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Social capital and proximity in regional network dynamics: A mixed-method approach

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Abstract

This paper aims to understand the effect of proximity (i.e. geographical, cognitive and organizational) on the evolution of social ties that shape a geographically bounded network. We collected data over a six-year period on an emerging collaborative network among hospital organizations within an Italian region, and we employed a mixed method approach consisting of longitudinal models for network analysis and a multiple case study. The results indicate that the identified forms of proximity affect the evolution of social ties, but in a different manner. Geographical proximity is positively related to the organizations? propensity to collaborate over time. Organizational proximity, measured in terms of same organizational arrangement, has a positive effect, while organizational proximity, measured in terms of similar size, has a negative effect. Cognitive proximity has a negative effect. Theoretical and managerial implications that can be drawn from our findings, as well as limitations of our study and directions for future research are discussed.

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Keywords: Social Capital; Proximity; Networks dynamics; Mixed-method approach

1. Introduction

Previous research has illustrated how regional social capital influences various economic and organizational outcomes (Beugelsdijk & Schaik, 2005; Coleman, 1990; Guiso, Sapienza, & Zingales, 2004; Kawachi I., Kennedy B.P., & R.. 1999; Knack & Keefer, 1997; Laursen, Masciarelli, & Prencipe, 2012a; Mellor & Milyo, 2005; Putnam, Leonardi, & Nanetti, 1993; Zak & Knack, 2001). Notwithstanding the widespread consensus on the importance of social capital in the modern economy, within this well-established and large literature there is a lack of studies that have analyzed its dynamics. Interest in understanding how and why regional networks change overtime is a relatively recent issue and is in line with a new strand of research that investigates such phenomena borrowing concepts and methods from organizational sociologist and network theory (Borgatti & Foster, 2003; Lee et al., 2011).

In this study we look at the evolution of social ties in a geographically bounded emerging network using a social capital perspective. We understand social capital as the localized norms and networks that enable organizations to act collectively within a region (Laursen et al., 2012a; Masciarelli, 2011; Woolcock & Narayan, 2000). More specifically, we focus on the structural dimension of social capital, which refers to the overall pattern of connections between organizations (Nahapiet & Ghoshal, 1998). A central tenet of contemporary studies on social capital is that all forms of economic interactions are centered on social relationships, and that this "embeddedness" produces effects that economic models cannot predict (Ebers & Grandori, 1997; White, 2002). Consequently, a wide range of organizational behaviors and outcomes can be understood by analyzing inter-organizational relationships.

Research has tried to explain the formation of inter-organizational networks focusing on different level of analysis (Ebers & Grandori, 1997). At the actor level, it has mainly concentrated on discerning the motivation of actors for forging networking relationships. For example, through cooperation organizations may attempt to increase their revenue, to mitigate competition, to have a cost-efficient access to crucial know-how, skills, complementary resources and capabilities or to closely coordinate their use of existing resources (Gulati & Gargiulo, 1999; Ingram & Yue, 2008; Kilduff, Tsai, & Hanke, 2006; Powell, Koput, & Smith-Doerr, 1996). At the relational level, research has tried to explain how pre-existing and past relations among actors may endogenously induce networking (Gulati & Gargiulo, 1999; Soda, Usai, & Zaheer, 2004) and how different positions a firm occupy within the web of relationships in the industry affect the formation of networking relationships (Burt, 1992; Gulati, 1995). At the institutional levels, scholars have sought to identify cultural, industry, and regional environment conditions that facilitate and constrain the engaging in inter-organizational relationships. Literature on economic geography, industrial

districts or spatial regional clustering of specialized resources and know-how are well known examples (Becattini, 1991; Giuliani, 2013).

Despite this large and heterogeneous literature, knowledge about the dynamic process of creating, maintaining, or growing linkages within a network is still just emerging and there is need for more research (Ahuja, Soda, & Zaheer, 2012; Lee, 2009). In particular, as claimed by Kilduff et al. (2006), social capital research programs should be reconsidered integrating quantitative and qualitative analysis and focusing on highly differentiated contexts and consequences of different type of assumption, social structure and forms of talk. Measures of structural or relational social capital are often studied in isolation and aggregated up to the patterns of a large sample or path-dependent algorithms of network action, while entirely qualitative studies of social capital often attempt to relate a myriad concept and suffer an ambiguous and often over descriptive analysis (Lounsbury & Ventresca, 2003). Mixed data sources and methods can provide a more comprehensive understanding of why the underlying links or generative mechanisms between network structural forms and human agents acting out relational and cognitive actions occur in a particular way (Kilduff & Tsai, 2003; Lee, 2009).

In this paper we use the construct of proximity, in its three different dimensions (geographical, cognitive, organizational), in order to understand the evolution of social capital over time. According to Boschma (2005), we defined geographical proximity as the spatial distance between each pairs of actors, organizational proximity as the extent to which social ties are embedded in an inter-organizational arrangement, and cognitive proximity as the extend to which actors share common knowledge, capacities and expertise. Despite proximity has been identified a key issue in the formation of social ties, there are few empirically evidences on its role in defining and shaping the evolution of social capital within a geographical region. In line with previous studies (Knoben & Oerlemans, 2006), we assume that the different dimensions of proximity represent important determinants of inter-organizational relations. In addition, we employ a mixed method approach consisting of stochastic actor-based model for network dynamics (Snijders, Steglich, & van de Bunt, 2010) and multiple case study analysis (Creswell, 2003). The aim of choosing this model of analysis is to put simultaneously attention to the inter-subjective systems of meanings and localized network structural mechanisms that play an important role in the development of social capital (Kilduff & Tsai, 2003; Kilduff et al., 2006).

