

**CONCEPTUALIZING CLUSTERS
THROUGH THE LENS OF NETWORKS:
A CRITICAL SYNTHESIS**

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Conceptualizing clusters through the lens of networks: a critical synthesis

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Abstract

Clusters, as spatial concentrations of economic activity, constitute an important form of coordination with significant repercussions in the configuration of firm and territorial strategies. They are recognized, both by academics and policymakers, as a territorial pattern of economy yielding critical issues in terms of competitive advantage, innovation, and economic growth. Despite that, a rigorous and clear-cut definition of cluster is still far from being reached. In the present paper, resorting to a critical synthesis of the literature on networks and clusters, we propose a unified, encompassing, and less blurred definition of cluster.

Keywords: Clusters, Networks, Concepts

JEL-Codes: R10; B52

1. Introduction

Searching for a unified, sufficiently comprehensive, although not too vague definition of cluster is a challenging task. Since the first explicitly insights from Porter in the 1990s, cluster accounts have mushroomed in several directions. This profusion of studies, however, was not accompanied by the assumption of a 'common' definition of cluster. Rather, such definition emerged from several, sometimes conflicting, inputs depending on the analysis undertaken (Gordon and McCann, 2000).

One interesting aspect about clusters is the recurrent way in which authors generically use synonymous like agglomeration economies, industrial districts, *milieux* to define them (Oakey *et al.*, 2001; Maskell, 2001; Tallman *et al.*, 2004). Several recent studies (Gordon and McCann, 2000; Malmberg and Maskell, 2002; Martin and Sunley, 2003; Maskell and Kebir, 2005) maintain that this interchangeable use of labels seriously affects concept clarity and, consequently, the validity of a cluster theory. For instance, Martin and Sunley (2003: 6) view clusters as “a world-wide fad, a sort of academic and policy fashion item”, whose elements are conveniently indeterminate so to embrace a broad range of industrial groupings. Aware of this pitfall, Maskell and Kebir (2005) subscribe Reich's (1990: 925) claim that “the cluster concept will join those rare terms of public discourse that have gone directly from obscurity to meaninglessness without any intervening period of coherence”.

Clusters involve two key dimensions: spatial proximity and network elements. Networks are effective forms of organising economic activity and producing relevant outcomes. They emerge as an appropriate institutional arrangement to face innovation complexity (Imai and Baba, 1989), to create/transfer knowledge by its ability of connecting economic agents with complementary capabilities; and to face technological demands such as uncertainty and rapid pace of change. Indeed, one feature of the innovation process is its complexity, reflected on the fact that one single organization does not possess all the required capabilities to successfully innovate and operate (Coombs and Metcalfe, 1998; Dahl and Pedersen, 2003; Howells *et al.*, 2003). Simmie (2004: 1095) mentions innovation as “an internationally distributed system of activities” encompassing a broad spectrum of actors. In this context, firm interaction and networking emerge as critical (Malmberg, 1997; Hotz-Hart, 2000; Cooke and Morgan, 2003). It seems intuitive that if an organization does not dominate all the required sources to innovate it will have to access external sources, and here networks, involving a broader set of actors, seem to fit quite well (Kline and Rosenberg, 1986; Nelson,

1993). Consequently, the complexity of innovation finds a correspondence in the complex configuration of networks, in which several organisations (firms, universities, public research agencies, financial system, etc.) collaborate at different degrees (Coombs and Metcalfe, 1998; Howells, 1999; Howells and James, 2001). Another feature of innovation is associated with its reliance on the capacity to create knowledge through processes of learning (Lundvall, 1992; Amin and Wilkinson, 1999; Pinch et al., 2003) and adapting (Cohen and Levinthal, 1990). One can divide the effects of such reliance in two strands of interest. First, innovation has a spatial root that, to a certain degree, is localised. This element of proximity is related to the properties of knowledge that, being partially tacit, is best transmitted locally, sufficiently complex to take time to diffuse across space (Jaffe *et al.*, 1993), and highly dependent of the specific social, economic and geographical context (Von Hippel, 1994; Howells, 2002). Although innovation appears to be developed in several localised concentrations of economic activity there is some literature (see for example Powell and Grodal, 2004) that stresses the role of information and communication advancements in the creation and sustenance of *virtual networks*. These networks can be successfully maintained and managed independently of geographical affiliation, being the proximity between partner's solely based on intellectual affinities. In this context, Saxenian and Hsu (2001) make reference to the case of technical communities, such as Silicon Valley and Hsinchu-Taipei, whose industrial upgrade partially relies on long-distance cultural/intellectual affinities. Secondly, innovation relies on interaction between organisations with diverse (but complementary) capabilities (Lundvall, 1992; Richardson, 1972). Networks are considered to be "vehicles for producing, synthesizing, and distributing ideas" (Powell, 1998: 231). Podolny and Page (1998) also stress networks as means of learning, claiming that they promote rapid transfer of information and may, inclusively, generate new knowledge, out of the interaction between agents. In addition, networks promote the existence of trust, inhibiting opportunism and malfeasance (Granovetter, 1985). Gulati (1995) also maintains that past networks may both inform about partner's reputation and work as a form of peer control.

