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# Cluster connectivity and inter-cluster alliance portfolio configuration in knowledge-intensive industries

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**Abstract.** This conceptual paper examines factors that shape inter-cluster alliance portfolio configuration in knowledge-intensive industries. Drawing on the resource-based view, the dynamic capabilities approach, and social network theory, we propose that the configuration of an inter-cluster alliance portfolio is determined by a cluster's alliance capacity and needs, which are themselves shaped by its resources and capabilities, its alliance strategy, and environmental conditions. This research contributes to the growing literature examining cluster connectivity – a configuration of cluster linkages – and helps advance understanding of the conditions clusters should consider when building their cluster-level connectivity through inter-cluster alliances.

**Keywords:** cluster, connectivity, inter-cluster alliance, alliance portfolio, alliance portfolio configuration

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## INTRODUCTION

The literature has widely accepted the idea that innovation, knowledge creation, and learning are strongly stimulated in areas with a high concentration of actors exchanging information through interactive processes (Boari, Elfring & Molina-Morales, 2016a; Malmberg & Maskell, 1997). Research has demonstrated that spatial clustering favors the 'local buzz,' an "information and communication ecology created by face-to-face contacts, co-presence and co-location of people and firms within the same industry and place or region" (Bathelt, Malmberg & Maskell, 2004: 38). However, as industries and technologies become more global, local ties need to be complemented by global links (Bathelt et al., 2004; Owen-Smith & Powell, 2002) to obtain access to external knowledge bases. Through external links, a cluster can "'hook on to' the global production and innovation system" (Lorenzen & Mudambi, 2013: 502) thus favoring the transfer of codified knowledge (Bathelt et al., 2004), which entails more formal ways of connecting than those created locally.

Prior research studying cluster connectivity – the configuration of links through which a cluster is connected to external partners – has identified two types of links: person-based and organization (firm)-based (Lorenzen & Mudambi, 2013). However, a third type of increasingly important inter-cluster link has emerged – between clusters as entities, typically in the form of inter-cluster alliances. While person-based and organization-based links connect people and firms with counterparts in other clusters, inter-cluster alliances enable a greater number of people, firms, research labs, and other organizations to benefit from cross-cluster partnerships (Colovic & Lamotte, 2014). This is particularly appealing in knowledge-intensive industries, as research has demonstrated that

bridging ties with other clusters improves innovation-related outcomes in a cluster (Boari, Elfring & Molina-Morales, 2016b).

Because knowledge is often dispersed geographically, clusters increasingly form multiple alliances to access knowledge worldwide (Cantwell & Piscitello, 2015). This requires clusters to create, develop, and sustain multiple alliances, filling them with 'content,' in other words instilling knowledge exchange and joint knowledge creation as part of their alliances. Clusters are also under pressure to connect with multiple partners (build an alliance portfolio) from environmental conditions, such as inter-cluster competition to access the knowledge of other clusters, or rapid change in the environment. This leads to a certain tension, as clusters need to develop several partnerships simultaneously and, at the same time, avoid wasting resources in ineffective partnerships.

The increasing commitment of clusters to inter-cluster alliances is readily observable worldwide[1]. At the same time, there is a clear lack of understanding of which factors clusters should consider when they design their alliance portfolio, as, surprisingly, the literature has paid little attention to cluster-level linkages despite their development in the business world. Consequently, to advance understanding of cluster-level connectivity, this paper aims to answer the following research question: *What determines a cluster's alliance portfolio configuration?* Our approach to answering this question is conceptual and we aim to develop a model of determinants of alliance portfolio configuration. We understand clusters as organized groups of actors – firms, research laboratories, educational institutions – located in a limited geographical area, and whose activities are managed and coordinated by a dedicated 'cluster management team.' Clusters are a kind of networked organization. Although business-related alliances can also be formed between clusters, our investigation focuses on alliances involving knowledge-intensive activities, because such alliances require more formalization and have mainly higher-order goals, such as enhancing a cluster's competitive profile through large-scale, knowledge-intensive inter-cluster cooperation. In line with previous research (Hoffmann, 2005, 2007; Lavie, 2007; Lavie & Miller, 2008), we define an inter-cluster alliance portfolio as the aggregate of all of a focal cluster's inter-cluster alliances, or as a focal cluster's egocentric alliance network (Wassmer, 2010). Alliance portfolio configuration refers to "the content of an alliance portfolio and its arrangement" (Wassmer, 2010: 150).