To address these issues empirically we rely on original fieldwork and data that we collected on patient transfer relations within a regional community of hospital organizations in Italy. Patient transfer flows reflect collaboration and the existence of underlying relationship between the hospitals involved (Iwashyna, Christie, Moody, Kahn, & Asch, 2009b; Lee et al., 2011; Lee, 2009;

Lomi & Pallotti, 2012; Mascia, Di Vincenzo, & Cicchetti, 2012; Pallotti & Lomi, 2011). Patient transfers between hospitals are directly observable and are not possible without high levels of coordination and communication. The transfer of a patient requires the exchange of detailed clinical information, by definition complex due to the growth and specialization of clinical knowledge and due to the multitude of conditions patient may suffer in combination, and it involves the co-construction of an understanding of the patient that must also consider the cognitive aspects of the actor involves in the exchange (Cohen, et al., 2012). To our knowledge, no studies in the literature have yet examined longitudinally patient transfer determinants and the many dimensions that could affect social capital evolution in this empirical context.

We begin the study with the development of several hypotheses that explain the effect of geographical, organizational and cognitive proximity on the evolution of social ties that shape a geographically bounded network. We then present our research setting and our mixed methodology of investigation. We end by reflecting on the implications of the work for existing research and practitioners.

2. Theory and hypotheses

The impact of social capital on economic activities is of long-standing theoretical interest. The attention of scholars on this topic was due to the works of Coleman (1990) and Putnam et al. (1993), who can be considered the pioneers on the research on social capital. They recognized social capital as an attribute of a social community, suggesting that social capital "*... is not a single entity, but a variety of different entities, with two elements in common: they all consist in some aspect of social structures, and they facilitate certain actions of actors within the structure*" (Coleman, 1990: 302).

These studies have encouraged an extensive body of research that has investigated the impact of various aspects of social capital on economic and organizational outcomes. Previous research, for example, has illustrated how social capital influences public health (Kawachi I. et al., 1999; Mellor & Milyo, 2005), economic growth (Beugelsdijk & Schaik, 2005; Zak & Knack, 2001) financial performances (Guiso et al., 2004), innovation and external knowledge acquisition (Hauser, Tappenier, & Walde, 2007; Laursen et al., 2012a), collective learning and knowledge spillovers (Capello & Faggian, 2005), and the propensity of organizations to the internationalize their business (Laursen, Masciarelli, & Prencipe, 2012b).

Although prior research has greatly advanced our understanding of the effects of social capital on various outcomes, we know preciously little on how social capital evolves over time. In order to test the impact of the geographical, organizational and cognitive dimension of proximity introduced by

Boschma (2005) on the formation of inter-organizational relations over time, we have developed specific research hypotheses reported below.

2.1. The geographical dimension of proximity

Scholars have recognized the importance of the geographical dimension of proximity in explaining several phenomena, such as innovation processes (Breschi & Lissoni, 2001) and knowledge spillovers (Laursen, Reichstein, & Salter, 2011; Torre, 2008). Extant literature emphasizes that knowledge tends to spillover through imitation and active knowledge sharing in the same geographical context (Rosenthal & Strange, 2003). Geographical distance seems to play a significant role especially in knowledge intensive industrial sectors (Powell, White, Koput, & Owen-Smith, 2005).

The main reasoning behind these effects is that short geographical distances bring organizations together, favor interaction with a high level of information richness and facilitate the exchange of, especially tacit, knowledge between actors (Torre & Gilly, 2000). The larger the distance between actors, the more difficult it is to transfer these tacit forms of knowledge. This is also true for the exchange and use of codified knowledge, because its interpretation still requires tacit knowledge and thus spatial proximity (Howells 2002). Geographical proximity is especially important for these industries where knowledge is "person-embodied, concept-dependent, spatially sticky and socially accessible only through direct physical interaction" (Morgan, 2004:12).

In the healthcare industry, knowledge has these key characteristics and therefore the geographical dimension of proximity may strongly facilitate the hospitals' decision to collaborate and to develop a localized network of hospitals for patient referrals. Much of the knowledge held by hospitals is "sticky" and its transfer may also involve personal contact (Patel & Pavitt, 1991). Patient transfer is typically not considered by hospitals only as a solution to contingent one-off problems, but rather it happens in a highly structured and localized social context that facilitates and actively promotes interpersonal contact between doctors working in different hospitals (Cohen, Hilligoss, & Kajdacsy-Balla Amaral, 2012; Lomi & Pallotti, 2012). These arguments lead us to assume that geographical proximity has a positive effect on the choice of individual organizational partner selection. More formally:

Hypothesis 1: *Geographical proximity is likely to have a positive impact on the evolution of structural social capital, i.e. the propensity of hospitals to collaborate*.

2.2. The organizational dimension of proximity

As Boschma (2005) suggests, the geographical dimension of proximity alone may not be enough to

explain how the collaboration among organizations evolve over time. The organizational dimension of proximity considers the similarity in organizational context and in organizational dimension. Belonging to the same Local Health Authority (i.e. organizational context) leads hospitals to share a common understanding of the working practices: the presence of similar routines makes actors understand what activities they have to accomplish (Feldman, 2000) and how these activities must be sequenced (Filippi & Torre, 2003; Nelson & Winter, 1982). Furthermore as organizations interact in a same organizational context they tend to become more similar in their structure, behavioral focus, and strategic posture and therefore they may find it easier to coordinate their activities (Powell et al., 2005).

