwear firms in the district (such as its degree centrality), we also draw the configuration of this knowledge network on the aggregate level. This provides answers to questions like: are there dominant players in the network, to what extent can the knowledge network be characterised as a local network, which cognitive subgroups exist in the region, to what extent does the network exceed the region's boundaries, and who has access to knowledge drawn from outside the district?

We have been able to conduct structured interviews with 33 of the 58 final firms involved in footwear production in the Barletta district region, which consists of five municipalities (ter Wal, 2005). This means we got a good response of 58% of the total population. Although small firms are underrepresented in our sample, a goodness-of-fitness test showed that the distribution of firms over the size classes does not differ significantly from the population's size distribution. In other words, the sample can be considered representative for the population as a whole. Our sample of 33 firms consists of 12 large firms (20 or more employees), 13 medium-sized firms (10-19 employees) and 8 small firms (1-9 employees).

In measuring knowledge relationships between firms in the survey, we follow the so-called 'roster-recall' method (Morrison, 2004; Giuliani and Bell, 2005). In this method, each firm is confronted with a list (or roster) on which the names of the largest firms were already given. The firm has to indicate on the list from which enterprises technical support and market knowledge was received, which organisations benefited from technical support and market knowledge provided by the firm, and with whom the firm was involved in research collaboration. Besides, the respondent is asked to recall the names of all other enterprises (both competitors, clients and suppliers; both local and non-local) with which they were involved in a knowledge relationship and to add them to the list. Moreover, we collected information on three different characteristics of each of the knowledge relationships we identified: first on the importance of the contact for firm's innovative performance as perceived by the entrepreneurs themselves, second on the question whether the exchange partner was a competitor, client or supplier and finally on the nature of the contact (degree of formality).

Applying this roster-recall methodology, two types of knowledge networks have been constructed: on market-strategic knowledge and on technical knowledge. The first type of knowledge includes knowledge about consumer preferences, market sales trends of product faults of the offered goods. The second concerns, for example, knowledge about new methods of production, new materials, new designing techniques and more efficient machineries.

As stated earlier, the resulting regional knowledge system is analysed through social network analysis, in which the network ties with other firms are examined. We make use of graph theoretical methods, which allow us to determine different dimensions of network structure (density, connectivity, coverage) and network position (degree centrality, betweenness centrality and geographical openness). It is important to remind here that only horizontal inter-firm relationships have been taken into account, not vertical linkages. In Figure 2, we have depicted the local network of knowledge exchange of market issues in the Barletta footwear district. In Figure 3, the local knowledge network

