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When and why companies benefit from collocation in clusters?

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Abstract

The goal is to understand when and how firms access to cluster knowledge. The paper covers this gap by bridging the organization theory and the economic geography, developing fertile cross-field theory which reduces fragmentation and ambiguity and amplifies the cluster theory addressing the role of firms. The paper borrows concepts from the organizational perspective using the dynamic capabilities in conjunction with the absorptive capacity framework. In doing so, the paper criticizes the taken-for-granted assumption that knowledge spillovers (KS) are the unique assets conveying flows of knowledge in clusters, arguing the importance of traded interactions. In addition, the paper explores when and how a co-located firm gains access to the cluster knowledge in order to expand its repository of resources. The paper's discussion is placed at the firm level, addressing the interplay between the un-traded and the traded flows of knowledge and providing insight about the central role of networks.

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Key words: clusters, co-located firms, dynamic capabilities, absorptive capacity, knowledge, networks.

1. Introduction

Despite the growing body of research conducted by scholars about clusters/industrial districts¹ from disciplines which have deepened into this concept emphasizing the potential available involuntary flows of knowledge or externalities², the existing research on clusters is fragmented (into topics and disciplines) and provides conflicting advice for managers and policymakers about how to reap the benefits from co-location and thus upgrade the firms' knowledge and their competitive advantage. Put differently, when and how co-location enables a firm to upgrade its repository of knowledge through accessing to external (to the firm) sources of knowledge in a cluster? This is a simple question not fully answered in the cluster literature. The paper covers this gap research surveying literature about clusters and bridging organizational theory and economic geography. In other words, the purpose of this paper is to develop a general model of firms in clusters. This, at once, integrates the various strands of research and provides a common ground from which further work can proceed, building a consensus between economic geography and organizational strategy and suggesting possible implications which may facilitate the continuing dialogue in the Academia.

Contradicting some of the taken for granted assumptions in the cluster literature, the capabilities and forms in which firms accumulate and recombine knowledge are mainly *firm-specific* (Hervas-Oliver and Albers-Garrigos, 2009) , but the literature does not concentrate on the role of firms

¹ In this work, clusters and the industrial district concept will be used without distinction, although we do recognize differences in both concepts, especially due to the social aspects frequently observed in industrial districts

² Starting with Marshall's seminal work in 1890.

with the same energy (Martin and Sunley, 2003). In this vein, addressing the firm-level, most papers cite the absorption capacity without conducting or addressing empirical exercise (e.g. Tallman et al., 2004). The concept of *absorptive capacity* (AC, hereinafter) (Cohen and Levinthal, 1989;1990:128) is defined as “*the ability of a firm to recognise the value of new external information, assimilate it and apply it to commercial ends*”, and it comes from the strategic management perspective. This idea was earlier advanced by Jaffe (1986) empirical evidence, arguing that the stronger the firms are in their R&D efforts, the better the access to technological spillovers, while weak R&D firms underperformed those stronger ones. Nevertheless, the literature has tended to adopt the idea that AC was automatic, i.e., that just co-located firms, *per se*, take advantage of knowledge externalities (KS) just “*being there*” (Gertler 1995), and the automatic association of distance and access to local resources (e.g. Gertler, 1995; Grabher, 2002) is in line with the cluster tradition of addressing the co-located firms as a *homogeneous* block (e.g. Molina, 2001, Cainelli, 2008). Following this chain of thought, the assumption that collocation means direct absorption of local resources has been criticized with theoretical (Breschi and Lissoni, 2001; Malmberg and Maskell, 2002) and empirical evidence (Lissoni, 2001; Doring and Schnellenbach, 2006; Huber, 2010). Theoretically, absorption capacity means that learning interactions in which a firm can participate are moderated by its own resources which, in part, determine the type and quantity of knowledge accessed. Therefore, geographic distance or co-location, *per se*, do not involve full access to the available externalities (McEvily and Zaheer, 1999) due to moderation exerted by a firm’s own resources (e.g. Hervás-Oliver and Albors-Garrigos, 2009). In this vein, Martin and Sunley (2003:17) seminal critique on clusters connects with the aforementioned idea about of firms and the absorptive capacity concept:

“Ironically, however, the problem here is that the cluster literature, including Porter’s own approach, lacks any serious analysis or theory of the internal organization of business enterprise (Best and Forrant, 1996).”