Differently, organizational proximity in terms of organizational dimension similarity seems to affect negatively their propensity to collaborate (Iwashyna, Christie, Kahn, & Asch, 2009a; Iwashyna et al., 2009b; Lee et al., 2011). Hospitals adopted heterogeneous collaborative patterns (i.e. patient sharing) on the strength of their dimension: Iwashyna et al. (2009a: 831) stated that patient is 'systematically transferred to more capable hospitals' possess advanced specialties meanwhile hospitals that only send patients are smaller (Iwashyna et al. 2009b). We therefore assume two different hypotheses on the impact of organizational proximity on the hospitals' propensity to collaborate.

Hypothesis 2a: *Organizational proximity in terms of organizational context similarity is likely to have a positive impact on the evolution of structural social capital, i.e. the propensity of hospitals to collaborate).*

Hypothesis 2b: *Organizational proximity in terms of organizational dimension similarity is likely to have a negative impact on the evolution of structural social capital, i.e. the propensity of hospitals to collaborate.*

2.3. The cognitive dimension of proximity

According to Wuyts et al. (2005), we consider the cognitive proximity as the extent to which actors similarly perceive, interpret, understand, and evaluate the world. Cognitive proximity represents therefore a measure of cultural homogeneity (Molina-Morales, Garcia-Villaverde, & Parra-Requena, 2011). Extant literature has underlined the positive effects of cognitive proximity: it favors knowledge exchange between organizations (Knoben & Oerlemans, 2006), enhances innovation (Dakhli & De Clerq, 2004), organizational performance (Krause, Handfield, & Tyler, 2007) and diminishes conflicts and misunderstandings in communication (Inkpen & Tsang, 2005). This similarity increases the likelihood to form inter-organizational collaboration because it reduces

the "cognitive distance" between partnering organizations in search of mutual benefits (Wuyts et al., 2005) and provides identity for organizations in search of exchange partners (Lazega, 2009).
However, we posit that in the healthcare sector the cognitive dimension of proximity affects how hospitals choose the partners with whom to exchange patients in a different manner compared to other sectors. Specifically, Cohen et al. (2012:3) indicate that some cognitive distance could enhance handoff safety and efficiency: "it can be seen that different mental models are not necessarily good or bad but that the way they are handled during a handoff is what actually matters. […] Especially when a diagnosis is unclear, a discussion between two participants with similar mental models may be less safe, as both may be agreeing on an incorrect diagnosis".
In this perspective, sharing knowledge bases, common language and communication protocols might lead hospitals belonging to the same network to choice partners in patient sharing but could be unsafely with out an "optimal cognitive distance" (Wuyts et al., 2005). As claimed by Cohen et (2012:4) "handoff is not a telegram but a co-construction of understanding by parties". In this perspective, the cognitive proximity and its opposite determine individual organizational behavior and, consequently, the evolution of the whole network (Inkpen & Tsang, 2005). Accordingly, we assume that cognitive proximity has a negative effect on the choice of individual organizational partner selection. More formally:

Hypothesis 3. *Cognitive proximity is likely to have a negative impact on the evolution of structural social capital, i.e. the propensity of hospitals to collaborate*.

3. Method

3.1. Empirical context

Our sample includes the entire network of 35 hospitals providing services to the patients of Abruzzo, a region in central Italy with a population of approximately 1,300,000 residents. The Abruzzo health system is part of the I-NHS, a publicly funded health system that provides universal coverage through a single payer.
The I-NHS allocates resources to 20 Italian regions, which are responsible for providing community health care services to their target populations. At the central level, the government bears the responsibility for defining the core benefit packages and ensuring that basic coverage is provided to the entire population, whereas responsibility for the organization and delivery of health services is almost totally devolved to the regions. Regional governments, responsible for delivering health care services to their resident populations, have wide-scale autonomy in strategic planning, allocating

financial resources, and organizing services at a regional level.

The Abruzzo regional health system is entrusted to six Local Health Authorities (LHAs), and 35 hospital organizations (22 public and 13 private) provide healthcare. Of the 22 public hospitals, two are teaching hospitals. Public hospitals provide highly specialized hospital care and are characterized by technical, economic, and financial autonomy. Teaching hospitals are hospitals linked to universities and provide education, research, and tertiary care. Private hospitals are partially financed by the regional healthcare service and are investor-owned organizations that provide ambulatory assistance, hospital care, and diagnostic services.

3.2. Why this case

Within this framework, our study setting seems to be particularly appropriate for the purpose of this research. The first reason is that earlier research on this setting (Mascia & Di Vincenzo, 2011; Mascia et al., 2012) and our on-field analysis showed the presence of local networks of collaboration among hospitals, which mainly occurs by patient sharing between hospitals. Patient sharing occurs when one hospital directly transfers one or more elective patients to another hospital in the same calendar day. For example, hospitals that only provide basic services may send patients with more complicated clinical problems to another provider offering comprehensive specialty care. Patient sharing may alternatively be driven by "asymmetries" in regional providers' clinical resources or competences: e.g., hospitals may transfer patients to other local providers if they lack necessary medical equipment (e.g., intensive care unit beds), expertise (e.g., staffing), or supplies. These informal networks become established and may have important implications on organizational performance (Lee et al., 2011; Mascia & Di Vincenzo, 2011; Pallotti & Lomi, 2011).

The second reason is that given the great strategic and organizational autonomy of the empirical setting at the hand, there are no significant external factors that may influence the networking process for which we need to control. In the period considered in this study there has been no policy interventions aimed at altering the institutional framework, the number of providers as well as the structure of the local inter-organizational network.