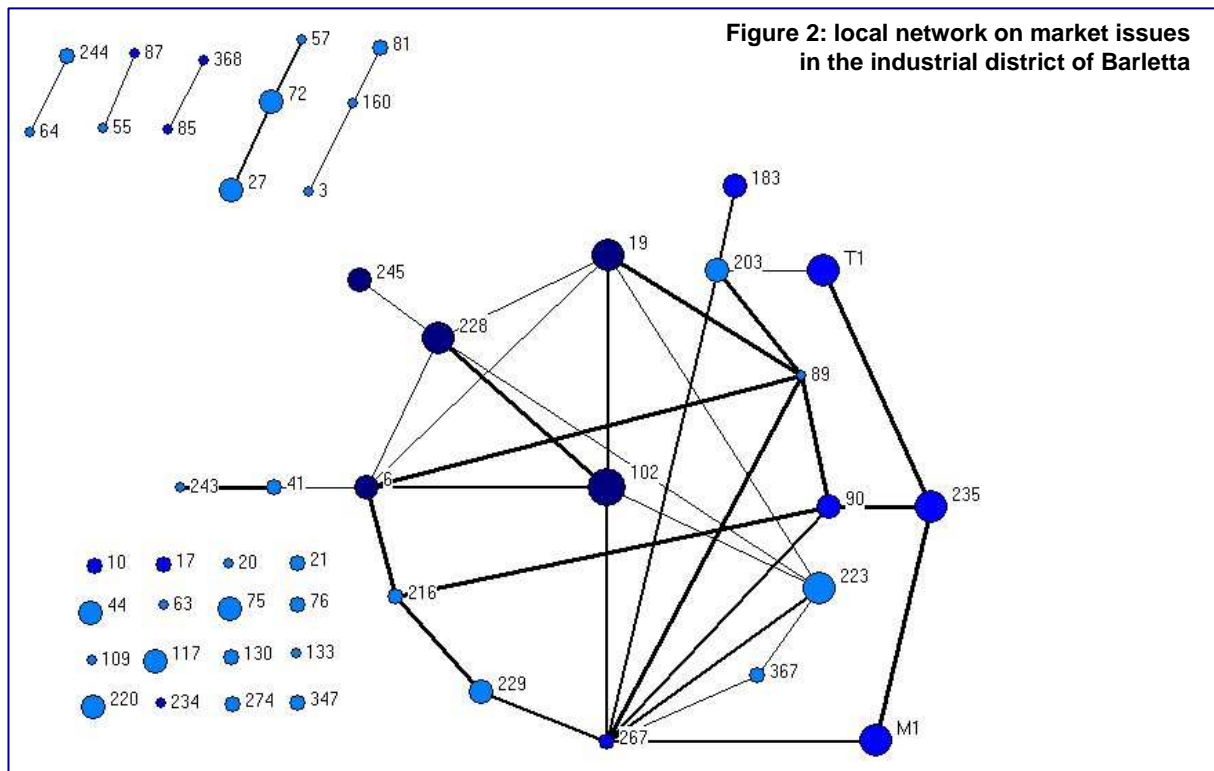


Figure 2: local network on market issues in the industrial district of Barletta

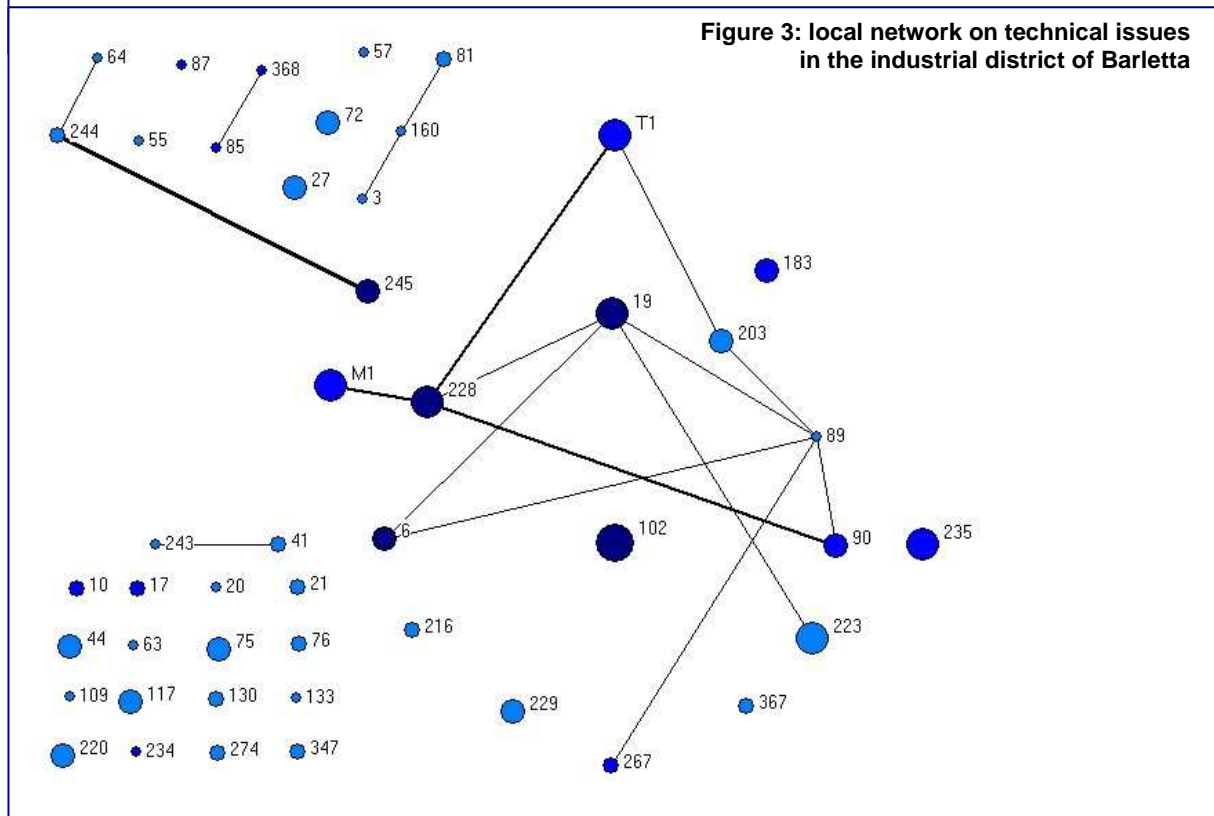


Figure 3: local network on technical issues in the industrial district of Barletta

Source: UCINET 6 (Borgatti et al., 1999) elaborations on own research data.

The size of the nodes denotes size of the enterprises (allocated to categories)
 The thickness of the lines denotes 'the importance of the networks links for innovation' as indicated by the enterprises themselves.

The colours denote producers of the following footwear categories:

- Safety shoes
- Shoes with injected soles
- Shoes with applied soles

concerning technical issues is projected.