In addition, and linked to the first blind spot, the aforementioned information debating externalities as a key ingredient of innovation (e.g. Griliches, 1979; Jaffe et al., 1993), is valid *as long as* the referred externalities are an *unintended* transfer of knowledge flows, or using Dosi (1984) and Storper’s (1995) terminology, the *un-traded* relationships. In fact, the mechanisms or channels through which geographical proximity or localized knowledge spillovers may influence firms’ innovative activities remain largely unexplored (Autant-Bernard, 2001; Breschi and Lissoni, 2001a; Audretsch and Feldman, 2004). Carlsson et al. (2002) distinguishes between the *unintentionally* technological spillover, i.e un-traded in the Storper’s (1995) sense, and the *intentional* transfer of knowledge. This division between intentional (traded) and unintentional (un-traded) is fundamental. While the unintentional is mainly covered by the un-traded idea, the

⁶ Traded can be assimilated to transactions and un-traded to spillovers, i.e. voluntary and involuntary forms of knowledge flows.

intentional can be referred to traded (pure or hybrid market-based transaction, as we discuss below) flows of knowledge. In the cluster literature the un-traded flows have been a central part of the theory. Un-traded flows of knowledge are represented by spin-offs, labour mobility and interactions. In this work we have adopted the idea of Scitovsky (1954) to label traded transactions, such as those occurring in a voluntary and pecuniary way. Thus, clusters resources are obtained through informal inter-firm ties and personal interactions (e.g. Camagni, 1991;). Nevertheless, there are also explicit and intended acts of collective learning in networks (Crevoisier, 2004). As such, our paper presents an attempt to cover the gap research manifested in the cluster literature which has been more focused on adopting the un-traded perspective and has conducted less effort on the voluntary and pecuniary transfers of knowledge. As Malmberg and Power (2005) pointed out, there is little evidence of formal linkages on local context.

Our contribution is three-fold. First, recognizing that a firm's architectural knowledge is the key access to knowledge in clusters, our paper goes a step further by incorporating a discussion *at the firm level*, rather than at the inter-firm one, and exploring the antecedents and factors which explain the process to understand *how*, *when* and *why* a co-located firm can achieve different advantage from clusters. Secondly, our work addresses the interplay between the un-intended and the voluntary flows of knowledge. Thirdly, the paper seeks to provide insight about the core conveyor of knowledge in clusters: the networks. In doing so, this paper brings ideas from organizational theory and uses them to make a more comprehensive framework explaining, at the firm level, how knowledge is created in co-located firms in clusters, its drivers, enablers and deterrents. The paper uses the absorptive capacity (AC) and the *resource-based view of the firm* (RBV, hereinafter) (e.g. Penrose, 1959; Barney, 1991) together with the *dynamic capabilities* (e.g. Teece et al., 1997) to develop fertile cross-field theory between the overlapping organization and economic geography perspectives. The organization is as follows: the next section presents a critical survey of the literature on the concept of externalities, unfolding the traded interactions in clusters and, the third section, discusses the concept of absorptive capacity using also the dynamic capability theory. In the last section, the paper offers an integration of the main findings and a conclusion.

2. Externalities “on the air”? Reality and multidimensionality of actors

Externalities or KS have been considered in economic literature as dense tied networks which allow and promote tacit knowledge transmission and trust (Uzzi, 1996), and a paradoxical combination of co-operation and competition in the territory (e.g. Harrison, 1991). Grossman and Helpman (1992:16) defined technological spillovers as firms who can access information created

by others without paying in a market transaction and the current owners have no effective recourse. The rationality of the un-traded or pure KS is that the geographical proximity provides unintentional contacts and interactions which foster the knowledge creation and diffusion and thus the technological learning among the co-located firms is achieved in a more satisfactory way. The agglomeration mainstream (e.g. Dumais, Ellison and Glaeser, 2002) assumes that the localized social and institutional interactions produce KS and affect- the productivity growth in a positive way. Put differently, the local informal networks and the knowledge they convey based on frequent and repetitive interactions sustain the idea of un-traded flows. Nevertheless, as shown below, there is a tipping point in which these expected results may become negative (e.g. Boschma, 2005) and lock-in problems may appear.

The local buzz claimed in the literature, which occurs in the trade associations meetings and training programmes, conferences, fairs, conventions and others, has overtaken the debate and there has been less effort in studying the *traded linkages* which occur on market-based transaction forms. The reason to consider these linkages is because they are also assets in clusters and, at the same time, it is expected, in clusters, that the formal and informal flows of knowledge are to some extent overlapped. Following Breschi and Lissoni (2001) some KS, which appear to be *pure*, are actually pecuniary ones.