The third reason for choosing this health care system is that the network of hospitals consists of a heterogeneous mix of public, private and teaching hospitals with different organizational features and performances. In addition, despite the high degree of autonomy, Abruzzo's health care system suffers of a lack of systemic planning and strategy coordination among hospitals (Lo Scalzo et al., 2009). Unlike some other regions that have fostered inter-hospital collaboration through well-defined and formal collaboration mechanisms (e.g., "hub & spoke" models or clinical pathways for patient referrals), coordination in Abruzzo mainly emerges through patient-sharing between

providers (Mascia et al., 2012).

The fourth and final reason why this is an ideal case to study network dynamics is that especially in regions where systemic planning and organizing of health provision is lacking collaborative initiatives among hospitals arise and evolve endogenously (Lo Scalzo et al., 2009). These emergent "self-organizing" properties of inter-hospital networks may produce outcomes and behaviors that can be investigated very well employing longitudinal models for social network analysis (Snijders et al., 2010).

3.3. Data collection and variables description

The analysis draws on a range of rich data sets. Data about patterns of collaborative interdependencies covering the period 01/01/2003 – 31/12/2008 among all hospitals within the region were provided by the hospital information system database managed by the Abruzzo Region. Data on hospital activities, as well as information about demographics and performances, were provided by the Abruzzo Health Agency archives and yearly reports. These data sets are collected regularly and archived digitally by the Region for its administrative purpose and by the Health Agency for its operational and reporting activities. Archival sources are generally more precise and detailed than surveys and has allowed us to collect complete information about the network of hospitals: no data were missing.

We integrated these official data sets and reports with qualitative data obtained through a structured questionnaire. Between May and August 2012 we have personally contacted the medical directors of hospitals operating in the region, and 30 agreed to be interviewed (the response rate is equal to 86%). We entirely transcribed the conversation to retain all details. The interviews allowed us to collect more soft, personal and intangible aspects of collaborative patterns such as the cognitive and organizational dimensions of proximity.

Since we are interested in understanding structural social capital evolution over time, our dependent variable is Inter-hospital collaboration. It was measured by considering the transfers of patients, which is one of the main ways through which hospitals coordinate their activities across boundaries (Iwashyna et al., 2009b; Lee et al., 2011; Lomi & Pallotti, 2012; Mascia et al., 2012). On-field interviews with managers and medical directors of the hospital in the empirical setting supported that patient flows represents a proper proxy for the measurement of inter-hospital collaboration network in the regional health system. Using available data on patient sharing between regional hospitals we build a "35 x 35" matrix. In each row and column of the matrix, we reported the different hospitals that sent or admitted, respectively, at least one patient in the evaluated year. Because changes in collaborative relationships may vary depending on the dichotomization

parameter, we conducted separated analyses to assess whether our hypotheses change in the present of different criteria (i.e. "greater-than" mean value, "greater-than" zero). The results we obtained were qualitative similar. Six different matrices were made for each year from 2003 to 2008.

To measure proximity, several different measures were used as independent variables. According to Laursen et al. (2011), we measured geographical proximity in terms of geographical distance between each pair of hospitals, measured in kilometers. Organizational proximity was measured in terms of staffed beds similarity, which indicates the propensity to collaborate with hospitals with similar number of available beds, and in terms of Local Health Authority (LHA) membership similarity, which represents the propensity to collaborate with hospitals of the same local administrative unit. In line with previous literature (Mascia et al., 2012; Pallotti & Lomi, 2011), we consider those two variables as good proxies of organizational proximity in the health care sector. In order to measure the cognitive dimension of proximity we used the case mix similarity and the number of common specialties, which indicate the similarity in clinical records complexity and the similarity in medical specialties respectively.

In line with previous studies employing stochastic actor-based models (Giuliani, 2013; Valente, Fujimoto, Palmer, & Tanjasiri, 2010), in the estimation we controlled for some endogenous effects such as outdegree, transitive mediated triplets, three cycles, balance, indegree-popularity and out-degree–activity (details are shown in Table 1).

Insert Table 1 about here

We also controlled for organizational-level variables that might influence the formation of new ties, such as productivity (performance), measured as the total number of admissions, adjusted for case mix, divided by total number of staffed beds (Mascia & Di Vincenzo, 2011) and percentage of emergency admissions (Iwashyna et al., 2009b; Lomi & Pallotti, 2012). Each variable was computed yearly for the period 2003-2008. Table 2 shows the descriptive statistics of the variables used in this research.

Insert Table 2 about here

3.4. Analysis

The analysis proceeded in three steps. First, we performed a static comparative analysis of network structure in the period considered, based on the set of network structure indicators presented in Tables 3 and 4.

Insert Table 3 about here

Insert Table 4 about here

Second, in order to understand the dynamics of structural social capital and the role played by geographical, organizational and cognitive proximity in this evolution, the research hypotheses were tested using a stochastic actor-based model for network dynamics (Snijders et al. 2010) The purpose of these models is to represent structural social capital dynamics based on observed longitudinal data. Observed changes can be explained as functions of both individual and dyadic characteristics of actors and structural effects. The specific actors attributes and the dyadic ones either support or inhibit the probability that two hospitals will transfer patients and so collaborate. The structural effects are endogenous network mechanisms that may also influence the probability of interdependence between actors. For the mathematical definition of effects used in actor-based models for network dynamics, we refer the reader to Snijders et al. (2010).

Third, a multiple-case study analysis was used to validate our findings (Eisenhardt, 1989; Leonard-Barton, 1990; Yin, 1994) Through this analysis we observed the common perceived meaning of collaboration and we are able to confirm that patient sharing (i.e. the dependent variable in the stochastic actor based model) is perceived by the practitioners as a good proxy of collaborative behavior. In addition, we conducted an analysis of interviews focusing on each relevant concept (i.e. collaboration, medical specialties absence, patient needs, geographical proximity, LHA membership and staffed beds availability) to better understand the role played by the geographical, organizational and cognitive dimensions of proximity in choosing collaborative partners.