Our research builds on three theoretical approaches. The first is social network theory (Burt, 1992, 2005; Granovetter, 1973; Kilduff & Tsai, 2003; Nohria & Eccles, 1992), which has been used extensively to study alliances (Gulati, 1999; Gulati, Nohria & Zaheer, 2000; Powell, Koput & Smith-Doerr, 1996) and spatial clustering (Breschi & Malerba, 2001; Lorenzen & Mudambi, 2013; Owen-Smith & Powell, 2002). The second approach is the resource-based view (RBV) (Barney, 1991; Wernerfelt, 1984), which, applied at cluster level, can provide important insights about how a cluster's resources and competencies determine its alliance capacity and desirability as an alliance partner. Lastly, we draw on the dynamic capabilities approach (Teece, 2014; Teece & Pisano, 1994), and consider that dynamic capabilities allow a cluster to adapt its resources and competencies purposefully to ensure strategic renewal and adapt to the changing environment.

Our contribution to the literature is twofold. First, we shed light on the growing phenomenon of inter-cluster alliances, focusing in particular on the alliance portfolio. Although cluster connectivity has attracted academic

1. For example, see 3 Bi (Brokering-Bio-Based Innovation) – www.3bi-intercluster.org; European Aerospace Cluster Partnership – www.eacp-aero.eu; the partnership between Japanese and French biomedical clusters –competitivite.gouv.fr/japon/un-nouvel-accord-de-partenariat-entre-clusters-japonais-et-biopoles-francais-336.html; the life sciences partnership between Quebec and Ontario – Ontario-Quebec Life Sciences Corridor –www.nce-rce.gc.ca/ReportsPublications-RapportsPublications/ExcelleNCENewsletter-BulletinExcellence/v4_i4/CQDM_eng.asp, or a formal partnership between several cities in the greater Boston region – The Life Sciences Corridor – lifesciencescorridor.com.

interest in recent years (Cano-Kollman, Cantwell, Hannigan, Mudambi & Song, 2016), cluster-level linkages, despite being widespread in practice especially among policy-driven clusters, remain under-researched. We thus advance understanding of cluster connectivity by adding the notion of cluster-level connectivity to previous research that analyzes person- and firm-level linkages (Bathelt et al., 2004; Lorenzen & Mudambi, 2013) and respond to the call for more research into "the processes of connectivity" (Cano-Kollmann et al., 2016: 257). Second, we propose a framework of determinants of inter-cluster alliance portfolio configuration to guide future research. While building on insights from alliance research, our framework is distinct from existing frameworks in that it focuses on the particular case of clusters and accounts for their unique characteristics. At managerial level, we believe that this research can help cluster management teams aiming to improve their cluster's knowledge connectivity. Management teams are under pressure to build their cluster's alliance portfolios; however, (i) understanding of what determines an (optimal) portfolio configuration remains very poor, and, (ii) there is a lack of tools to guide clusters through the process of alliance portfolio formation. The model that we build in this research is one tool that could guide clusters in that process.

## LITERATURE REVIEW

### CLUSTERS AND GLOBAL LINKS

Clusters encompass numerous resources and skills that firms can use to strengthen their resource endowment, improve their knowledge base, innovate, and develop internationally (Audretsch & Feldman, 1996; Libaers & Meyer, 2011). These resources and skills reside not only in local, home-country firms, but also in subsidiaries and affiliates of multinational enterprises (MNEs) located in clusters, which participate actively in local interactions (Beugelsdijk & Mudambi, 2013; Birkinshaw & Hood, 2000; Cantwell & Piscitello, 2015).