The literature pointed out that the KS takes place mainly through local labour mobility, spin-offs and also with interactions between staff of different local firms (e.g. Saxenian, 1994). In the classical literature, the aforementioned KS are separated into two groups, the pecuniary, rent or static externalities, those embracing economies of specialization and labour market economies; and the knowledge spillovers, which clearly represent the technological externalities (e.g. Scitovsky, 1954). In fact, the static or rent externalities, which represent about one-fifth to one-half of the observed geographic concentrations according to Ellison and Glaeser (1999), have been less studied in cluster literature which mainly addresses the KS. This is consistent with the idea that *KS are not the only flows of knowledge available in clusters, neither all clusters produce KS* (e.g. Breschi and Lissoni, 2001), nor all KS can be appropriated by co-located firms (Lissoni, 2001) Quoting Breschi and Lissoni (2001:976):

“...the meaning of the localized knowledge spillovers (LKS)-buzzword...has been recently used as if it could encompass any kind of localized knowledge flows...” “...LKS provides the researcher with an escape route to avoid studying the specific mechanisms through which the two phenomena (geography and innovation) are linked”.

The main problem suggested by Breschi and Lissoni (2001) is the fact that empirical papers do not distinguish pecuniary/static and KS. In fact, it seems that some externalities provided in empirical

papers are knowledge flows mediated by market mechanisms (Geroski and Walters , 1995 cited in Breschi and Lissoni 2001). In addition, there are contributions which assume, rather than prove, the existence of KS (e.g. Feldman and Florida, 1994; Audretsch and Feldman, 1996, Feldman and Audretsch, 1999). For instance, in Feldman and Florida (1994) it is pointed out that tacit knowledge is exchanged across industries by informal contacts. Put differently, it can be argued that in a cluster there are different types of assets and knowledge diffusion mechanisms (e.g. Tallman et al., 2004) in a multidimensional level (e.g. Breschi and Lissoni, 2001; Grabher and Ibert, 2006) not just restricted to KS. Kesidou et al. (2009) addressed this gap while defining a spectrum between the pure local knowledge spillovers and local knowledge transactions, based on the un-traded and traded flows, respectively, observed by Storper (1995). The classification which is offered in Kesidou's⁶ et al. (2009:252) work is as follows (see references in the original work). First, *pure KS*, which is based mainly on individual-level informal interactions between staff from different organizations, horizontal interactions “user-communities” with other firms, interactions with universities and RTOs and interactions in exhibitions & conferences. Second, *quasi KS*, which is firm-level based vertical interactions, interactions with RTOs and horizontal interactions, specially technological ones. This form includes some, at least at the beginning, formal interaction. Third, *quasi knowledge transaction* (interactions with customers) and *pure knowledge transactions* (KT, hereinafter) (purchase of services to consultants, suppliers, etc.).

Reinforcing this chain of thought, in the clusters of Oxfordshire and Cambridgeshire, the empirical evidence proclaims that a significant number of highly skilled scientists and engineers *have no social networks*, especially in the local context. In addition, the non-local (global pipelines) are more abundant (Huber, 2010; Moodysson, 2008; Boshuizen et al., 2009; Romijn and Albaladejo, 2002) than the local ones. These results are in line with those which claimed that (Bunnell and Coe 2001; Lagendijk and Oinas 2005; Trippel et al., 2009) interaction with distant providers of knowledge is also important. Moodysson's (2008) findings reveal that local buzz is largely absent in the Swedish part of the Medicon Valley life science region, where knowledge creation appears embedded in globally configured professional knowledge communities and attainable only by those who qualify. Following this chain of thought, Moodysson and Jonsson (2007) state that global knowledge collaboration is indispensable for most biotech firms in the same mentioned cluster, i.e. the local collaboration can never replace the necessary specialized knowledge found on a global arena. Finally, corroborating results in biotech firms in the Netherlands, Van Geenhuizen (2008) found that local/regional and global networks tend to coexist in clusters, although it is a fact that knowledge networks trend are increasingly shaped on a global scale. Complementary

conclusions are evidenced in Huber (2010) about the fact that the role of personal knowledge networks within the (Cambridge) cluster is limited, lessening the importance of social capital in clusters, and personal interactions mainly occur outside the cluster.

3 Integrating the firms' knowledge base to take advantage of clusters

3.1 Reinforcing heterogeneity in clusters

Following Lagendijk (2006) the debate in clusters should keep the right balance between more structural aspects and the pervasive role of difference and heterogeneity and diversity (Moulaert and Sekia, 2003), i.e. firms. As Boschma and Wal (2007) point out, the almost neglected concept of firms in clusters is based on the lack of recognition of their variety and heterogeneity of resources taking as starting point the argument of Nelson and Winter (1982), which claims that firms largely differ in their capabilities, strategies, and routines. Within the economic geography literature, and contrary to the idea that all cluster firms benefit from local resources, Malmberg (2001) and Boschma and Lambooy (2002) pointed out the heterogeneity across cluster firms in terms of capabilities which will moderate the access to clusters' resources. The latter idea is linked to the fact that several studies have initiated the idea that co-location is not sufficient (Camagni, 1991; Boschma, 2005), and the firms' characteristics really matter (e.g. Hervas-Oliver and Albors-Garrigos, 2009).