4. Results

4.1 Network characteristics and changes over time

In Tables 3, we report the key statistics describing the evolution of structural social capital in terms of density (i.e. the ratio between the number of collaborative ties yearly observed and the total number of dyads), average degree (i.e. the average number of collaborative partners for each node) and total number of ties. Except for the year 2009, the density and the number of ties are increased slightly: from 11% in 2003 to 12,2% in 2008 and from 131 in 2003 to 145 in 2008, respectively. Also, in the six-year period that we observed, the average number of collaborative partner improved from 3,743 to 4,143.

To deeper explore the structural social capital dynamics, we also considered the over time

collaborative patterns at dyadic level (see Table 4). The column labeled 0→0 in Table 4 reports the number of pairs of hospitals that didn't develop a collaborative relationship in the observed wave, while the column labeled 1→1 in Table 4 indicates the number of dyads that maintained their collaborative interdependences. The remaining two columns in Table 4 present the number of collaborative ties that were formed or dissolved from one year to the next. Consistently with the third column of Table 3, Table 4 shows a growing trend in ties changes: during the period of time that we are observing, 213 new collaborative ties were formed and 199 existing relationships were dissolved. Figure 1 and Figure 2 show the evolution of structural social capital between 2003 and 2008. In the observed period collaborative ties substantially increased especially among hospitals belonging to the same LHA.

Insert Figure 1 about here

Insert Figure 2 about here

4.2 Results of the R-Siena Analysis

The empirical results of the Stochastic actor based model estimations are presented in Table 5. Robustness check shows that the convergence of the model was good (t- ratios were all inferior to 0.10 for all coefficients) and no severe problems of multicollinearity were encountered.

Insert Table 5 about here

The rate parameters, defined as "the expected frequencies, between successive waves, with which actors get the opportunity to change a network tie" (Snijders et al., 2010: 51) are all positive and significant: this means that the whole collaborative network grows over years because there are growing opportunities to change social ties.

The analysis of endogenous effects suggests that collaborative ties did not evolve randomly: both the significant negative effect of outdegree and the significant positive effect of reciprocity indicate that hospitals tend to replicate over time their usual patterns of collaboration In addition, the network presents a weaker tendency for indegree popularity and transitive mediate triplets indicating that hospitals tend to draw new collaborative ties in reason of their pre-existent collaborative relationships.

Our results provide confirmation for Hypothesis 1 (*Geographical proximity is likely to have a positive impact on the evolution of structural social capital, i.e. the propensity of hospitals to*

collaborate). The variable *Geographic Distance* in Table 5 is negative and significant in affecting inter-hospital collaboration dynamics: this suggests that geographical distance hinder hospitals propensity to collaborate and conversely that geographical proximity enhances collaborative patterns. Pertaining to Hypothesis 2 (*Organizational proximity is likely to have a positive impact on the evolution of structural social capital, i.e. the propensity of hospitals to collaborate*), we find that the variable *LHA (same)* in Table 5 is positive and significant in affecting inter-hospital collaboration dynamics, showing that inter-hospital collaboration is more likely to develop between structures belonging to the same LHA. However, the variable *Staffed Beds (same)* is not significant meanwhile staffed beds alter is significant and positive. This result is consistent with our expectation and it can be explained by the fact that bigger hospitals may have a higher propensity to form more ties (Lee et al, 2011). Results do provide empirical support Hypothesis 3 (*Cognitive proximity is likely to have a negative impact on the evolution of structural social capital, i.e. the propensity of hospitals to collaborate*). *Case Mix (similarity)* has a negative impact on inter-hospital collaboration dynamics and while *Specialties (same)* is not significant. Among the control variables, emergency admitted alter, ego and similarity coefficients demonstrate that collaborative interdependences are deeply influenced by the ability to manage emergencies.

4.3 Results of the qualitative analysis

As illustrated above, we observed medical directors opinions about the use of patience transfer as form of collaboration and the impact of the different dimensions of proximity on the evolution of collaborative network analyzing the response of a structured questionnaire, articulated in 16 questions. Main results are shown in Table 6.

Insert Table 6 about here

Here we report two relevant questions:

Q1: Main reasons for patient transferring

Which are the more common reasons underlying the patient transferring?

Q2: Main criteria for receiver hospital individuation.

Which are the main criteria adopted to choice the receiver hospital in-patient transferring procedures?

First, our analysis confirms that patience transfer is an important form of collaboration among the hospitals that populate our network, as emerge clearly from the following statements: “Patient transfer is a very important form of collaboration among hospitals” (TC, Medical Director); “In this

sector, the most used forms of collaboration among hospitals are patience transfers and consultancies. The patience transfer occurs independently form the existence of formal agreements among hospitals" (SP, Medical Director).

Second, our interviews confirm that geographical proximity plays a role in explaining how the inter-hospital collaborations evolve over time: "When deciding where to transfer the patience, first we take into account his(her) clinical conditions and then we choose the nearest structure that can satisfy his(her) needs" (PQ, Medical Director). Another Medical Director (EF) states: "In patient transferring procedures we always prefer to send our patients to local hospital structures".