The graphs make clear that the network on market issues is much more developed than the one concerning technical issues. The technical network has a high number of disconnected firms, implying these are cognitively isolated from the rest of the district firms. Another striking feature is that the largest firm is entirely disconnected from the technical knowledge network. The differences between the market and the technical knowledge network can be further illustrated by the density of the network, expressed as a ratio between the actual number of ties and the maximum number of potential ties (Wasserman and Faust, 1994):

$$\Delta = L / g (g - 1) / 2 = 2L / g (g - 1) \quad \text{with:}$$

Δ	=	<i>network density</i>
L	=	<i>number of ties</i>
g	=	<i>group size (population size)</i>

The network on market knowledge has an average density of 0.0370, while this number is 0.0167 for the technical network. The strong prevalence of market knowledge relationships over technical knowledge relationships is further illustrated when looking at the valued density, which is the density weighted by the importance of the contact as indicated by the entrepreneurs in a number from 1 to 5 (Wassermann and Faust, 1994):

$$\Delta = \sum v_k / g (g - 1) \quad \text{with:}$$

Δ	=	<i>network density (in a valued graph)</i>
v_k	=	<i>value of line k (as expressed by the entrepreneur)</i>
g	=	<i>group size (size of population)</i>

In that case densities are 0.0712 and 0.0222 for the market and technical knowledge networks respectively. Apparently, the densities between market and technical knowledge diverge, which implies that on average local knowledge relations on market issues are 'deeper' (considered more important, more intensive) than technical knowledge ties.

The market knowledge network consists of one large component that is centred on the district's leading firm and five smaller components connecting two or three enterprises each. The network covers 66 percent of the district enterprises, while 38 percent is part of the component centred on the leading firm. This group of interconnected firms contains a large number of relatively large firms. The firms connected to the main component of the network may profit from relevant market knowledge that circulates in the network in general, and that may be transferred through the network by the leading firm (functioning as a gatekeeper) in particular. The leading firm is highly exposed to district-external sources of knowledge and generally possesses detailed information on consumer requests on distant markets. The same mechanism may be at work for other connected principal firms that have a relatively wide array of external relationships. The 34 percent of local enterprises that are

not connected to the local market knowledge network at all, however, are ascertained not to receive any relevant market knowledge from neighbouring firms.

For what the local network on technical issues is concerned, only 32 percent of all firms is involved in one way or another in inter-firm knowledge relationships. Even the leading firm is not connected to the district: it only cooperated at the technological level with a limited number of technologically advanced enterprises located outside the district. Consequently, the leading firm does not function as a *technological* gatekeeper for the other district firms. One can think of several reasons for why there is such a limited density and coverage of the technical network in the Barletta district. This may be due to the fact that – unlike the ideal-typical districts in the Third Italy – social capital – an essential precondition for knowledge exchange and collective learning – is lacking in this Southern Italian case. Another reason might be that the innovation potential of shoes with injected soles is nearly exhausted and that, as a consequence, local firms compete mainly on fashion characteristics of the shoes. This is confirmed by the fact that the existing technological inter-firm linkages involve almost no actors in the field of shoes with injected soles, which is the main sector of the district.

Figures 2 and 3 display only the horizontal inter-firm ties *within* the district. Applying the roster-recall method however, also vertical knowledge linkages and external (both horizontal and vertical) linkages have been identified. Table 1 shows the presence multiplied by the importance of inter-firm ties (average valued degree) for all types of inter-firm knowledge relationships we distinguish. In comparison with horizontal local knowledge relationships, vertical local knowledge relations are more widespread and considered more important when the transfer of technical knowledge is concerned. This may be due to the fact that the existing client-supplier relationships within the district automatically may induce some flows of technical knowledge and that the fear of unintended imitation by competitors that usually characterises horizontal ties is lacking in case of vertical relationships. The difference between vertical and horizontal inter-firm relationships does not occur in case of market knowledge, where both vertical and horizontal ties were equally distributed and valued.

Table 1: Average valued degree of firm's ego networks

	Market knowledge		Technical knowledge	
	Horizontal	Vertical	Horizontal	Vertical
Local ties	0.65	0.59	0.19	0.61
Non-local ties	0.25	1.10	0.07	1.16

Relationships with external actors are important to remain competitive and to prevent a cognitive lock-in in existing routines. As said before, the leading firm is connected to a disproportional large number of non-local firms through intense knowledge relations. Beside the leading firm, a limited number of other, smaller firms is directly connected to extra-district sources of knowledge. In case of vertical relationships, district-external linkages were even rewarded higher than local relationships. The presence and importance of non-local knowledge linkages implies that inter-firm networking is not affected by geographical proximity only, and that the network configuration is not merely local.

Distant actors, mainly in other footwear specialised districts in the Northern and Central parts of Italy, are involved in the district's local network through direct linkages to a limited number of

enterprises. Thus, many firms that do not have direct non-local knowledge linkages are dependent on their connections to the local knowledge network, through which external knowledge obtained through other firm's district-external relationships might circulate. By contrast, firms that are not connected to other local actors may have independent knowledge linkages with district-external actors.