In clusters, people and organizations are embedded in networks (Al-Laham & Souitaris, 2008; Boari et al., 2016b), giving them access to additional assets, market or industry-specific information, and expertise. Network embeddedness leads to the creation of a specific cluster ecosystem of resources and competencies, in which dynamic interaction between the cluster's actors creates new knowledge and enhances innovation (Giuliani, 2007; Grabher & Powell, 2004). Interaction and information exchange within the cluster constitute the 'local buzz' (Bathelt et al., 2004), arising from physical co-presence. Local buzz includes both the broad conditions that exist in industrial clusters, the 'atmosphere,' and more diffuse forms of knowledge acquisition that arise from chance encounters and the fact of being in the same location (Wolfe & Gertler, 2004). It is conducive to the transfer of tacit, sticky knowledge (Bathelt et al., 2004), because this type of knowledge requires relational embeddedness and extensive interaction between actors (Nonaka & Takeuchi, 1995).

While local interactions facilitate information exchange and knowledge transfer within a cluster, they are not sufficient to keep pace with worldwide technological advancement (Bathelt et al., 2004; Boari et al., 2016b; Cantwell and Piscitello, 2015). Therefore, clusters need to develop global links (Gertler & Levitte, 2005; Martin & Sunley, 2006) or global pipelines (Bathelt et al., 2004). Because these links allow in- and outflows of resources, information, and knowledge (Lorenzen & Mudambi,

2013), they can provide the cluster with much needed access to valuable knowledge in other clusters. However, although these global links can provide clusters with significant benefits, they are not without challenges, particularly with regard to formation, development, and management. Just like individual firms partnering with their counterparts when building global pipelines, clusters need to choose the right partners, determine what information should be disclosed or kept confidential, allocate necessary resources to the alliance, and decide about joint activities and monitoring. The major challenge of external linkages is finding the right trade-off between cooperation and competition, and investing accordingly (in human, financial, technological, and other resources). Because of this 'planned,' more formal relationship, knowledge transferred through global pipelines is codified rather than tacit; interaction via global pipelines is oriented toward specific goals and is more focused; and risks and costs are greater as is the need for advanced planning and monitoring (Bathelt et al., 2004).

Lorenzen and Mudambi (2013) argue that the configuration of global linkages constitutes 'cluster connectivity.' They propose that, in addition to global pipelines, which can be considered as organization-based linkages, inter-cluster linkages can be person-based. While organization-based linkages are created to move resources across space by creating organizational commonality, person-based linkages are based on social proximity, kinship or friendship (Lorenzen and Mudambi, 2013). Building on these insights, and the aforementioned observations of cross-cluster linkages in the business world, we contend that cluster connectivity should be extended and defined as a three-level phenomenon: person-level, organization (firm)-level and cluster-level. Cluster-level partnerships typically take the form of agreements or alliances, and clusters frequently form a number of these alliances to tap into local knowledge endowments of different clusters.

Therefore, the literature on clusters and their global linkages points to an increasing connectivity between clusters, combining resources and competences, tapping into knowledge sources worldwide, and developing new areas of expertise. In the business world, in addition to person-based and organization-based connections, clusters are increasingly connecting at cluster level, forming inter-cluster alliances.

## FROM A SINGLE ALLIANCE TO ALLIANCE PORTFOLIOS

Alliances are formed when combining partners' resources and capabilities can lead to joint value creation (Bucic & Gudergan, 2004; Kogut, 1988; Pérez & Cambra Fierro, 2018). They are voluntary arrangements between independent entities involving exchange, resource sharing, and co-development or provision of products, services or technologies (Gulati, 1999). Research on alliances has relied extensively on social network theory to highlight the importance of external resources, available through networks (Gulati, 1999; McEvily & Marcus, 2005). Findings indicate that networks provide access to information, resources, markets, and technologies (Gulati et al., 2000), together with learning opportunities. It has been argued that the ability to access and use others' knowledge can significantly enhance performance (Dosi, 1988).