Generic trends such as rapid technological change (Coombs and Georghiou, 2002), decreasing product cycle times, market uncertainties and increasing costs and risks of R&D (Howells *et al.*, 2003) promote network activities (Powell, 1990; Saxenian, 1991). As such, the importance of networks for economic activity has been receiving scholarly recognition with an increasing number of studies on the field. Granovetter (2005) analyses the importance of social networks for economic outcomes such as labour market, prices, productivity and

innovation. In a similar, but more focused perspective, Gulati *et al.* (2000) acknowledge the role of networks for firm behaviour and performance.

Being networks a key dimension of clusters, and given the difficulty in reaching a comprehensive and meaningful concept of clusters, in the present paper we undertake a critical synthesis of the literature aiming at conceptualizing clusters through the lens of networks.

The paper is organized as follows. In the next section (Section 2) we introduce the concept of networks and summarise some relevant literature in the area. Then, in Section 3, we develop the main argument of the investigation – to uncover the elements of networks relevant for the conceptual understanding of clusters. Finally, in Conclusions we put forward the main points of this critical synthesis.

2. Concept of networks and its main varieties

The literature on network forms of organisation is quite extensive. Paraphrasing Podolny and Page (1998: 59), network is “any collection of actors that pursue repeated, enduring exchange relations with one another”. Also Castilla *et al.* (2000: 219) highlight networks as a “set of nodes or actors (persons or organizations) linked by social relationships or ties of a specified type”. The social relationships that individuals and/or firms maintain may, thus, originate different types of networks.

In the early 70s, Richardson (1972: 883) developed an argument for what he viewed as a gap in the theoretical account of the forms of organising economic activity – “the dense network of cooperation and affiliation by which firms are interrelated”. This author admitted his initial assumption about an economic landscape merely composed of planned (firms) or spontaneous (market) coordination. However, the assumption of an organization of industries based on a combination of capabilities, knowledge and skills made Richardson point out the fact that some of the industry activities – complementary in nature – called for networks of collaboration (Richardson, 1972). Consequently, networks were interpreted as the appropriate form of coordination in the management of different but related activities, at industry level.¹

¹ The elements of the debate involving the forms of organising economic activity own their first developments to Coase (1937). Overcoming the limitations of the neoclassical accounts about the firm as a mere ‘black box’, he stressed the importance of the firm as a governance structure. Moreover, this scholar saw firms and markets as alternative forms to organize similar types of transactions. In a valuable overview of networks, Powell (1990) identifies the resurgence in interest about this debate in the 1970s, with a strand of literature comprising the transaction costs theory. These accounts subscribed Coase’s (1937) argument about the importance of organizational forms for economics.

In a different perspective the work by Williamson (1975) – *Markets and hierarchies* – rather than focusing on networks highlights a dichotomous view, between firms and markets, in the coordination of economic activity. According to the author, the form of organisation depends on the nature of the transaction involved: if it is uncertain, frequent and with specific investments, the transaction will preferably occur within a firm; if, on the contrary, the exchanges are more simple, not so frequent and without specific investments, then the transaction can efficiently be made through the market.

Later contributions from this leading figure of the transaction cost theory make reference to the existence of networks as hybrid forms of coordinating economic activity (Williamson, 1991). Nevertheless, Podolny and Page (1998) argue that Williamson's view on networks did not actually account for networks as independent forms of coordinating economic activity. On the contrary, they are inserted on a continuum of alternatives to the pure forms (market and hierarchies), which ultimately will prevail when compared to the hybrid forms (Williamson, 1985, 1991).

Fierce opposition emerged against both the dichotomy of forms of organising economic activity (markets vs. hierarchies) and the continuum perspective. For instance, Granovetter (1985: 499) criticises Williamson's dichotomy by arguing that, according to this perspective, there is an overestimation of the "efficacy of hierarchical power". This author supports the idea of social embeddedness in economics, meaning that economic behaviour and social institutions are intertwined and influenced by ongoing social relations (Granovetter, 1985). Therefore, social relations and the corresponding structures (networks) may be more effective than firms or markets in guaranteeing order in economic life, that is, promoting trust and avoiding malfeasance (Granovetter, 1985). In this sense, interpersonal ties, namely between individuals that do not communicate so frequently (*weak ties*), emerge as powerful sources of novelty (Granovetter, 1973).