In summary, a slight majority of footwear enterprises in the district Barletta is involved in the local knowledge network on market issues. Non-local knowledge is brought into this local network by firms (such as the leading firm) that have district-external knowledge linkages. In the technological field, however, almost no knowledge exchange exists at the district level: firms tend to rely merely on individual (mainly vertical) non-local knowledge relationships. The leading and principal firms within the district do not diffuse relevant technological knowledge through the district and, therefore, do not function as technological gatekeepers.

4. Results

The foregoing made clear that firms are highly heterogeneous concerning their position in knowledge networks. The question now is why firms differ in that respect, and whether this affects their performance? Section 4.1 examines the extent to which the absorptive capacity of firms, controlling for other firm-specific features (such as size), affects the position of Barletta's footwear firms in the knowledge network. Section 4.2 examines the extent to which the network positions of firms determines the innovative performance of firms. Due to the low number of cases, we make use of common non-parametric techniques, to investigate which factors may be held responsible for firms' positions in the knowledge network, and which factors contribute to the innovativeness of footwear firms in the Barletta district.

4.1 Network position

In order to explain the network position of firms, we constructed two types of dependent variables that measure the network position of the firm. First, we measured the firms' *betweenness centrality* in the local network of horizontal linkages. Supposing that two actors always take the shortest geodesic path in a network to communicate with each other, this measure indicates the probability that an actor is on the route of communication between two other actors. Betweenness centrality is calculated as follows:

$$C_B(n_i) = \sum_{j < k} g_{jk}(n_i) / g_{jk} \quad \text{with:}$$

$$\begin{aligned} C_B(n_i) &= && \text{betweenness centrality index of node } i \\ g_{jk} &= && \text{number of geodesics (shortest routes) linking nodes } j \text{ and } k \\ g_{jk}(n_i) &= && \text{number of geodesics (shortest routes) linking nodes } j \text{ and } k \\ &&& \text{containing actor } i \end{aligned}$$

We calculated betweenness centrality both for the local network of market knowledge and for the one of technical knowledge. Since this betweenness centrality measure only involves local horizontal linkages, we developed a second group of dependent variables on the basis of firms' ego networks. This second group of variables concerns the *valued degree of network relationships*. This measure for

network centrality is expressed by the number of inter-firm relationships a firm has (both horizontal and vertical), multiplied by the importance of the contact for a firm's innovative behaviour as indicated by the entrepreneurs themselves (on a scale from 1 not important to 5 extremely important). This measure has been calculated in three different ways, by taking into account 1) the local knowledge relationships; 2) the non-local knowledge relationships; and 3) the local and non-local knowledge ties taken together. Applied to both the market and technical knowledge types of relationships, this results in a group of six dependent variables.

Since our aim is to explain the network position of firms, we have measured a number of independent variables that account for firm-specific characteristics. The most important one is the absorptive capacity of the firm. Following Giuliani and Bell (2005), we expect that the absorptive capacity of a firm positively affects its network connectivity. With absorptive capacity, we mean the knowledge base of a firm that is required to absorb and exploit external knowledge (Cohen and Levinthal, 1990). As Giuliani and Bell (2005), we measured several variables and employed a Principal Component Analysis to construct a single component for a firm's absorptive capacity. The following five variables were used to construct the final indicator (in brackets their weights in the component): (1) the level of technical education of the technical personnel (.924); (2) the number of technicians engaged in product and process adaptation and innovation (.776); (3) the number of years of experience in the sector of the technical personnel (.736); (4) the number of former employers in the sector of the technical personnel (.702); and (5) the type and intensity of R&D undertaken by the firm (.592). The component explains 56.8% of the original variance of the five variables.

Table 2. Mean, standard deviation, minimum and maximum value of each variable

	Mean	Standard deviation	Minimum	Maximum	N
Network position					
Betweenness centrality market network	5.66	11.48	.00	51.29	33
Betweenness centrality technical network	1.33	3.84	.00	14.50	33
Valued degree of local relationships (market)	1.24	1.23	.00	4.00	33
Valued degree of local relationships (technical)	.80	1.18	.00	5.00	33
Valued degree of non-local relationships (market)	.68	.86	.00	4.00	32
Valued degree of non-local relationships (technical)	1.23	1.41	.00	4.20	31
Valued degree of market relations (local + non-local)	1.91	1.63	.00	6.00	32
Valued degree of technical relations (local + non-local)	2.03	2.13	.00	9.00	31
Firm characteristics					
Absorptive capacity	.00	1.00	-1.34	2.05	25
Firm size (volume of production 2004 in 100.000 pairs)	5.14	6.55	.10	35.00	31
Firm age (years)	18.85	14.37	.50	59.00	33
Entrepreneur experience (index)	.90	.62	.00	2.00	33
Innovative performance					
Number of product innovations (corrected for firm size)	2.27	1.84	.00	8.38	28
Number of process innovations (corrected for firm size)	.60	.61	.00	2.10	28
Share of innovative sales in last year's turnover	.62	.31	.00	1.00	30

Besides absorptive capacity, the analysis includes other firm-specific features that might affect the network positions of firms. The size of firms has been measured in terms of volume of production (number of pair shoes produced in 2004). The age of the firm has been determined by the number of years since the establishment of the firm, while the experience of the entrepreneur has been gauged by the number of years the entrepreneur has experience as an entrepreneur or employee in footwear or related sectors. Table 2 presents the descriptive statistics of the variables.