According to the RBV, alliances are used to link complementary resources and to create synergies by pooling or transferring such resources (Ahuja, 2000a; Eisenhardt & Schoonhoven, 1996). Consequently, an organization's resource endowment plays a fundamental role in its alliance strategy and ability to attract alliance partners

(Eisenhardt & Schoonhoven, 1996). Among the different types of alliances, technological alliances extend the pool of distinctive capabilities (Khanna, Gulati & Nohria, 1998; Teece & Pisano, 1994) and create a balance between exploitation and exploration (Baden-Fuller & Volberda, 1998). For these reasons, such alliances are used increasingly to improve partners' resource bases or to reduce the effects of uncertainty (Eisenhardt & Schoonhoven, 1996; Powell, 1998).

Because of environmental uncertainty and the pace of technological advances in knowledge-intensive industries (Ben-Manahem, Kwee, Volberda & Van Den Bosch, 2013), it has become increasingly necessary to form multiple alliances. An organization's collection of immediate alliance partners constitutes its *alliance portfolio* (Hoffman, 2005, 2007; Lavie & Miller, 2008), or its egocentric alliance network (Wassmer, 2010). The management of risk and uncertainty is a key motivation for building alliance portfolios (Wassmer, 2010) rather than relying on single alliances. Multiple alliances spread risk across different alliances, reducing an organization's vulnerability to alliance partners' misconduct and the uncertain outcomes of alliances. Furthermore, organizations accumulate alliance experience by engaging in multiple alliances, learn more quickly, and enhance their alliance management skills (Anand & Khanna, 2000).

Alliance portfolio configuration is a central issue in alliance portfolio research (Wassmer, 2010), as it strongly impacts alliance investment, management, and outcomes. Baum, Calabrese & Silverman (2000: 270) argue that an alliance portfolio is efficiently configured when it provides "access to more diverse information and capabilities per alliance […] with minimum costs of redundancy, conflict, and complexity." Based on an extensive analysis of the alliance portfolio literature, Wassmer (2010) identified the following alliance portfolio configuration properties: (i) size (number of alliance partners); (ii) structural dimension – breadth, density, level of redundancy within the portfolio; (iii) relational dimension – tie strength of individual alliances; and (iv) partner dimension – partner-related characteristics.

Many scholars have investigated portfolio size, finding that it relates positively to performance. However, some studies suggest that it is not a sufficient predictor of performance, and that it should be considered in conjunction with other characteristics (Wassmer, 2010). The structural and relational dimensions within the portfolio have mainly been studied from the network perspective, particularly the distinction between strong and weak ties (Granovetter, 1973). The partner-level attributes investigated in the literature include quality, resource endowment, reputation, and international dimension (Wassmer, 2010). With regard to portfolio internationalization, while some authors argue that highly internationalized portfolios give firms access to diverse, globally spread knowledge (Eisenhardt & Schoonhoven, 1996; Powell, White, Koput & Owen-Smith, 2005), Lavie & Miller (2008) found that, considering (national) dissimilarities between partners, alliance portfolio internationalization has a sigmoid relationship with performance. At low levels of portfolio internationalization, performance is likely to decline, because of unobserved national differences. As internationalization becomes moderate, the organization increases its absorptive capacity and specialized routines to support cooperation with foreign partners, leading to a positive relationship between portfolio internationalization and performance. But, if internationalization increases further, these routines become ineffective, which impairs performance.

In summary, the key insights from the alliance and alliance portfolio literatures are the following: i) alliances enable the combining of partners'

resources and competences to achieve strategic goals; ii) technological alliances are particularly crucial for improving the partners' knowledge base; iii) organizations typically build a set of alliances or an alliance portfolio because of environmental uncertainty and to reduce the effects of alliance failure; and iv) the portfolio configuration is crucial to ensure the optimization of resources invested in alliances and the benefits that accrue from the alliance portfolio.

