How proximity matters in innovation networks dynamics along the cluster evolution. A study of the high technology applied to cultural goods

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ABSTRACT

The role of proximity in innovation and inter-organisational networks has recently received increasing attention in management, organisational, economic geography and regional studies. Despite the rich literature devoted to these themes, most contributions on networks are mainly static, as they focus more on the network's structure than its dynamics. Our aim is to investigate the role of various forms of proximity in innovation network dynamics along the cluster evolution. The article focuses on two specific research questions: (i) How do the different forms of proximity influence the formation of innovation networks? and (ii) Does the impact of different forms of proximity change during the cluster's evolution?

The analysis investigates the cluster of High Technology applied to Cultural Goods in Tuscany and adopts an advanced econometric method such as the Stochastic Actor-Oriented Models to investigate the evolution of the networks over a time period of more than ten years.

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1. Introduction

The role of proximity in innovation and network dynamics has recently received increasing attention in management studies (Knoben & Oerlemans, 2006; Molina-Morales, Belso-Martinez, Mas-Verdù, & Martinez-Chàfer, 2015; Presutti, Boari, & Majocchi, 2011; Ritter & Gemunden, 2003), organisational studies (Oerlemans & Meeus, 2005), economic geography (Boschma, 2005; Boschma & Frenken, 2010), etc. However, several theoretical frameworks are used and different forms of proximity are investigated.

The most investigated form of proximity is geographical proximity. Spatial proximity and co-location of economic activities have traditionally been considered as important factors for competitiveness and innovation starting from Marshall and the concepts of agglomeration economies, industrial district and cluster. The clustering effect facilitates knowledge spillovers (Audretsch & Feldman, 1996) and promotes interactive learning among local networks (Belussi, Sedita, & Sammarra, 2010). Geographical proximity also facilitates the transmission of information and knowledge among firms and employees (Bell & Zaheer, 2007).

Nevertheless, geographical proximity has recently been criticised (Knoben & Oerlemans, 2006) as it does not consider the relevance of global and not-localised knowledge networks (Rallet & Torre, 1999). In particular, this stream of research has been particularly prolific in management and organisational studies, where an increasing number of contributions have started to investigate the important role of several forms of proximity in knowledge sharing and inter-organisational collaboration (Knoben & Oerlemans, 2006; Molina-Morales et al., 2015), innovation success (Ritter & Gemunden, 2003), and firms' performances (Oerlemans & Meeus, 2005).

Some authors even investigate how geographical proximity could impede entrepreneurship and innovation (Ben Letaifa & Rabeau, 2013). Others show that the benefits of geographical proximity in a cluster are not equally distributed to all firms, but depend on the position of a firm in the local network (Bell & Zaheer, 2007; Morrison & Rabellotti, 2009).

Despite the rich literature devoted to these themes, most contributions on networks are mainly static, as they focus more on the network structure than network dynamics according to an evolutionary approach. Only recently few contributions adopt an evolutionary perspective on network dynamics (Balland, De Vaan, & Boschma, 2013; Castro, Casanueva, & Galán, 2014; Giuliani, 2013; Ter Wal, 2013). This stream of research investigates several forms of proximity underlining that the various forms of proximity have different impacts on firms' innovativeness, and that they change during the cluster evolution (Menzel & Fornahl, 2010).

This study contributes to the debate on the importance of different forms of proximity. The aim is to investigate the role of various forms of proximity in innovation network dynamics along the cluster evolution. The article focuses on two specific research questions: (i) How do the different forms of proximity influence the formation of innovation networks? and (ii) Does the impact of different forms of proximity change during the cluster's evolution?

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The article focuses on the cluster of High Technology applied to Cultural Goods (HTCG) localised in Tuscany, where several innovations for cultural goods and policy-supported innovation networks have been developed in the last decades (Lazzeretti and Capone, 2016). It is important to investigate this business as the context is multidisciplinary and involves many high technologies (chemistry, physics, opto-electronics, ITC, etc.), which are usually applied to a totally new sector (cultural goods) (Casprini, Pucci, & Zanni, 2014). This could enrich the research agenda on how and which forms of proximity facilitate transversal innovations applied to new sectors and industries.

A new generation of Stochastic Actor-Oriented Models for social networks is now available, which may help advance the study of network dynamics. For the purpose of this study, five forms of proximity are investigated: geographical, social, institutional, cognitive, and organisational proximity. This paper applies a stochastic actor-based simulation approach with the SIENA package (Snijders, Van De Bunt, & Steglich, 2010) to 42 policy-supported innovation networks developed over 15 years (1995–2012) in order to investigate the network evolution over time. It focuses on network dynamics and analyses how these change during the cluster evolution, from a phase of emergence to growth (Menzel & Fornahl, 2010).

2. Innovation networks, proximity and network dynamics

In fields where scientific or technological progress is developing rapidly and the sources of knowledge are widely distributed, networks can become the locus of innovation (Powell, Koput, & Smith-Doerr, 1996). There is in fact a mature literature on networks of innovators and on their role in knowledge creation (Phelps, Heidl, & Wadhwa, 2012; Powell & Grodal, 2005). The growth of knowledge-intensive industries has increased the importance of networks in R&D, strategic alliances and so forth.