Also Powell (1990) contests this dichotomous world of economics, aiming to demonstrate the distinctive identity of network forms of organisation. Subscribing Granovetter's idea (1985), that economic activity cannot be insulated from social context and relations, Powell (1990) highlights three ways in which Williamson (1975, 1985) theory fails: 1) capturing the rich context of transactions; 2) providing an appropriate pattern of economic development; 3) providing explanations on the role of collaboration/networking as alternative coordinating mechanism.

Table 1 synthesizes the advantages and disadvantages of markets, firms and networks coordination of economic activity. Powell (1990) argues that the prevalence of networks is directly related to three basic reasons, namely the ability to: exchange of know-how; face rapidly environment changes, namely technological; and build trust among partners of the structure.

Following this review, Podolny and Page (1998) produce a functional characterisation by considering four main levels where networks play an effective role: (i) learning, since networks constitute a means of gathering and transferring information; (ii) legitimation and status; (iii) economic benefits accruing from the decrease in transaction costs; (iv) other benefits, namely the reduction of uncertainty and social welfare.² The investigation of network failure conditions led Podolny and Page (1998) to conclude that beyond experience on past networks (Gulati, 1995), cultural and organizational affinities are critical. These scholars also group the criticisms about the Williamson dichotomy depending on the scholars’ background (Podolny and Page, 1998). Indeed, while economists’ views are either under or over socialised (Granovetter, 1985) and excessively focused on costs advantages, sociologists pursue a research agenda more balanced when it comes to the issues of social context, relations and its influence in economics. Specifically, they tend to focus on the qualitative advantages of networks, such as quality of production (Uzzi, 1997) or capacity to adapt to unanticipated contextual changes (Powell, 1990; Kanter, 1991).

Table 1: Economic forms of coordinating: advantages and disadvantages

Forms of coordination	Advantages	Disadvantages
Markets	Choice, flexibility and opportunity	Poor form to learn and transfer know-how
	Fast and simple communication	Frequent and complex exchanges imply high costs of conducting and monitoring
	Prices constitute a simplifying mechanism	Prices do not capture specificities and dynamism of exchange
	Market coordination is non-integrative	
Firms	Visible hand of management	Weaknesses of the hierarchical features when confronted with high demand variations or unanticipated changes
	Hierarchical structure (boundaries, authority, formal decisions) well-suited for mass production and distribution	
	Reliability of hierarchical structure	
Networks	Share risks for activities beyond the scope of action of a single entity	Bad conduct or opportunism of partner
	Open-ended and relational nature of networks promotes ability to exchange and learn new skills and knowledge	Networks involve dependency and particularism
	Fast access to new technologies/markets	Possibility of conflicts between partners involved in networks

Source: Powell (1990).

² More recently, building on several empirical studies, Powell and Grodal (2004) consider the following main benefits of networking: (i) information diffusion; (ii) share of resources; (iii) access to specialised assets, and (v) collective learning.

Networks' validity as an independent form of organising economic activity is thus intrinsically related to the academic background of the researchers that approach this issue. While sociologists (Granovetter, 1975, 1985; Powell, 1990; Podolny and Page, 1998) generically stress network qualitative advantages as legitimating networks form of coordination, economists (Williamson, 1975, 1981; Hennart, 1988; Zajac and Olsen, 1993) tend to focus on costs accountings and view networks as an example of a broader hybrid world of forms that combines features from markets and firms.

Based on the forms of governance and duration of networks, Grabher and Powell (2004) distinguish between four categories: 1) project networks; 2) business networks; 3) informal networks, and 4) regional networks (cf. Table 2).

Table 2: Typologies of Networks

Strategic social relations	Project networks	Business networks
Spontaneous social relations	Informal networks	Regional networks
	Short-term	Long-term

Source: Grabher and Powell (2004).

Additionally, Powell and Grodal (2004) consider three basic criteria to differentiate networks. First, and using Granovetter's (1973) distinction, these scholars mention networks with weak and strong ties. According to this criterion, elements such as the level and frequency of interaction between individuals are essential to determine the type of network and the type of information shared (Powell and Grodal, 2004).

Second, based on Burt's (1992) contribution, the authors stress networks as bridges and as structural holes. In this case, networks may be characterised either by their ability to connect with distant individuals/firms or by their ability to connect with an entire new set of individuals/firms (Powell and Grodal, 2004).

Third, networks may be transactional or relational in nature. While the former are intentionally generated to fulfil a specific task, the later do not emerge from a strategic purpose but, rather, from ongoing social relationships (Powell and Grodal, 2004). On an attempt to systematise these issues the authors propose four main categories (see Table 3).