Table 3 shows the outcomes of the non-parametric analyses. Firstly, we categorised the independent variables and tested with a Kruskal-Wallis test whether the averages of the centrality measures differed significantly over the different categories of firms. In Table 3, we have specified the means of each of the three categories for the variable absorptive capacity. For the remaining independent variables, we only mentioned the number of categories for each variable, as given by df+1 in Table 3. Secondly, we calculated the Kendall tau-b non-parametric correlation coefficient in order to show the direction of the relation between the independent and dependent variables. If both methods show significant results, one can conclude a significant relationship exists.

Table 3: The relationship between firm characteristics and their network position, measured as betweenness centrality and valued degree

N = 25 – 33		df	Betweenness centrality	Betweenness centrality	Valued degree of local	Valued degree of local	Valued degree of non-	Valued degree of non-	Valued degree of	Valued degree of
			market network	technical network	market relationships	technical relationships	local market relationships	local technical relationships	market relationships (local + non-local)	technical relationships (local + non-local)
Absorptive capacity	Kruskal-W χ^2	2	4.638 *	.973	1.442	1.370	4.448	11.61 ***	3.381	9.041 **
	Kendall tau-b		.167	-.050	.156	.106	.298**	.465 ***	.240	.433 ***
- low	Mean	N = 8	4.67	1.94	0.95	0.40	0.45	0.33	1.40	0.73
- medium	Mean	N = 11	1.55	0.09	1.31	0.95	0.59	0.82	1.90	1.76
- high	Mean	N = 6	4.94	2.08	1.60	0.57	1.58	2.97	3.18	3.53
Firm size	Kruskal-W χ^2	4	8.822 *	4.082	4.539	6.411	3.534	15.56 ***	6.169	13.79 ***
	Kendall tau-b		.394 ***	.279*	.331 **	.305 **	.230 *	.520 ***	.378***	.499 ***
Firm age	Kruskal-W χ^2	3	3.419	2.061	.007	1.976	.907	.822	.144	.501
	Kendall tau-b		.229 *	.191	.018	.072	.071	.031	.036	.021
Experience entrepreneur	Kruskal-W χ^2	2	1.063	1.069	1.605	.359	6.088 **	1.917	3.343	1.544
	Kendall tau-b		.060	.044	.002	.043	.183	.185	.085	.171