From the analysis of the interviews, we find that organizational proximity matters in explaining collaboration among hospitals. As claimed by one of our interviewed medical director: "The first criterion that we use to decide where to transfer our patience is the satisfaction of the patient needs. The second criterion is that we prefer one of the structures of our LHA" (RL, Medical Director), meanwhile in another point of view "The first criterion that we use to identify the patience receiver hospital is the LHA membership, but also need to consider the patient's preferences" (LM, Medical Director). Interviews also confirm our Hypothesis 2b "We send patients where staffed beds are available and where they could immediately receive medical cares" (IS, Medical Director).

Finally, pertaining cognitive proximity, from the interviews we observed that the lack of specialties and patient medical needs are two others determinants of inter-hospitals collaboration: "In my hospital we transfer patients to those structures that have a greater number of specialties and that are able to address an higher case mix" (LC, Medical Director); "Based on my twenty-years experience in this field, I can say that transfers always occurs from structure with lower with higher complexity one" (FD, Medical Director).

5. Discussion and conclusions

Despite the large body of empirical research on social capital and inter-organizational network ties formation, we know preciously little on how they evolve over time. This research contributed to filling this gap in the literature by empirically investigating the evolution of social ties that shape a geographically bounded network of hospital organizations within an Italian region. More specifically, we investigate the role played by three dimensions of proximity (i.e. geographical, organizational and cognitive proximity) in explaining the evolution of social capital and inter-organizational relations over time. The opportunity to test our hypotheses and to apply innovative methods of investigation were provided to us thanks to the availability of a very rich dataset and to the identification of an ideal and very appropriate empirical context in the healthcare.

Three main conclusions can be drawn from the results of the present research. First, we found that

the geographical dimension of proximity is positively related to the organizations' propensity to collaborate. It means that a reduced geographic distance between each pairs of actors over time facilitates their communication and patients exchange processes, enhancing the hospitals' decision to collaborate with other hospitals nearby. Second, we find that the two dimensions of organization proximity, which represents the extent to which social ties are embedded in an inter-organizational arrangement explain hospitals' propensity to collaborate. More specifically, testing the impact of our proxies of organizational proximity emerges that bigger hospitals have higher propensity to form more ties between them, and that belonging to the same Local Health Authority (i.e. administrative unit) impact positively on collaboration. These results are in line with recent studies on patient sharing among hospitals (Lee et al., 2011; Mascia et al., 2012) and confirm their validity with new longitudinal data. Third, we found that cognitive proximity negatively affect hospital collaboration. This finding provides an important contribution to the literature on cognitive proximity where it is argued that actors sharing common knowledge, capacities and expertise perform better (Noteboom, 2000; Wuyts et al., 2005). In our study, we prove that the effect of cognitive proximity is strictly dependent on the sector in which organizations operate. Looking at patient sharing in the health sector, we explain that some cognitive distance allows to better address the complex problems related to patient's illness and, ultimately may enhance patient transfer safety and efficiency (Cohen et al., 2012).

In addition, from our analysis it emerges the shape and the evolution over time of the phenomenon of inter-organizational collaboration within our empirical setting. In line with previous research, we find that the formation of collaborative ties between organizations is explained by peculiar forms of structural (or local) configurations, composed by subsets of two or three network actors and the possible ties among them (Madhavan, Gnyawali, & He, 2004). These dyadic and triadic microprocesses are not used as direct measurements of the property of the network. Rather, they are statistically measured with the aim to provide evidence about endogenous, local forces, which drive the formation (and evolution) of the network itself (Mascia & Di Vincenzo, 2013; Robins, Elliott, & Pattison, 2001); Elliott, & Pattison, 2001). Among the dyadic configurations, outdegree (the overall tendency of hospitals to exhibit outgoing collaborative interdependence) and reciprocity (the overall tendency of hospitals to exhibit reciprocal interdependence) are both significant, giving us an idea of how the network over time is not static but evolves endogenously. Among the triadic configurations we find that transitive triplets (the tendency toward transitive closure, where collaborative ties are established with partners of partners), and indegree-popularity (the tendency of hospitals experiencing numerous incoming collaborative ties to become more exposed to collaboration) are significant and help us to better understand how the network evolves over time.

This study makes significant contributions to the literature. It contributes to the literature on network dynamics (Valente et al., 2010; Snijders, 2010; Giuliani, 2013) by exploring the evolution of network over time using a social capital perspective. Using a mixed method approach we were able to capture the impact of relational dimension in structural social capital and different dimensions of proximity. Exploring these heterogeneous dimensions allows a more comprehensive understanding of the dynamics of intra-group collaboration in geographically localized network (Kilduff et al., 2006; Lee, 2009). Also, we contribute to the economic geography literature (Boschma, 2005; Laursen et al., 2011; Knoben & Oerlemans, 2012) by explaining how different dimensions of proximity influence emerging collaborative relationships among hospital organizations. By adopting a mixed method approach, this study provides a methodological contribution in managerial research. The mixed methods approach combines different qualitative and quantitative data collection and analysis techniques, which can increase our understanding of the phenomena both through the triangulation of data sources and through use of the findings from one method to develop or inform the other method (Creswell, 2003). Finally, this study contributes to research in the healthcare management (Mascia et al., 2012). Prior research stresses the importance of developing new approaches for more accurate analyses of hospital collaboration so that hospital administrators and policymakers can increase their understanding about the environment in which health care organizations behave and perform.