These modalities of networks fit on more specific typologies, mentioned extensively in the literature. Richardson (1972), for instance, stresses four main forms of networks, namely trading relationships, subcontracting, retail chains and transfer of technology. Powell (1990), in turn, illustrated network relevance with examples ranging from sectoral level (networks in craft industries, vertical disaggregation), to regional level (industrial districts).

Table 3: Typologies of Networks

Fluid membership	Closed membership	<i>Primordial type</i> Examples: Film, construction, ethnic community	<i>Supply chain type</i> Examples: Automotive supply chains
	Fluid membership	<i>Invisible college type</i> Examples: research collaboration, information sharing	<i>Strategic type</i> Examples: Networks involving biotech, venture capital and pharmaceutical firms
		Informal	Contractual

Source: Powell and Grodal (2004: 64).

Others like Freeman (1991) broaden the modalities of strategic networks to include the collaboration forms that can be relevant for innovation (see Table 4).

Table 4: Forms of strategic networks

Categories of Networks
Joint-ventures
Joint R&D agreements
Technology exchange agreements
Direct investment
Licensing agreements
Subcontracting
Research associations
Government-sponsored research programmes
Computerised data banks and value-added networks
Others (namely informal networks)

Source: Freeman (1991: 502).

Summing up, we contextualised the interest on networks on the broader debate about forms of organizing economic activity. The scholars’ background is seen as relevant for their view on networks. While sociologists tend to stress network qualitative advantages as legitimating networks form of coordination, economists tend to focus on costs accountings and view networks as an example of a broader hybrid world of forms that combines features from markets and firms. Additionally, the study of networks in a variety of forms and attributes is

due to reflect the different criteria and classifications used, as well as dimensions approached – innovation, strategic goals, durability, among others.

3. Uncovering the elements of networks relevant for the conceptual understanding of clusters

3.1 Defining clusters: how explicit are networks?

Searching for a unified, sufficiently comprehensive, although not too vague definition of cluster is a challenging task. Since the first explicitly insights from Porter in the 1990s, cluster accounts have mushroomed in several directions. This profusion of studies, however, was not accompanied by the assumption of a ‘common’ definition of cluster. Rather, such definition emerged from several, sometimes conflicting, inputs depending on the analysis undertaken (Gordon and McCann, 2000). In Table 5 we group cluster definitions depending on the dimension they highlight: either spatial proximity or network elements. We argue that the inquiry of network elements involved in clusters can contribute to a more rigorous definition of the later. The analysis of Table 5 is supported by Maskell’s insights (2001). According to this author, the literature on clusters experienced a shift on emphasis from more descriptive accounts (e.g., Swann and Prevezer, 1996; Porter, 1998a), stressing benefits from agglomeration economies rooted in the Marshallian tradition,³ to a more dynamic perspective (e.g., Maskell and Lorenzen, 2004; Dahl and Pedersen, 2003), highlighting knowledge, learning, adaptation, and innovation as critical mechanisms.

The analysis of the table allows depicting a set of common elements in the cluster notions. A first shared element is the geographical dimension of clusters. Such dimension implies some degree of *spatial proximity*, at local, regional or, even national level (OECD, 1999).

A second common element regards the *related nature of activities* interacting in the same location. Expressions like ‘inter-industry level’ (DeBresson, 1996), ‘related firms’ (Baptista and Swann, 1998; Maskell, 2001; Van Klink and De Langen, 2001), ‘interconnected companies’ (Porter, 1998a), ‘interdependent firms’ (Hertog and Maltha, 1999), ‘symbiotic organisations’ (Steinle and Schiele, 2002) and ‘closely capabilities’ (Maskell and Kebir, 2005) translate this feature.

A third generic element in these notions of cluster concerns the *interaction* among economic agents. Drawing on the contributions of Brandenburger and Nalebuff (1996), Porter (1998b)

³ The Marshallian tradition regards both Marshall’s work (1890) and the works grouped as New Industrial Districts (Sabel *et al.*, 1987; Pyke and Sengenberger, 1992).

stresses the existence of a double dimension of interaction inside clusters – competition and cooperation – labelled as *coopetion*. Other scholars capture the aspects of cluster interaction in the existence of networks (DeBresson, 1996; Hertog and Maltha, 1999) clubs (Steinle and Schiele, 2002) and communities (Porter, 1998a, Dahl and Pedersen, 2003).