* significant at the .10 level

** significant at the .05 level

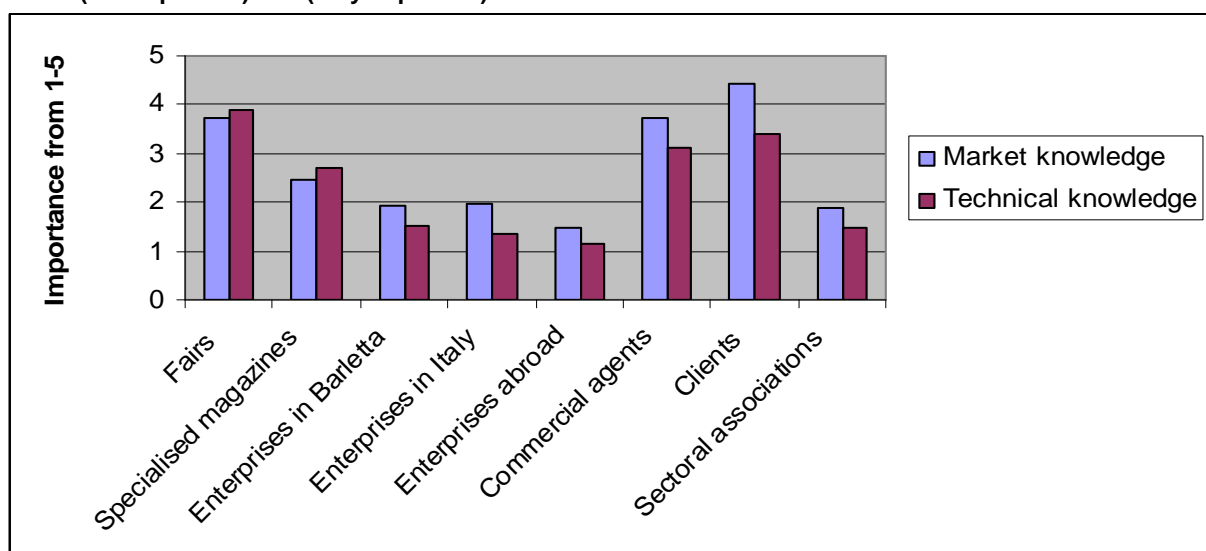
*** significant at the .01 level

Following Giuliani and Bell (2005), we expect that firms with higher absorptive capacities are more central in the local network, and have a wider array of local and non-local network relations. Table 3 shows a significant relationship between absorptive capacity and network position in a number of cases. Firms with high absorptive capacities have significantly more (or more important) non-local relationships, especially concerning technical knowledge. This is as expected, because having a high

absorptive capacity means the firm is well equipped to identify and process external knowledge from non-local sources (see e.g. Drejer and Vinding, 2005). Also the valued degree of both local and non-local technical relationships together is positively and significantly related with absorptive capacity. There exists no significant relationship between absorptive capacity and network positions of firms as far as market knowledge is concerned, although the data in Table 3 suggest a positive (but not significant) relationship. One possible reason is that our indicator of absorptive capacity (e.g. measured as technical personnel and education) is more biased towards technical knowledge.

Contrary to the study of Giuliani and Bell (2005), we found no relationship between absorptive capacity of firms and their position in the local knowledge network. So, despite geographical and cognitive proximity, no important local knowledge relationships have been established. A plausible reason is that social and institutional proximity was lacking in the Barletta district (Boschma, 2005a). This is not uncommon for a region situated in the South of Italy where social capital, being a potential bridging mechanism for local agents to overcome uncertainty, is often found missing (Putnam et al., 1993; Boschma, 2005b). Another possible explanation for why there is no significant relationship between absorptive capacity and local network position of firms is that inter-firm relationships are considered less important than other sources of knowledge. This is confirmed by our data. Firstly, the footwear firms in the Barletta district indicated themselves that both local and non-local inter-firm linkages represent only minor external sources of knowledge. Instead, as Table 4 shows, fairs, commercial agents and clients were considered more important in this respect. Secondly, the firms also acknowledged that they depended significantly more on internal knowledge creation for undertaking innovative activities, instead of relying on external sources of knowledge (among which inter-firm ties).

Table 4: Average importance of knowledge sources as indicated by the Barletta footwear firms on a scale from 0 (not important) to 5 (very important)



With respect to the other firm specific characteristics in Table 3, only firm size significantly affects the network position of firms in a number of cases. Especially the non-parametric correlation coefficients show that larger firms have significantly more or higher valued network relationships. The significant

relationship between absorptive capacity and network position may be due to the fact that larger firms have higher absorptive capacities. This is confirmed by the statistical significance of the non-parametric correlation coefficient Kendall tau-b between the two variables (0.506) at the 0.01 level. In contrast, a firm's age or the experience of the entrepreneur (as a spin-off or a re-starter) has no effect on the current network position of the Barletta footwear firms.

4.2 Innovative performance

We finally examined the extent to which the network position of footwear firms (in terms of intensity and geographical range) has contributed to learning and innovation.

The innovative performance of the footwear firms has been measured by three indicators. The first indicator measures product innovation. As mentioned frequently by the respondents, in a mature industry as the footwear sector, the use of new fashionable materials is a major source of product innovation. It has been measured by the number of new materials adopted for footwear production in the last three years by the firm, divided by the log of the number of employees. This latter correction accounts for the fact that this measure tends to underestimate the performance of small firms. This is confirmed by our data: firm size was indeed positively correlated with this indicator, but the correlation disappeared after correction. The second measure accounts for process innovation, using the number of new, technically more advanced machines the firm adopted in the last three years. As the first indicator, this variable has been transformed by dividing it by log size. The third indicator measures innovative performance by the share of new products developed in the last three years in the total sales of the firm in 2004. This indicator is widely used in innovation studies because it takes into account the success of a product innovation for the firm concerned.

We expect that a firm's network position positively affects its innovative performance. The network position of firms has been categorised in three different ways, depending on the geographical range of their knowledge relationships. In doing so, we can test the impact of location. To be more precise, it enables us to assess whether membership of a local knowledge network enhances the performance of firms, and whether non-local relationships contribute to learning and innovation.

The first categorisation covers the local dimension of networks. We distinguish between firms that belong to the network component centred on the district's leading firm (strongly locally connected), firms that have other (horizontal or vertical) local knowledge relationships (weakly locally connected), and firms that have no (horizontal and vertical) local knowledge relationships (locally disconnected). Table 5 shows the outcomes of the Kruskal-Wallis test: firms being member of the leading firm's network perform best in terms of innovation, followed by firms having other local relationships and locally disconnected firms. With respect to the local network of technical knowledge, this is true for two of the three dependent variables. For the network on market knowledge, this pattern is, however, only significant for process innovation. Over the whole, one could say that having local knowledge ties in general, and being connected to a network with larger, technically more advanced firms in particular, raises the innovative level of the footwear firms in the Barletta district.