In this vein, the question about whether *all* co-located firms can access and exploit the external available resources or externalities in clusters has been revised and discussed recently (e.g. Giuliani, 2007; Hervas-Oliver and Albors-Garrigos, 2009). Despite the efforts, the geography of innovation linkages is still a debated issue (Belussi et al., 2009), and the lack of rigorous research in the cluster literature about firms (Martin & Sunley, 2003) is paradoxical due to the fact that there are some non-proved assumptions taken-for-granted. Thus, Bathelt (2005:206) states that:

“...automatically exposed to news reports, gossip, rumors and recommendations about technologies, markets and strategies by just being in the cluster”.

In other words, co-located firms take advantage of these externalities just “*being there*” (Gertler 1995), and thus distance means access (e.g. Gertler, 1995; Grabher, 2002). In addition, most of the literature on clusters have not empirically backed the aforementioned assumptions (see Malmberg and Maskell, 2002; Breschi and Lissoni, 2001; Doring and Schnellenbach, 2006; Huber, 2010). We argue that this ambiguity can be solved by introducing the theory from the organizational perspective, as Tallman et al. (2004) did. This firm-based approach can enrich the economic geography perspective. Similarly, the concept of embeddedness in networks, rather than in the “whole cluster,” is also mentioned in Gulati (1998) as the routinization and stabilization of

linkages among members (of the network) as a result of a history of exchanges and relations within a group or community. The point is interesting because most of the alliances described in the strategic literature occur among firms and have an important formal or contractual form. Put differently, the geographic space represents an environment which fosters potential alliances, but the decision and intention is based on the firm or its individuals.

It is claimed that the fertile context found in the cluster provides a competitive advantage to the co-located firms which use the *passive and collective efficiencies* (Bell et al., 2009) in a *restricted way* (e.g. Saxenian, 1994). Put differently, the technological opportunities in clusters *vis-à-vis* with scattered locations provide an advantage due to the existence of interactions (e.g. Storper and Venables, 2004). This conversation referred to the co-located firms as a homogeneous block (e.g. Molina, 2001). This is exactly the opposite to the heterogeneity concept claimed in the strategic management perspective (e.g. Nelson, 1991), clusters (in the sense of Tallman et al., 2004; Jenkins and Tallman, 2010:608) or industrial dynamics (Klepper, 2007; Menzel and Fornahl, 2009) perspectives. Put differently, the firm-specific resources and capabilities or architectural knowledge (Tallman et al., 2004) moderate the access and exploitation of local knowledge, i.e. innovation externalities from the cluster benefit members unequally.

3.2 The process of managing external knowledge to reinforce competitive advantage in firms

3.2.1 Understanding knowledge creation in firms

We use the RBV and the AC in order to understand how a firm builds its repository of knowledge ; and the *dynamic capabilities* (Teece et al., 1997) to understand how companies manage their resources to create rents. As a starting point and for the sake of simplicity, the point is to deconstruct the processes by which firms create knowledge. As Morrison (2008:18) says

“ A large part of the literature seems to take it for granted that industrial districts are able per se to translate and share external knowledge....the literature rather overlooks some of the key issues concerning the specific mechanisms and actors through which learning and knowledge diffusion occur within districts”

The learning mechanism (e.g. Edquist, 1997) based on inter-firm and inter-personal interactions create a source of knowledge which gives a chance to the firms to recombine and deploy the new knowledge into its existing expertise, extending the available knowledge in the firm. This *synergistic effect* between external and internal flows of knowledge (Lee et al., 2001) upgrades a firm's repository of knowledge. In addition, this synergistic effect of combinations and re-combinations of knowledge from multiple interactions is expected to be more intensive in clusters (Hervas-Oliver and Albors-Garrigos, 2009), due to the fact that co-located firms are engaged in

frequent interactions (Storper and Venables, 2004; Tallman et al., 2004; Arikan, 2009). At this point, our purpose consists of combining the firm-based and the cluster-level perspectives to deconstruct the aforementioned process of creation, diffusion and amplification of (architectural) knowledge in co-located firms.

The RBV (e.g. Penrose, 1959) and the relational view (Dyer and Singh, 1998) are bridged by the absorptive capacity concept (Cohen and Levinthal, 1990) and explain, at least in part, the aforementioned process of knowledge creation and learning in the territory. In addition, dynamic capabilities are referred not just to firm's resources, but the ability "to continuously create, extend, upgrade, protect, and keep relevant the enterprise's unique asset base" (Teece, 2007:1319). Put differently, how a company manages its resources to ensure sustainable competitive advantage, or in Zott's (2003:120) view, "dynamic capabilities are more than a simple addition to resource based view since they manipulate the resources and capabilities that directly engender rents". This is similar to the capability to re-generate and re-configure a firm's architectural knowledge, ensuring that the necessary flows of knowledge are acquired and managed. Following Teece (2007: 1319), dynamic capabilities can be disaggregated into the capacity (1) *to sense and shape opportunities and threats*, (2) *to seize opportunities*, and (3) *to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets*. Then, these different stages are going to be associated to the absorptive capacity construct to understand better the creation of knowledge process. Therefore, AC and dynamic capabilities are going to be used together in order to framework the process of creation of knowledge.