## DETERMINANTS OF INTER-CLUSTER ALLIANCE PORTFOLIO CONFIGURATION: A CONCEPTUAL MODEL

In this research, we suggest that cluster-level links complement the person-based and organization-based inter-cluster links previously identified by Lorenzen and Mudambi (2013). We further argue that cluster-level connectivity mainly concerns knowledge-intensive activities, requiring large-scale investment and the involvement of multiple actors in each cluster. Cluster-level links take the form of inter-cluster alliances, which we define as voluntary agreements between clusters to combine resources and capabilities and jointly create value and generate benefits for the alliance partners, most notably in terms of knowledge creation and sharing.

As explained above, we understand clusters as organized groups of actors, located in a specific geographical area and managed by a dedicated team. This definition views clusters as organized networks, in line with Kilduff and Tsai (2003), who contend that networks are often formally established and governed, and goal directed rather than occurring serendipitously. Cluster management teams usually include representatives of large companies (sometimes working part time for their company and part time for the management team), small-and-medium-sized firms, entrepreneurs, and public officials.

When establishing alliances, clusters sign agreements on knowledge-intensive cross-cluster cooperation, and initiate one or more projects accordingly. Several automotive clusters in Europe have thus formed an alliance partnership, focusing on knowledge exchange and joint innovation in the fields of road safety and 'green' vehicles (Mov'eo, 2013). Similarly, Japanese clusters have formed partnerships with clusters in Europe, North America, and Asia (mostly in China and South Korea)[2]. Some, but not all, cluster firms and research and educational institutions take part in such projects. This selective involvement is not of particular concern, because the purpose of inter-cluster alliances is not to involve all cluster actors, but to give those who are willing the opportunity to do so. Unlike firm-based inter-cluster links, cluster-level links are not about individual firms. Their goal is for several different types of actors (firms, research institutes, universities, etc.) in each cluster to engage jointly in knowledge-intensive, usually large-scale projects that could not be accomplished by individual firms. However, while the development of firm-level and person-level links is not the primary target of inter-cluster alliances, the latter do provide fertile ground for such links to develop, as they offer opportunities for people and organizations to meet, learn about each other and initiate individual partnerships.

The alliance literature stresses that a single alliance rarely suffices to attain strategic goals, particularly when the knowledge is dispersed in different locations. Consequently, strategic goals to build capabilities through partnerships are more frequently achieved by a bundle of alliances – an alliance portfolio (Hoffman, 2005, 2007; Wassmer, 2010), particularly

2. Visit www.meti.go.jp and www.mext.go.jp for more information about the Industrial Cluster Policy and Knowledge Cluster Policy of Japan.

when the speed of environmental change is high, which is typical of knowledge-intensive industries. It follows that clusters operating in such industries tend to build a number of alliances or an alliance portfolio instead of focusing on single alliances. In this context, the factors that shape alliance portfolio configuration are crucial to the design of an effective alliance portfolio.

## THE CONCEPTUAL MODEL

From the network perspective, an organization's alliance portfolio represents its social capital (Ahuja, 2000b; Koka & Prescott, 2002). Researchers have argued that large, highly international portfolios are conducive to superior results in terms of innovation, knowledge acquisition, and learning, the argument being that the greater the diversity of knowledge sources the greater the innovation outcomes (Ahuja, 2000a; Kim, Park & Kang, 2015; Kogut & Zander, 1992). Studying the configuration of alliance portfolios, Hoffmann (2007: 829) argues that "alliance portfolios must be aligned with external environmental conditions, internal resource endowment and […] strategy to positively contribute to […] performance." Because clusters can be understood as organized groups of actors, managed by a dedicated team, these insights can constitute a starting point for developing a model of alliance portfolio configuration that focuses particularly on clusters. First, like firms/organizations, clusters are subject to the influence of the environment in which they operate. External environmental conditions span a variety of areas, but, most significantly, clusters are impacted by the rate of (technological) change in the environment and the competitive conditions between clusters operating in the same industry. Second, as argued for networks of firms (Lavie, 2006), resources and competencies possessed by cluster members form a cluster's resource endowment. In the case of knowledge-intensive industries, the most important resources and competences are those related to knowledge, such as distinctive technologies or patents. Third, as organized groups of actors, clusters develop strategies. While the word 'strategy' is not used systematically across clusters, most organized clusters develop some kind of plan, defining development targets and, more specifically, those related to acquiring new resources/knowledge through partnerships. We draw on these arguments to analyze how these three types of conditions – resource endowment, strategy, and environment – influence inter-cluster alliance portfolio configuration. We argue that they shape the cluster's alliance capacity and its inter-cluster alliance needs. Alliance capacity refers to the ability of clusters to form alliances, while alliance needs refers to a cluster's needs to form alliances. Both alliance capacity and alliance needs shape alliance portfolio configuration.