Table 5: Clusters definition: several contributions

	Author	Cluster definition
Focused on spatial proximity dimension	Swann and Prevezer (1996: 1139)	"groups of firms within one industry based in one geographical area"
	Oakey, Kipling and Wildgust (2001: 401)	"cluster and agglomeration will be judged synonymous since they both define geographical areas where an industry (or industries) are concentrated to produce localised economic advantages"
	Bresnahan, Gambardella and Saxenian (2001: 836)	Regional cluster: "spatial and sectoral concentration of firms"
	Maskell (2001: 922)	"referred to as 'locational economies' and embraces those economies that arise from geographical agglomeration of related economic activities... <i>the</i> territorial configuration most likely to enhance learning processes"
	Van Klink and De Langen (2001: 450)	"concentration of related activities in a particular area"
	Maskell and Lorenzen (2004: 991)	"specific spatial configuration of the economy suitable for the creation, transfer, and usage of knowledge"
	Tallman, Jenkins, Henry and Pinch (2004: 259)	Regional cluster: "or industrial districts as examples of advantage-generating 'superfirm' groups inside industries, within each member firms simultaneously shares and differentiates sources of competitive advantage"
	Maskell and Kebir (2005: 1)	"non-random geographical agglomerations of firms with similar or closely complementary capabilities"
Focused on network dimension	DeBresson (1996: 161)	Innovative cluster: "not a simple concentration of independent economic agents, but display at an inter-industry level, underlying networks of inter-related co-operating businesses"
	Baptista and Swann (1998: 525)	Geographical cluster: "strong collection of related companies located in a small geographical area, sometimes centred on a strong part of a country's science base"
	Porter (1998a: 199)	"geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions in a particular field, linked by communities and complementarities"
	Hertog and Maltha (1999: 193)	"networks of production of strongly interdependent firms (including specialised suppliers), knowledge-producer agents (universities, research institutes), bridging institutions (brokers, consultants) and customers related to each other in a value-adding production chain"
	Steinle and Schiele (2002: 850)	"localised sectoral agglomerations of symbiotic organisations that can achieve superior business performance because of their club-like interaction"
	Dahl and Pedersen (2003: 7)	Regional cluster: "homogeneous knowledge communities"

Beyond these explicit elements derived from Table 5, it is also important to make reference to the *institutional and cultural context* involving the existence of clusters. The social context is a relevant factor explaining the economic behaviour and outcomes (Granovetter, 1985, 2005). In this sense, some contributions point out the relevance of a *localised institutional*

infrastructure for the existence of a cluster (Maskell, 2001; Powell *et al.*, 2002; Maskell and Lorenzen, 2004). Moreover, the existence of cultural affinities (common language, values, academic/intellectual backgrounds) is also important for the sense of identity of the cluster (Saxenian, 1991, 1994).

Summing up, and relying on the contributions above, one can define **clusters** as,

Spatial configurations of economic activity, which articulate a wide range of economic agents (firms, producers, suppliers, service providers, universities, research institutes, governmental agencies, financial system, consultants, clients, etc.) that interact in proximity. This combination of capabilities, under a peculiar institutional frame can be seen as promoting local competitive advantage, innovation and growth.

Spatial proximity, interrelatedness of capabilities/activities, interaction between agents and institutional endowment are, therefore, key elements of clusters.

3.2 Clusters and networks – a two way conceptual relation

There is a generalized agreement, in the literature, about the networks' relevance for clusters development and success. Specifically, networks are an effective answer to the localisation of economic activity, in which clusters are a representative phenomenon.

However, networks and clusters relationships are not clear-cut. On the one hand, one should mention the few signs of communication between the vast, but distinct, bodies of literature⁴ that study either networks or clusters. On the other hand, all the literature does not seem to be very clear in terms of the boundaries between network and cluster meanings.

Once the elements of *network* and *cluster* definitions were discussed it is now time to investigate three main issues concerning their relationship: 1) Accepting that clusters involve networks, does the opposite also holds truth?; 2) Assuming that clusters evolve in specific geographical locations, is it possible to conceive networks merely in proximity?; 3) Is it possible to define a clear boundary between networks and clusters? That is, to define common and distinguishing dimensions?

Breschi and Malerba (2001: 819), reviewing the main issues of a collection of insights about clusters,⁵ highlight that “learning through networking and by interacting is seen as the crucial force pulling firms into clusters and the essential ingredient for the ongoing success of an

⁴ While networks are an extensively studied concept in sociology, organizational behaviour, and economics, clusters seem to be a more appealing label to economic geography and strategic management scholars.

⁵ Theoretical contributions are incorporated in a special issue from *Industrial and Corporate Change* entitled “The geography of clustering and innovation”. Peter Maskell, Anna Lee Saxenian, Maryann Feldman, Philip Cooke and John Cantwell are among the authors.

innovative cluster”. Therefore, beyond the geographical proximity inherent to clusters, their performance relies heavily on thick networks of knowledge. This opinion is also shared by Steinle and Schiele (2002), for they view a cluster’s full potential to be exploited through the combination of co-location (bringing advantages like lower transport cost) with interaction, namely in terms of close membership.