3.2.2 Sensing and exploring knowledge: the search strategy

Sensing means the scanning, exploration and recognition of opportunities, both local and distant ones (March and Simon, 1958 in Teece et al., 2007), i.e. in the local buzz and the global pipelines. This is similar to *absorptive capacity* (Cohen and Levintal, 1990) identification process. This process of recognition is a function of the human resources in organizations, as well as their organizational routines (e.g. Lane et al., 2006), i.e. analytical and personal capacities to monitor, filter and so forth.

The core elements of a firm's search strategy are innovation inputs from external sources such as suppliers, clients, competitors, universities and research transfer offices (e.g. Katila and Ahuja). The innovating firm's ways of accessing knowledge from external channels are named *open search strategies* (Larusen and Salter, 2006) and have been extensively discussed in the economics of innovation literature. Nevertheless, the search strategy becomes crucial to innovation when a

firm is capable of identifying and valuing the potential value of certain external knowledge. This capacity, as mentioned in Grimpe and Sofka (2009) is a part of the Cohen and Levinthal's (1989; 1990) absorptive capacity construct. In fact, a firm's network of relational resources of knowledge, i.e. interactions or co-operations with other organizations, becomes vital because innovation is often in practice a collaborative process embedded in innovation systems (Lundvall, 1992). The process of effective searching (e.g. Pisano, 1990) requires absorptive capacity and also relational capabilities (Lane and Lubatkin, 1998).

3.2.3 Seizing and accessing knowledge: the Relational view and the management of networks

Loasby (1998:883) developed the idea of *indirect capabilities* based on Richardson's (1972) definition of industrial system as "dense networks of cooperation and affiliation by which firms are inter-related". Indirect capabilities are the necessary resources or capabilities not directly employed for productive purposes to interact with other firms. This concept is similar to the one described in Barney (1991) about the organizational capabilities based on Tomer (1987) which are part of the firms' resources, such as the coordination systems between firms and their environments. Therefore, accessing external sources of knowledge requires that a firm should manage and develop the capabilities required to seize market and environment's opportunities. This idea is well rooted in the dynamic capabilities view (Teece et al., 1997) which suggests that:

"Enterprises with strong dynamic capabilities are intensely entrepreneurial. They not only adapt to business ecosystems, but also shape them through innovation and through collaboration with other enterprises, entities, and institutions (Teece 2007, p.1 de 32)".

"Enterprises with good dynamic capabilities will have entrepreneurial management that is strategic in nature and achieves the value enhancing orchestration of assets inside, between, and amongst enterprises and other institutions within the business ecosystem." (Teece, 2007, p.26 de 32)

Access to external local knowledge by co-located firms may be easier due to the trust, mutual understanding or the use of the same language and values which occur in the local context (e.g. Becattini, 1990). It is important to note that within a firm's resources **the social capital asset** (in the sense of Uzzi, 1996: trust based on social relationships and continuous interactions) is a vital driver, different from just geographically distance concept, *moderating the access to local knowledge and interaction* (e.g. Boschma, 2005; Jenkins and Tallman, 2010).

This is highly dependent on the relational point of view that (e.g. Dyer and Singh, 1998:672) a firm's decision to access to external knowledge is influenced by the complementary knowledge of potential partners and a partner's relational capability, *i.e., a firm's willingness and ability to*

partner. Following Dyer and Singh (1998:662) the justification of the relational rents which may be achieved in the partnerships are classified into four categories:

1. *Investments in relation-specific assets;*
2. *Substantial knowledge exchange, including the exchange of knowledge that results in joint learning;*
3. *The combining of complementary, but scarce, resources or capabilities (typically through multiple functional interfaces), which results in the joint creation of unique new products, services, or technologies; and*
4. *Lower transaction costs than competitor alliances, owing to more effective governance mechanisms.*

As Dyer and Singh (1998:662) established, a relational rent is *as a supernormal profit jointly generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners*. To be more specific, we are looking for these rents when a firm makes interactions in clusters, which are the *proper institutional environment that encourages or fosters trust among trading partners (i.e., has effective institutional "rules" or social controls for enforcing agreements) may facilitate the creation of relational rents* (North, 1990 in Dyer and Singh, 1998:673). Put differently, the relationships with other firms are unique resources of new ideas and information which create value (e.g. Dyer and Singh, 1998).