Table 5: the relationship between local network position and innovative performance: Kruskal-Wallis non-parametric test

			Product innovations (corrected for firm size)	Process innovations (corrected for firm size)	year's turnover sales in last innovative	Share of innovative sales in last year's turnover
local network (market knowledge)	df = 2	$\chi^2 =$	1.561	6.805 **		1.301
- member of leading firm centred network	N = 11	Mean	2.69	0.93		0.71
- other firms having local relationships	N = 9	Mean	2.41	0.55		0.63
- locally disconnected firms	N = 8	Mean	1.54	0.22		0.48
local network (technical knowledge)	df = 2	$\chi^2 =$	3.424	4.912 *		5.216 *
- member of leading firm centred network	N = 6	Mean	3.12	1.13		0.78
- other firms having local relationships	N = 11	Mean	2.65	0.59		0.71
- locally disconnected firms	N = 11	Mean	1.44	0.33		0.45

* significant at the .10 level

** significant at the .05 level

*** significant at the .01 level

The second categorisation concerns the non-local knowledge linkages. As shown in Table 6, it consists of firms having non-local knowledge relationships, and firms lacking them. By and large, footwear firms having knowledge relationships with firms beyond the district's boundaries perform better than firms lacking district-external knowledge linkages. The differences are significant in three of the six cases identified. The outcomes till so far tend to suggest that it is important for innovative performance not only to be connected to neighbouring firms in the cluster, but also to have non-local knowledge relationships that can bring in new relevant external knowledge.

Table 6: the relationship between geographical openness and innovative performance: Kruskal-Wallis non-parametric test

			Product innovations (corrected for firm size)	Process innovations (corrected for firm size)	year's turnover sales in last innovative	Share of innovative sales in last year's turnover
non-local networks (market knowledge)	df = 1	$\chi^2 =$	1.805	.296		4.814 **
- geographically open firms	N = 18	Mean	2.61	0.55		0.72
- geographically closed firms	N = 10	Mean	1.66	0.70		0.45
non-local networks (technical knowledge)	df = 1	$\chi^2 =$	4.721 **	1.263		3.117 *
- geographically open firms	N = 16	Mean	2.91	0.75		0.72
- geographically closed firms	N = 11	Mean	1.33	0.40		0.49

* significant at the .10 level

** significant at the .05 level

*** significant at the .01 level

The third categorisation combines the local dimension of the first categorisation and the non-local dimension of the second. Hence, firms that are strongly connected to the local knowledge network

(being member of the leading firm's centred network) are divided between those that have non-local knowledge relationships and those that have not. The same procedure is applied to weakly connected and disconnected firms to the local knowledge network. The logic behind the sequence of the categories depicted in Table 7 is as follows: the more firms are connected, the higher they are ranked. For instance, the most connected firms (with the highest rank) are those that are strongly locally connected and have non-local relationships as well. The data on the technical knowledge should be interpreted with caution, since the distribution over the categories is highly skewed.

Table 7: the relationship between position in local and non-local networks and innovative performance: Kruskal-Wallis non-parametric test

			firm size) (corrected for innovations Product firm size)	firm size) (corrected for innovations Process innovations year's turnover sales in last innovative Share of
Local and non-local networks (market)	df = 5	$\chi^2 =$	5.524	9.343 *
- strongly locally connected + geogr. open	N = 8	Mean	2.64	0.74
- strongly locally connected + geogr. closed	N = 3	Mean	2.81	0.63
- weakly locally connected + geogr. open	N = 6	Mean	2.83	0.74
- weakly locally connected + geogr. closed	N = 3	Mean	1.57	0.43
- locally disconnected + geogr. open	N = 4	Mean	2.23	0.64
- locally disconnected + geogr. closed	N = 4	Mean	0.86	0.33
Local and non-local networks (technical)	df = 5	$\chi^2 =$	7.041	10.497 *
- strongly locally connected + geogr. open	N = 4	Mean	3.34	0.93
- strongly locally connected + geogr. closed	N = 1	Mean	2.98	0.50
- weakly locally connected + geogr. open	N = 9	Mean	3.05	0.73
- weakly locally connected + geogr. closed	N = 2	Mean	0.83	0.60
- locally disconnected + geogr. open	N = 3	Mean	1.95	0.39
- locally disconnected + geogr. closed	N = 8	Mean	1.25	0.47

* significant at the .10 level
 ** significant at the .05 level
 *** significant at the .01 level