A wide mentioned case of a successful cluster, which is structured according to networks, is Silicon Valley. In fact, the region’s dynamism and success is attributed to “networks of interdependent yet autonomous producers” (Saxenian, 1991: 430). More specifically, Saxenian (1991, 1994) maintains that the share of cohesive values, such as reciprocity, mutual commitment, stability, quality, etc., coupled with economic rationales (decrease product development times and increase ability to learn) promoted critical long-lasting and trust-based interactions between computer system firms and suppliers. More concretely, Granovetter and his colleagues stress three basic types of networks, critical for Silicon Valley’s performance: (i) networks of access and opportunity related to labour market issues; (ii) networks of power and influence, namely from venture capitalists and lawyers, whose role goes beyond the conventional ones; (iii) networks of production and innovation to point out the transmission of information and the governance mechanism nature (Castilla *et al.*, 2000).

Notwithstanding the consensus on the relevance of networks for cluster development, Gordon and McCann (2000) claim that industrial clusters may exist in the absence of cooperation and, therefore, of networks. In the context of a *pure agglomeration model*, firms enjoy from proximity advantages like specialisation, services or information. Such advantages are free of any cooperation or formal structure, and can be found in cases such as economies of metropolitan areas (Gordon and McCann, 2000). Even so, these scholars suggest two other forms of clustering, *industrial complex* model and a *social network* model, which imply close interaction and explicit networking. Furthermore, it is acknowledged that these three structures are pure and real world examples are, frequently, characterised by a combination of features from several models.

For all that has been said it seems sensible to recognise that cluster success call for the existence of networks. However, the literature is far from being clear when it comes to the opposite claim – that is, if the existence of networks implies clusters.

Looking into the literature one cannot find evidence of networking being enough for clusters existence and development. A first way of analysing this issue is by *investigating the spatial*

nature of networks. Underlying this work is the fact that *clusters* possess a localised nature, translated into co-presence of firms and related economic agents. Consequently, in the hypotheses of networks being a sufficient condition for cluster existence, they would also need to develop in proximity or bounded environments.

Several authors have come to conclude that networks are not necessarily bounded by geographical proximity (Echeverri-Carroll and Brennan, 1999). In this context, Gordon and McCann (2000: 521) are quite straightforward claiming that “co-location will be a necessary but not sufficient condition for access” to a network. Others, like Powell and Grodal (2004), maintain that ICT developments are considerably improving the interaction between technical communities, and, therefore, creating space for the emergence of *virtual networks* of innovators, whose proximity is mainly intellectual. In a study about technical communities, Saxenian and Hsu (2001) also maintain that knowledge and skills can be exchanged across long distances. That is the case of two different communities, Silicon Valley and Hsinchu-Taipei, networking distantly, through their skilled labour, as a source of industrial upgrading.

Another line of argument stresses that clusters are not self-contained but, rather, dependent on both local and external networking (see, for example, Storper and Venables, 2002; Bathelt et al., 2002; Wolfe and Gertler, 2004). As point of fact, beyond the type of knowledge that flows in spatially local networks⁶ the cluster needs to maintain external connections⁷ for its renewing and success. In this context, Staber (1996) argues that networks are supportive of these cluster local and global linkages, existing both in spatial proximity and distantly. Some phenomena that greatly contribute to this inter-cluster interaction are the spatial patterns of critical assets like knowledge and innovation, quite dispersed in nature (Coombs and Metcalfe, 1998; Amin, 2002; Howells *et al.*, 2003; Simmie, 2004). One case where the need for distant networking is particularly acute is the high-tech sectors like biotechnology or pharmaceuticals (Powell *et al.*, 2002). As a result concentration – implied in clusters – can co-exist with dispersion of economic activity. In both patterns of distribution, networks constitute a critical mechanism. Sturgeon (2003), for instance, claims that a cluster, such as Silicon Valley, is organized through ‘modular production networks’ that manage both local linkages and contacts at a global scale.

⁶ This local environment is labelled by Storper and Venables (2002) as ‘local buzz’ and regards regional networks.

⁷ The connections of the cluster with its external environment concern ‘global pipelines’ and involve strategic partnerships (Owen-Smith and Powell, 2002; Storper and Venables, 2002).

Summing up, the spatial pattern of networks could be both concentrated and dispersed and, consequently, they would not be sufficient for cluster existence.