Among the literature on innovation networks, several authors investigate formal contractual networks such as those created via subcontracting relationships, alliances or research consortia, and there are also several studies on informal ties based on common membership in professional or trade associations. (Powell & Grodal, 2005).

Corsaro, Cantù, and Tunisini (2012) distinguish between three main perspectives on innovation networks – macro, meso and micro – but the boundaries between these levels are quite blurred. Studies within the macro perspective investigate the impact of innovation networks on macro systems, where the single actor has a secondary role. The meso perspective focuses mainly on the processes at dyadic and network levels, while the micro level perspective is concentrated on the single firm.

Within the meso and micro levels, important contributions derive from the influence of sociological issues, the application of social network analysis and the theory of embeddedness (Granovetter, 1973; Burt, 1992, and others). This research branch has mainly focused on the analysis of the network structure and the position occupied therein by organisations.[1]

This latter contribution has motivated the study of dyadic relationships, which provides relevant clues at the meso level. In recent years, this kind of research, powered by advanced techniques (SIENA, ERGM, etc.), has undergone an evolutionary breakthrough into the study of network dynamics over time.

A related line of research started to focus on *proximity*, exemplified by Boschma and Frenken's work (2010), began with static investigations, but has recently explored how the proximity between two actors can influence innovation networks in a dynamic setting.

Among those adopting an evolutionary approach, Balland (2012) investigated proximity and the evolution of collaboration networks in Global Satellite Navigation Systems in the VI Framework Programme during the period 2004–2007. He shows that geographical, organisational and institutional proximities favour collaborations, while cognitive and social proximities do not play a significant role. The author also underlines that geographical proximity maintains its relevance over time. Balland et al. (2013) study the evolution dynamics of the video game industry and the formation of network ties between firms along the life cycle of a creative industry from 1987 to 2007. They indicate that innovation relationships take form through a mechanism that is stable over time, whereas their weight is subject to change. Cognitive and geographical proximities are increasing determinants as the industry evolves over time.

Ter Wal (2013) explores the interplay between geographic distance and triadic closure, seen as the two main driving forces in the evolution of collaboration within inventor networks in German biotechnology. As the industry changes over time, the direct impact of geographic distance on network formation decreases and that of transitivity increases. Molina-Morales et al. (2015) analyse a foodstuffs cluster in Spain with Exponential Random Graph Models, aiming to clarify the detrimental effects and complementarities that may arise among proximity dimensions. They found a negative effect of cognitive and institutional proximity dimensions on the creation of linkages in advanced stages of the cluster life cycle.

Heringa, Horlings, van der Zouwen, van den Besselaar, and van Vierssen (2014) analyse *ego-alter* relationships among professionals in the Dutch water sector. They find that social and cognitive proximities have a positive effect, while geographical and organisational proximities have a negative effect. Morrison, Balland, and Belso-Martínez (2016) investigate informal relationships in business and technical networks in a Toy cluster in Spain. Their results underscore the positive impact that geographical, cognitive and institutional proximities can have, but also suggest that the dynamics of the two networks differ. Proximity is more crucial for technical knowledge networks, while embeddedness plays an equally important role in the dynamics of both networks. Table 4 summarises the main results of this literature, highlighting in particular research that developed evolutionary analyses.

However, proximity in itself is not a positive supporting factor for innovation. Too little proximity between firms could be detrimental to interactive learning and network formation, whereas too much of it could create 'lock-in' problems (Geldes, Felzensztein, Turkina, & Durand, 2015) or impede innovation (Ben Letaifa & Rabeau, 2013). This is called the *paradox* of proximity (Broekel and Boschma, 2012). In the literature there is evidence that too much cognitive proximity can reduce inter-firm knowledge exchange and too much proximity between agents in any of the dimensions might harm their innovative performance.

As already seen, the core studies on proximity have focused on innovation networks, but not all the relevant literature has confined itself to them. For example, Geldes et al. (2015) analyse inter-firm marketing cooperation by exploring all the different forms of proximity. The authors point up that marketing relationships are mainly influenced by social proximity, while the geographical has no relevance. In particular, this study investigates how geographical proximity moderates the relationship between inter-firm marketing cooperation and non-spatial dimensions of proximity.

Cantù (2010) argues that the convergence of cognitive and technological proximities can generate innovation. She focuses on how proximity supports innovation, demonstrating that different proximity dimensions influence firm boundaries, in accordance with the approach of the Industrial Marketing and Purchase (IMP) group to business-to-business relationships (Hakansson & Snehota, 1995, 2006). She uses a qualitative approach of semi-structured interviews to investigate the network relationships in a spin-off of the ceramics business. Finally,

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[1] Granovetter (1973) stresses the importance of the links built up with distant actors from usual network of contacts, which shares redundant knowledge. Creating links with cognitively distant actors is crucial for innovation and acquisition of new knowledge. Burt (1992) states that the discontinuities or *structural holes* occurring in the socio-relational fabric are the main determinants of actors' behaviour.