The resulting pattern derived from this classification is presented in Table 7. The non-parametric results are significant in three of the six cases. Broadly speaking, one could say that the more a firm is connected, the better its innovative performance. For instance, members of the core local network with access to the outside excel in innovation almost without exception, as opposed to isolated firms (both locally and non-locally). In addition, regarding technical knowledge, it holds for almost every category that geographically open firms perform better than geographically closed firms. This may be explained by the low density of the local technical network, which makes firms to rely more on non-local relationships. Local firms who do so, perform considerably better than those who don't. An exception is the category of locally disconnected firms that do not perform better when connected with the outside world. With respect to market knowledge, an almost similar conclusion applies. For most of the categories concerning market knowledge – especially the firms that are weakly locally connected or

even locally disconnected – it holds that geographical openness enhances their innovative performance considerably. This seems, however, not true for firms with strong local connections: non-local ties do not seem to improve further their high innovative performance.

To end with, we tested the impact of a series of firm-specific characteristics on innovative performance. We used the non-parametric correlation coefficient Kendall tau-b to examine whether firm characteristics are directly related to innovative performance. Table 8 shows the results. Neither the age of the firm, nor the experience of the entrepreneur, nor the absorptive capacity of the firm has a direct impact on the innovative performance of the Barletta footwear firms. Given the latter result, our analyses seem to suggest that absorptive capacity has only an indirect influence on innovation. Since firms with high absorptive capacity have significantly more (or more important) non-local relationships, and firms with non-local relationships tend to perform better, it seems that absorptive capacity impacts indirectly on innovative performance through non-local (but no local) relationships.

Table 8: The relation between firm characteristics and innovative performance: Kendall tau-b correlation coefficient

22 ≤ N ≤ 33		New materials adopted	New machineries adopted	Share of innovative sales in last year's sales
Firm age	Kendall tau-b	.182	-.009	-.064
Entrepreneur's experience	Kendall tau-b	-.024	.178	.550
Absorptive capacity	Kendall tau-b	-.107	-.171	.035

* significant at the .10 level
 ** significant at the .05 level
 *** significant at the .01 level

5. Conclusions

The results of the Barletta case study have some interesting research implications. First of all, the study shows that cluster analysis should take seriously the firm level, instead of treating the firm as a black box (Maskell, 2001). The data showed there exists a large variety of firms in a cluster as far as their absorptive capacity and network connectivity is concerned, and this strongly affects their economic performance. Economies are featured by a variety of firms, some of them successful, others having a hard time to survive, and clusters are no exception to that rule. It implies that one should be careful in saying that knowledge externalities in districts are in the 'air', because knowledge tends to accumulate and remain inside the boundaries of firms and networks.

Another striking result was that only a limited number of local actors were part of the local knowledge network in the Barletta footwear cluster. Many local firms were not engaged in local networking activities at all, despite geographical proximity. Our study showed this had serious implications for their performance: a strong local network position of firms impacted positively on their innovative performance. So, it mattered being locally connected: being co-located was just not

enough. What also mattered was being connected to non-local actors: firms having non-local knowledge relationships were more innovative than firms lacking such a window on the outside world. There was only poor evidence of leading firms acting as gatekeepers for the local firms: the core local network centred on the leading firm was selective, not pervasive, to paraphrase Giuliani (2005), and the leading firm of the district was even disconnected to the technical knowledge network.

Another key outcome was that the absorptive capacity of firms did not influence their position in the local knowledge network, which is contrary to findings of Giuliani and Bell (2005). This seems to suggest that a combination of geographical and cognitive proximity between firms does not automatically result in important local knowledge relationships. Nor could we observe a direct impact of absorptive capacity on innovation. However, our study showed that firms with high absorptive capacity were more connected non-locally, which is in line with our expectations. As firms with non-local knowledge relationships also tended to perform better, it might suggest that absorptive capacity impacts only indirectly, through non-local relationships, on the innovative performance of firms.

This study has taught us that we should be cautious not to take the impact of the place for granted, even in the case of a cluster. Our study provided strong evidence that it is essential to disentangle analytically the impacts of the firm, the network and the place on the performance of firms in a cluster. Only then can we determine whether geographical proximity matters or not (Boschma, 2005a). This would mean that other issues not addressed in this paper should be accounted for before we can draw a complete picture. First of all, a remarkable outcome was that cognitive proximity (or absorptive capacity) did not favour local networking activities between firms. It might be that a lack of social capital or trust formed a major obstacle, but we did not examine this issue explicitly in our case study. Furthermore, it has been left unexplained why clustering of footwear production occurred in the Barletta region. It might have something to do with other mechanisms as potential sources of local knowledge spillovers, such as spin-off dynamics and labour market mobility. It may even be so that the reasons for clustering in such mature districts have disappeared over time (Brenner, 2004). To find out, an in-depth historical analysis of the evolution of the cluster might be useful. Taking such an evolutionary perspective would really increase our understanding of whether geographical proximity matters or not in innovation processes.

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