A second way of analysing the lack of evidence regarding networks being sufficient for clusters is by *characterising critical elements of the later*. As it was argued before, spatial proximity, interrelatedness of capabilities/activities, interaction between agents and institutional endowment are key elements of clusters existence and success. Networking emerges as one of the ingredients, and not the only, for the receipt of cluster performance. Recently, a study from Giuliani (2005) came to raise concerns about the effective way to promote clusters' development. Arguing for the unevenness and selectivity of cluster networks, Giuliani stressed the importance of knowledge base affinities. This finding stands in sharp contrast with the tendency in the literature to exacerbate proximity of firms as a sufficient condition of cluster performance. Consequently, cluster benefits are maximized with intellectual affinities, namely the existence of a common knowledge base, and networks need to be responsive to such affinities, locally or distantly.

According to this evidence, one can conclude that:

Networks are a necessary but not sufficient condition of clusters existence and performance. Therefore, whereas clusters imply the existence of networks, the opposite is not necessarily true.

The answer to the last question raised at the outset of this section calls for the enquiry about the common and distinguishing features of networks and clusters. Since the concepts are related but different, it is pertinent to suggest some type of boundaries between the two.

Maskell and Lorenzen (2004) propose a differentiation (see Table 9) between networks and clusters that is mainly established by the industry characteristics and the level of relational stability. Whereas networks are best suited for stable relations, clusters seem appropriate for uncertain industries or ambiguous markets.

Therefore, clusters emerge as a form of coordinating economic activity structured in a territorial dimension (Maskell and Lorenzen, 2004). Such stickiness is also related to the relevance of the social endowment for cluster existence and performance. In this context, some scholars (e.g. Maskell, 2001; Powell *et al.*, 2002) stress the importance of local and specialised institutions, supportive of the activities developed within the bounded, but porous, limits of the cluster. Specifically, Maskell and Lorenzen (2004) summarize four key roles of localised institutions: (i) reduce transaction costs; (ii) work as pre-condition of flexibility; (iii) contribute to enhance social trust; and (iv) contribute to improve knowledge creation.

Table 2: Networks and clusters comparison

Networks	Clusters
Institutional arrangement	Institutional environment
Firms as shareholders	Firms as stakeholders
Strong ties	Weak ties
Club institutions	Social institutions
Trust, sunk costs	Social trust, reputation
Codebooks	Social codebooks

Source: Maskell and Lorenzen (2004:pp)

The analysis of Table 9 allows realising the higher relational density of clusters when compared to networks. Such density is directly related to geographical proximity, a phenomenon that does not necessarily occurs in networks, and to the communal social culture inherent to such spatially bounded environment (Maskell and Lorenzen, 2004).

Another distinguishing feature between networks and clusters is related to the forms of interaction. While the former are confined to networking, clusters embrace more sources of interaction. Following Edquist (2004), *interaction* between agents may either occur in competition, transaction or networking relations. In the case of clusters, Porter (1998b) stresses the co-existence of competition and cooperation (labelled as '*coopetition*'), revealing of the cluster's richness.

In summary, clusters seem to heavily rely on networks as means of creating and exchanging knowledge, reducing uncertainty, accessing new markets/technologies and sharing risks. One can, inclusively, assume cluster structure as a set of networks that promote localized dynamics and, at the same time, guarantee external connections with other relevant concentrations of knowledge and innovation.

However clusters are not confined to networking. On the contrary, they are built around a *critical social mass*, combining specific institutions and a common culture (including language, values, norms, codes, etc.), which is *eminently localized*, that is, with spatial roots.⁸

⁸ One straightforward and helpful exercise is listing well-known clusters like Silicon Valley (with electronics), Baden-Württemberg (with the automotive) or Emilia-Romagna (with textiles and fashion) and emerging clusters like North Jutland (with ICT's) and California (with Biotech). The consideration of a cluster reports immediately to a specific region or location.