This paper has some limitations that provide opportunities for future research, but also suggest some caution in interpreting the findings. First, in measuring the network evolution over time we only consider the structural dimension of social capital while the relational dimension is not considered (Nahapiet & Ghoshal, 1998). Second, in defining proximity we follow the article of Boshma (2005) that identifies geographical, organizational and cognitive proximity. However, as reported by Knoben and Oerlemans (2006) in their review of the literature, the theme of proximity has been widely analyzed in the literature and various other measurements and theoretical constructs have been defined. For example, in addition to the three measures employed in this paper, they find the constructs of institutional, cultural, social, and technological proximity. We encourage future studies to integrate theory and empirical measures about a broader range of proximity constructs. Third, we have selected for analysis one specific relation, i.e. patient transfer among hospitals. Notwithstanding this measure of inter-hospital collaboration is widely used in the literature (Iwashina et al., 2009; Lee et al., 2011; Mascia et al., 2012), and despite our field experience make us confident that this relation captures important dimensions of collaboration between hospitals, it is possible that hospitals collaborate in other ways as well. For example, exchange of doctors, cross training of medical staff and technology transfer may reveal same

collaboration patterns between hospitals. In addition, future studies will have to pay attention to the multiplexity that inter-organizational collaboration is likely to involve (Lomi & Pattison, 2006). Fourth, our findings are based on a 6-year period of data from hospitals in a single region of Italy and may reflect issues specific to the local context or study period. We strongly encourage future research on hospital dynamics of collaboration to extend the application of social network analyses to other settings and to see whether our findings may be generalized.

Appendix

Table 1: Summary of endogenous effects

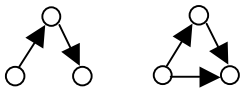
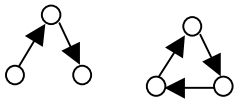
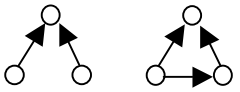
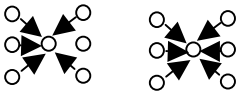
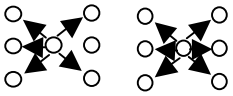
Endogenous effects	***Structural configuration***		***Interpretation***
	t_0	t_1	
Outdegree (density)			The tendency of a hospital to exhibit outgoing collaborative interdependence.
Reciprocity			The tendency of a hospital to exhibit reciprocal interdependence.
Transitive mediated triplets			A tendency toward transitive closure. Outgoing collaborative ties are established with partners of my direct partners (i.e. "*the friend of my friend, becomes my friend*").
Three-Cycles			The general tendency toward closure and cyclic network structures of collaboration.
Balance			The general tendency to collaborate between hospitals with similar collaborative interdependences.
Indegree-popularity			The tendency of hospitals experiencing numerous incoming collaborative ties to become more exposed to collaboration.
Outdegree-activity			The tendency of hospitals having many outgoing collaborative ties to become more active in terms of strategic initiatives of collaboration.

Table 2. Descriptive statistics of independent and control variables

Variables	Changing/ Costant	2003				2004				2005				2006				2007				2008			
		Media	StD	Min	Max	Media	StD	Min	Max	Media	StD	Min	Max	Media	StD	Min	Max	Media	StD	Min	Max	Media	StD	Min	Max
Geographic distance	*Costant covariate*	90,38	45,11	0	197	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LHA	*Costant covariate*	3,00	1,81	1,00	6,00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Staffed beds	*Changing covariate*	183,03	164,68	20,00	730,00	167,83	146,70	20,00	661,00	168,17	145,27	20,00	650,00	167,83	146,70	20,00	661,00	167,83	146,70	20,00	661,00	132,97	129,73	20,00	572,00
CaseMix	*Changing covariate*	1,03	0,13	0,81	1,40	1,03	0,13	0,81	1,40	1,02	0,12	0,70	1,42	1,03	0,11	0,66	1,29	0,92	0,20	0,00	1,24	0,90	0,12	0,66	1,22
Specialties	*Costant*	33	7,32	1	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Productivity	*Changing covariate*	35,65	16,80	5,45	79,40	42,92	23,13	9,21	130,44	50,93	27,10	11,21	136,37	32,49	16,24	5,74	77,16	28,10	14,72	0,00	60,00	38,10	19,78	6,51	103,49
% Emergency admitted	*Changing covariate*	31,657	25,53	0	71	35,74	24,25	0,00	71,00	37,35	24,54	0	74	34,77	28,07	0	79	34,69	27,44	0	75	31,26	25,55	0	71

Table 3. Key statistics of social capital evolution

Years	*Density (%)*	*Average degree*	*Number of ties*
2003	11	3,743	131
2004	10,2	3,457	121
2005	11,2	3,800	133
2006	9,5	3,229	113
2007	11,5	3,914	137
2008	12,2	4,143	145

Table 4. Number of changes between subsequent observations

Observation waves	**0→0**	**0→1**	**1→0**	**1→1**
2003-2004	1030	29	39	92
2004-2005	1022	47	35	86
2005-2006	1029	28	48	85
2006-2007	1021	56	32	81
2007-2008	1000	53	45	92
Total	5102	213	199	436

Table 5. Results of RSiena analysis

Rate Function	***Estimates***		***Std Error***
Rate parameter period 1	3,9040		0,6753
Rate parameter period 2	5,8398		1,0498
Rate parameter period 3	4,8776		0,8322
Rate parameter period 4	7,8833		1,6453
Rate parameter period 5	7,4250		1,3402
Endogenous effects			
Outdegree	-3,0054	***	0,2476
Reciprocity	0,5556	***	0,1607
Transitive mediated tripletes	0,3712	*	0,1716
Three-Cycles	- 0,1347		0,1086
Balance	0,0383		0,0369
Indegree popularity	0,0610	**	0,0202
Outdegree activity	0,0414		0,0305
Independent and control variables			
Geographical Distance (same)	-0,0078	***	0,0016
LHA (same)	1,1892	***	0,1456
Staffed Beds (similarity)	0,0702		0,3947
Staffed Beds (alter)	0,0028	***	0,0007
Staffed Beds (ego)	0,0001		0,0008
Specialties (same)	-0,3809		0,7575
Casa Mix (similarity)	-1,2336	*	0,6416
Case Mix (alter)	-0,6578		0,3895
Case Mix (ego)	0,7640		0,4055
Emergency admitted (similarity)	0,6374	**	0,2578
Emergency admitted (alter)	0,0079	**	0,0030
Emergency admitted (ego)	0,0158	***	0,0036
Productivity (similarity)	1,6980		0,6837
Productivity (alter)	0,0036		0,0034
Productivity (ego)	-0,0025		0,0037