Then the assimilation process depends on the structural organization in firms (e.g. Szulanski, 1996). In so doing, it is necessary to unfold how knowledge is seized and assimilated. Contrary to the idea that the knowledge is in the air (e.g. Marshall, 1920) and other taken for granted assumptions (just “*being there*”, Gertler, 1995) the diffusion process just occurs within **networks** (e.g. Morrison, 2008) and the knowledge is a “club-good” in the sense of Breschi and Lissoni (2001). The low development **of networks** (Malerba, 2006) in clusters is a major constrain to the development of the field. The knowledge, rather than circulating freely, is constrained within small epistemic communities (Steinmueller, 2000), which are characterized by multiple-level networks (Giuliani 2007) and is not available to every firm in clusters (e.g. Breschi and Lissoni, 2001). How does knowledge circulate in clusters? Extending the important efforts conducted by Tallman et al. (2004), understanding the creation and circulation of knowledge in clusters requires focus on several enablers or drivers. First, the knowledge base of a co-located firm moderates the knowledge access (e.g. Giuliani, 2007) and the creation of the network (Ahuja, 2000). Following Ahuja (2000), about the formation of strategic alliances depends on how opportunities are expected by partners. Following Von Hippel (1987) when a firm transfers knowledge, then *reciprocity* is the expected pay-off. Put differently, as Giuliani (2007) suggests the firms with more advance knowledge are more likely to exchange knowledge, remarking the cluster strategic heterogeneity of co-located firms.

Thus, firms with a strong knowledge base are attractive to be connected to due to the potential source of learning what they may offer, while weaker firms in terms of knowledge are not attractive partners (Giuliani 2007). This idea is well rooted in the idea of reciprocity [e.g. Von Hippel, 1987]. Therefore, the firms' resources will moderate the knowledge accessed (e.g. Hervas-Oliver and Albors-Garrigos, 2009), and the alliances formation to access and create networks.

In addition, a part of a firm's knowledge base, affinity between firms' knowledge is also required, i.e. the knowledge structure (Zhang and Liu, 2009). Knowledge structure is based on the cognition concept of *schema* (e.g. Bartunek, 1984), and it is referred to as the way in which a firm perceives, interprets and analyzes (Walsh, 1995) the information accessed. Thus, a firm's knowledge structure or schema is that related to a certain type of a firm's function (technology, business, markets, etc.). Following Zhang and Liu (2009), firms with similar schemas belong to a cognitive community and in clusters it means that the firms have similar or compatible knowledge structures in order to organize, understand and solve cluster-related problems. The *cognitive community* (see references in Zhang and Liu, 2009) differs from the community of practice and produces a blocking and filtering effect on the process of knowledge diffusion within clusters. The Zhang and Liu's results pointed out that knowledge diffusion in clusters is better conveyed through firms in cognitive communities, i.e. firms who have a similar knowledge structure or scheme, which occurs especially in contexts of high level and low heterogeneity of knowledge distribution among firms. Thus, the higher the knowledge heterogeneity, the lower the knowledge diffusion in networks is expected. This connection between cognitive distance and innovation performance is an inverted-U shaped relationship [e.g. Nooteboom, 1992)] which established that the cognitive distance between firms is beneficial to innovate. Nevertheless, at a certain point cognitive distance becomes so large as to preclude sufficient mutual understanding and the expected outcome is negative. In Nooteboom (2007:1017) words, "*the challenge then is to find partners at sufficient cognitive distance to tell something new, but not so distant as to preclude mutual understanding*".

From the network and alliances literature, the inverted U effect is connected to the of *similarities between learning partners* (Ahuja & Katila, 2004). In this sense, it is evidence that far-knowledge interactions do not work but too close or related knowledge also are errors (Ahuja & Katila, 2004), suggesting a curvilinear relationship also documented in Levinthal and March (1993). These *too-much or too-distant* implications is familiar with the different concepts of proximity stated in Boschma (2005). In fact, according to the distance classification offered in Boschma (2005:62) it is claimed that "...too much and too little proximity (cognitive, organizational, social, institutional and geographical) may be harmful for effective interactive learning and innovation".