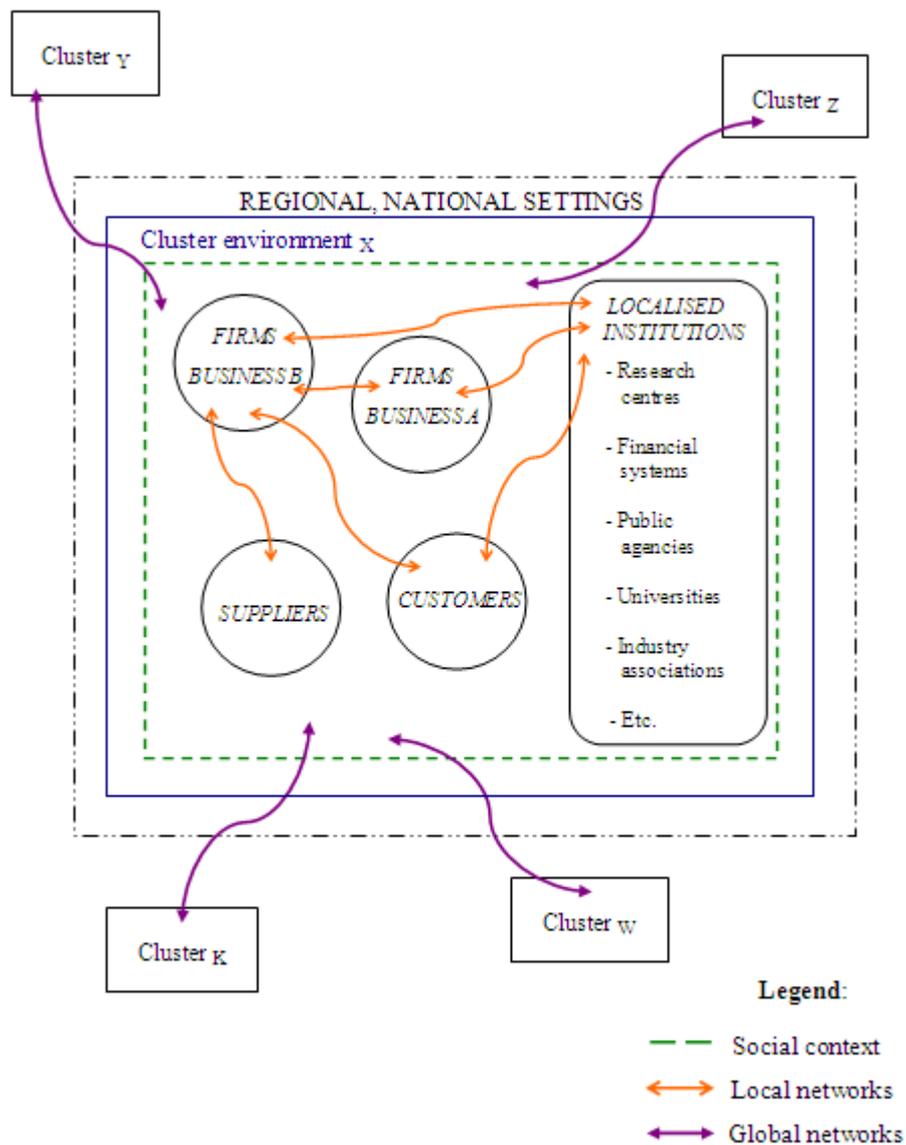


Figure 1: Clusters through the lens of networks

Figure 1 represents schematically the relationship between clusters and networks. Concretely, it reveals the importance of networks for clusters dynamics at two levels: internally by guaranteeing the communication of different but related economic agents; externally by maintaining contact with other dispersed centres of knowledge and innovation. It therefore recognises the existence of networks, both distantly and in proximity. Moreover, the figure also stresses the elements characterising clusters. The *spatial proximity* is represented by the close environment of the cluster; *interrelatedness of activities* is stressed by the indication of firms belonging to different businesses, including suppliers, *interaction* between agents appears in the form of networks, and the *institutional endowment* is typified by the enumeration of some localised institutions.

4. Conclusion

Clusters report to several dimensions - geographical, social, and political - of economic activity, that have been subject of enquiry for decades. Spatial proximity, interrelatedness of capabilities/activities, interaction between agents and institutional endowment are key elements of clusters.

Albeit the consensus in the literature about the relevance of networks for clusters development and success, the exact contents of both networks and clusters and their analytic relationship are far from being clear.

On one hand, one should mention the few signs of communication between the vast, but distinct, bodies of literature that study either networks or clusters. On the other hand, all the literature does not seem to be very clear in terms of the boundaries between network and cluster meanings. In this context, it was possible to conclude that:

Networks are a necessary but not sufficient condition of clusters existence and performance. Therefore, whereas clusters imply the existence of networks, the opposite is not necessarily true.

As a matter of fact, clusters seem to heavily rely on networks as means of creating and exchanging knowledge, reducing uncertainty, accessing new markets/technologies and sharing risks. One can, inclusively, assume cluster structure as a set of networks that promote localized dynamics and, at the same time, guarantee external connections with other relevant concentrations of knowledge and innovation. However, clusters are not confined to networking. On the contrary, they are built around a critical social mass, combining specific institutions and a common culture (including language, values, norms, codes, etc.), which is eminently localized, that is, with spatial roots. Networks, in turn, are not necessarily bounded by geographical proximity.

Notwithstanding the above mentioned remarks we demonstrate in this paper that scrutinizing the network elements involved in clusters contributes to a more rigorous, dynamic and complex definition of the later. As such, we define cluster as

Spatial configurations of economic activity, which articulate a wide range of economic agents who interact in proximity. This combination of capabilities operates under a peculiar institutional frame, which is seen as promoting local competitive advantage, innovation and growth.

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