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table 6. Results of qualitative analysis on the reasons for patient transfer

	First answer	***Second answer***	***Third answer***	***Total frequency***
Patient care needs	17	7	4	28
Geographical proximity	5	5	2	12
Medical specialties	24	3	3	30
LHA membership	3	4	-	7
Staffed beds	10	4	-	14
Others	2	3	1	6

Figure 1. Social capital (i.e. collaborative network) in 2003
Note: Node dimension is proportional to number of staffed beds. The color indicates the LHA membership.

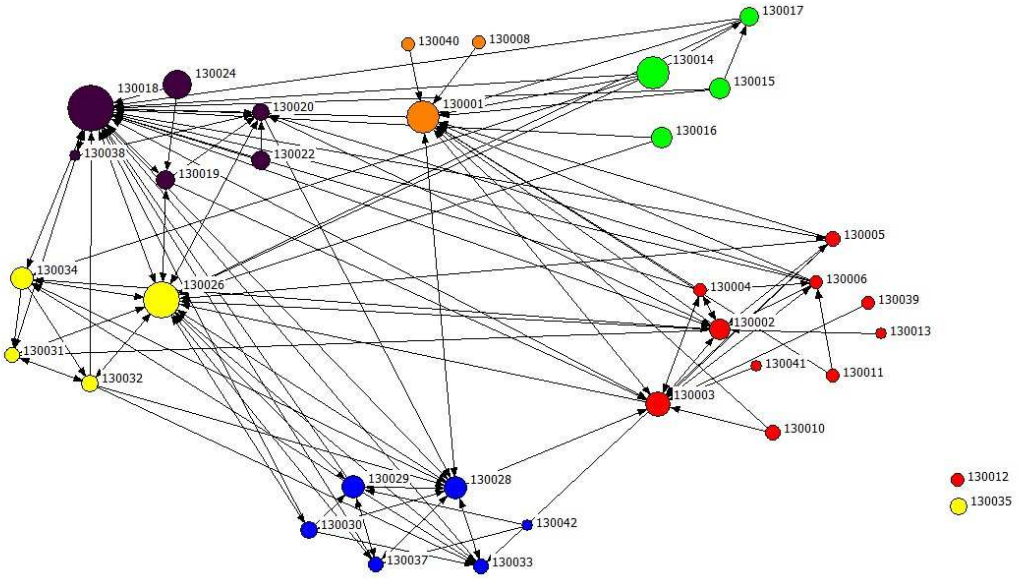
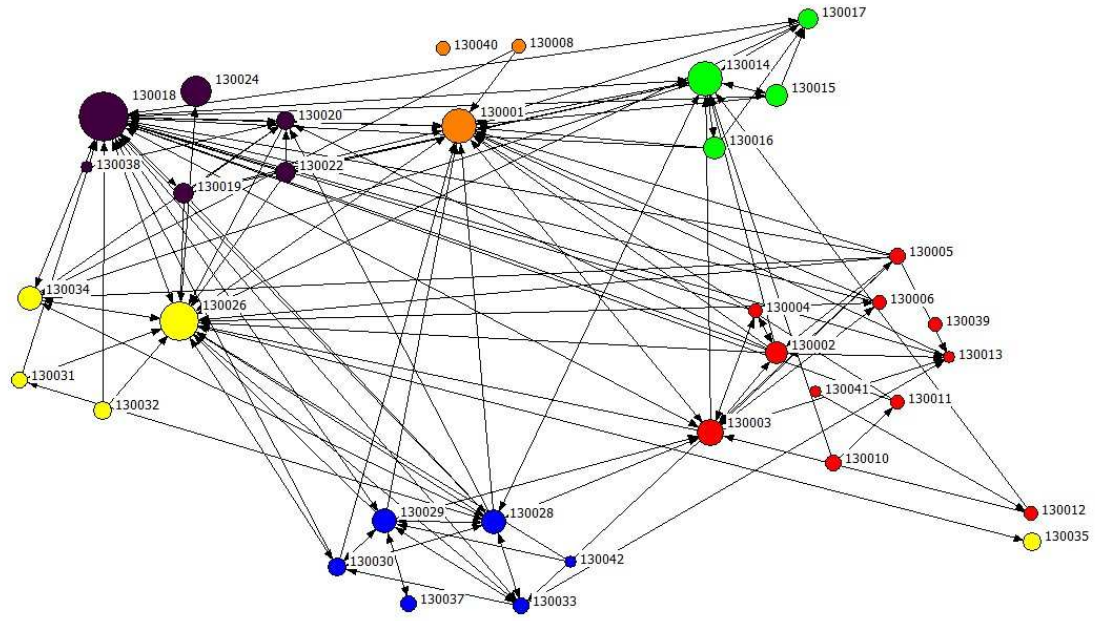


Figure 2. Social capital (i.e. collaborative network) in 2008
Note: Node dimension is proportional to number of staffed beds. The color indicates the LHA membership.



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