The main reasons or motivations (e.g. Kogut 1988) to form an alliance are: (1) reduction of transaction costs, (2) enhance the competitive positioning or market power, (3) learning. A strategic alliance is commonly defined as any voluntarily initiated cooperative agreement between firms that involves exchange, sharing, or co-development, and it can include contributions by partners of capital, technology, or firm-specific assets (e.g., Harrigan, 1988). Gulati (1999) pointed out that the accumulated network resources arising from firm participation in the network of accumulated prior alliances are influential in firms' decisions to enter into new alliances. This study highlights the importance of *network resources* that firms derive from their embeddedness in networks for explaining their strategic behaviour. *Network resources* result from the informational advantages they obtain from their participation in inter-firm networks that channel valuable information. A network of embedded ties accumulated over time can become the basis of a rich information exchange network that enables firms to learn about new alliance opportunities with reliable partners (e.g. Kogut, Shan, and Walker, 1992). Following Gulati (1995a), the interdependence moderates the formation of alliances. Thus, *strategic interdependence* between organizations describes a situation in which one organization has resources or capabilities beneficial to but not possessed by the other. As Hage and Aiken (1967: 914-915) claimed (in Gulati 1995a) the interdependence is described when organizations "because of their need for resources-not only money, but also resources such as specialized skills, access to particular kinds of markets, and the like."

In addition, Gulati (1995a;1998) stressed the key importance of the *structural embeddedness* to refer to the social ties or networks which underpin alliances, channel information and foster new alliances due to the frequency of past alliances and interactions and sharing common third-parties within the network which can constitute future alliances (Gulati 1995a). Evidence from previous research on strategic alliances suggests that the benefits of experience can translate into specific skills on the formation and management of alliances (e.g. Dyer and Singh, 1998). Once firms begin to enter alliances, they can internalize and refine specific routines associated with forming such partnerships. Put differently, past alliances give to the focal company skills and abilities about alliances formation and management of networks, while at the same time the social aspect of the network and the frequent and past (in a path dependence process) interactions also influences the likelihood to repeat the formation of alliances (due to the skills learned to manage them), increase the probability to repeat with the same partners (due to the trust and social aspect generated) and also acquiring network resources (information) which also may moderate the selection of other partners for future alliances from common third-parts from the existing network.

In addition, the social consideration of the network is also an approach to understand dynamically a network. In this vein, Gulati (1998) pointed out that each network or alliance should be understood in a dynamic way due to the “social network structure” that the economic relationship enable, meaning that repeated alliances and the process resulting from prior interactions will influence the future of the alliances and also allow more interactions and alliances based on the social network structure. A social network can be defined as ‘a set of nodes (e.g., persons, organizations) linked by a set of social relationships (e.g., friendship, transfer of funds, overlapping membership) of a specified type’ (Laumann, Galaskiewicz, and Marsden, 1978: 458). As pointed out by Marsden (1981), embeddedness is referred to the fact *that exchanges and discussions within a group typically have a history, and that this history results in the routinization and stabilization of linkages among members. As elements of ongoing social structures, actors do not respond solely to individualistically determined interests % a structure of relations affects the actions taken by the individual actors composing it. It does so by constraining the set of actions available to the individual actors and by changing the dispositions of those actors toward the actions they may take.* (Marsden, 1981: 1210)

Following this chain of thought about evolutionary networks, Khanna et al. (1998) suggested that the evolution of the networks depends on the overall pattern of partner firms’ activities, due to the fact that the common benefits of a particular firm are the proportion of this value that the firm appropriates. Put differently, a company can benefit from the common benefits and thus increase its private benefits when the company has more opportunity to apply what it has learned to other business outside the scope of the alliance. To some extent, it can be argued that the greater the overlap between the alliance scope and firm scope, the higher the common benefits and thus the learning is more difficult to be translated to other business in the participating firms due to their inexistence, lowering the potentiality to reap private benefits for each company.

3.2.4 Combining and amplifying knowledge

The last stage in dynamic capabilities theory is combining and reconfiguring a firm’s knowledge base with the new flows of knowledge to sustain competitive advantage. This is similar to the exploitation stage in the AC framework, in the sense that the recombined knowledge may create outputs to innovate in product or processes. The point is, once the company has learned, how can the company reap the benefits of the innovation? Following Teece (1986) some *complementary assets* are required. Put differently, the firm requires *appropriation strategies*. In this vein, Teece (1986) points out that the boundaries of the firm are an important strategic variable for innovating firms, i.e. a firm’s business strategy - particularly as it relates to the firm's decision to integrate and collaborate - is shown to be an important factor to appropriate innovation. In fact, it is also shown

how the *complementary or specific assets* in companies can moderate the appropriation of rents from innovation and thus imitators or other industry participants may benefit from the flows of knowledge. Following Teece's (1986:288) examples about how firms appropriate innovations it seems clear that the company which innovates can be winner (retaining fully the knowledge) or loser (imitators appropriate and use their complementary assets). For instance, *the commercialization of a new drug is likely to require the dissemination of information over a specialized information channel. In some cases, as when the innovation is systemic, the complementary assets may be other parts of a system.*

4 Conclusions and open questions

The purpose of this paper is to develop a general model of firms in clusters in order to explain when and how they access to external (to the firm) knowledge and thus upgrade their competitive advantage. For this purpose, the paper analyzes two gaps research in clusters surveying literature in a critical perspective and linking the organizational and economic geography perspectives. First, the paper criticizes the taken-for-granted assumption that knowledge spillovers (KS) are the unique assets conveying flows of knowledge in clusters, arguing the importance of traded interactions based on market transaction conditions. Thus, the paper denounces the fact that externalities, as un-traded interactions conveying flows of knowledge, are the unique valuable resource in clusters, without taking into account the voluntary or intended (traded) ones, and thus challenging the fact that un-traded interactions are the unique assets conveying flows of knowledge in clusters. Secondly, the paper explores when and how a co-located firm gains access to the cluster knowledge in order to expand its repository of resources. This work questions the assumptions that all co-located firms have absorptive capacity to access the available knowledge which is reduced to un-traded informal interactions made of tacit knowledge. And third, the paper provides insight about how the circulation of knowledge occurs in clusters through the networks.

This paper has constructed a comprehensive theoretical framework in which the economic geography is linked to the organizational perspective synthesizing and integrating the cluster theory in order to deepen our understanding about how a firm can take advantage of co-location. Thus, the paper builds consensus between the economic geography and the organizational theory, developing fertile cross-field theory which reduce fragmentation and ambiguity, amplifying the cluster theory. Results from the literature survey reduce much of the ambiguity and clarify some blind spots in the cluster literature. We leave examination of cluster-level to others and focus instead on how a co-located firm possesses advantage through its search strategy from the available resources in clusters.

Deconstructing the process of knowledge creation at the firm level when taking advantage of external knowledge in clusters, has shown how important a firm's knowledge base is in order to access networks or clubs of knowledge, which are the truly high-way through which knowledge flows in clusters, a part of the required social capital in order to understand the cluster's architectural knowledge (in the sense of Tallman et al., 2004). In addition, the access of knowledge does not mean direct exploitation but companies need to transfer it throughout their organizational structures and recombine it with their own knowledge base in order to appropriate as much as possible. As described above, the dynamic capability and the absorptive capacity theory are very similar and connected to the relational view to give more insight in the explanation about how firms can take advantage of clusters and thus expand and amplify their knowledge base to sustain and maintain their competitive advantage.

In addition, the paper pointed out the importance of networks, arguing that knowledge is not in the air but embedded in communities of practice. Thus, the access to networks in which the knowledge flow is not just a matter of distance (Boschma, 2005) or social capital (Uzzi, 1997), but it is highly dependent on a firm's indirect capabilities or relational assets, its complementary knowledge of potential partners and a partner's relational capability (Dyer and Singh, 1998), its complementary assets (Teece, 1986) to appropriate innovations, its cognitive community or schema (Zhang and Liu, 2009) and its expected reciprocity (Von Hippel, 1987) in the network. In addition, and following Gulati (1995a; 1999) the past alliances between two firms, the common third-party ties (in absence of prior direct ties between two partners), as well as the firms' interdependencies, are important factors which influence the likelihood to engage in networks and thus exchange knowledge. Lastly, the critical analysis of the literature has also revealed the key importance of personal interactions complementing the inter-firm level, the emerging debate on the formal and traded commercial partnerships and deals (with suppliers, universities, public labs., and so forth) which are also assets available in clusters and constitute important flows of knowledge, both individually or in combination and support with the un-traded KS.

The results also present and highlight important insights for policymakers. Thus, following the granted assumption that the knowledge is on the air within the cluster and not looking at the specific networks, companies and their knowledge repositories, among other factors, can arguably lead to naïve policy implications (Breschi and Lissoni, 2001) and the managerial and policymaking implications can be focus on the cluster rather than the networks or epistemic communities (Lissoni, 2001) in which externalities occur, addressing the complex and intertwined nature of traded and un-traded knowledge and paying more attention to the knowledge structure

compatibility and the appropriability conditions to be developed by firms. Especially, much effort should be devoted on addressing the firm-level and its role in clusters.

In addition, there are some questions which still remain open, offering interesting research avenues for future research. First of all, the key question about how knowledge is transferred within a geographical area is still debatable, recognizing the efforts by Tallman and colleagues' works. In this case, it is important to disentangle the personal, network, firms and cluster levels. Second, and following Breschi and Lissoni (2001) work, the epistemic networks and their access remains vital to understand the flows of knowledge among cluster members and thus the role of getting to know more about how networks work can be translated and imported from the organizational theory to enrich clusters. It is also necessary to explore when distance is not necessary to tap into local knowledge (see Jenkins and Tallman, 2010), especially in the global-pipeline circuit. It should be also interesting to address the different types of clusters and their coordination mechanisms (see Arikan and Schilling, 2009). Lastly, it would be important to consider in the agenda for future research the fact that the type of knowledge created in clusters, analytical versus synthetic, and their relation with the type of regional innovation systems.

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