*Cluster's resources and capabilities.* The RBV argues that competitive advantage resides in an organization's assets, in particular those that are valuable, rare, and difficult to imitate or substitute (Barney, 1991). Furthermore, the dynamic capabilities approach posits that these resources should be purposefully adapted to respond to organizational and environmental change (Teece & Pisano, 1994). Because clusters comprise firms and research/educational institutions in a specific geographic area, they concentrate numerous tangible and intangible resources, as well as competencies and capabilities (Cantwell, 2009; Cantwell & Piscitello, 2015; Fernhaber, Gilvert & McDougall, 2008). We suggest that a cluster's resource and capability endowment – the set of resources and capabilities possessed by the cluster's members and management team – significantly

impacts its inter-cluster alliance portfolio configuration, in three main ways. Firstly, this endowment is strongly related to the cluster's capacity to conduct knowledge-intensive activities. In other words, it positions the cluster within a broader network in its industry. Secondly, the cluster's resource and capabilities endowment strongly affects its desirability as an alliance partner (Barney, 1991; Eisenhardt & Schoonhoven, 1996). Lead clusters can be considered as knowledge hotspots (Pouder & St. John, 1996), and they are highly attractive alliance partners, because they have strong potential for transferring knowledge. Thirdly, the management team's alliance-management-related knowledge and skills shape alliance capacity, as alliances need to be negotiated, managed, and sustained. Taken together, these conditions will increase a cluster's capacity to form inter-cluster alliances. Accordingly, we formulate our first proposition:

*Proposition 1. A cluster's alliance capacity will be determined by its resources and capabilities.*

Access to external knowledge does not automatically lead to that knowledge spreading across the cluster. Yet it is essential for a cluster to spread the outputs of inter-cluster cooperation throughout the cluster, and thus improve the whole cluster's knowledge profile. Like firms, whose absorptive capacity (Cohen & Levinthal, 1990) is crucial to the success of a partnership (Ho & Wang, 2015), the ability to spread alliance outputs throughout the cluster is vital if an alliance partnership is to bring value to the whole cluster. Obviously, this ability depends on the cluster's network properties, including ties between members (Nohria & Eccles, 1992; Podolny & Page, 1998), and between members and management team, as the network's central agent. Thus, if its ability to spread alliance results throughout the cluster is limited, the cluster should limit its alliance activity, because the gains from this activity will not offset the investments made to establish alliance agreements. Consequently, we formulate our second proposition:

*Proposition 2. A cluster's alliance capacity will be determined by its ability to spread alliance outcomes (knowledge-related results of the alliances) throughout the cluster.*

In summary, a cluster's alliance capacity will depend on its assets, particularly knowledge-related assets, and its ability to spread the results of the alliances throughout the cluster. In terms of measurement, a cluster's resource endowment could be measured by its distinctive technologies or by patents filed in a given period. A scale could be developed to assess the alliance management skills of the cluster management team. The transmission of alliance outputs throughout the cluster could be measured by the number of cluster members taking an active part in inter-cluster relationships.

*Cluster's alliance strategy.* The second set of conditions that shape inter-cluster alliance portfolio configuration relates to the strategy underpinning the formation of such alliances. As organized groups of actors, managed by a dedicated team, clusters develop alliance strategies to improve their knowledge base and reputation in a particular industry. For example, clusters can develop alliances to tap into diverse knowledge sources (Kogut & Zander, 1992), or to focus on a few knowledge-intensive activities. Depending on these objectives, the needs for the alliances will differ: at one extreme, clusters will target numerous alliances with many partners, and at the other, a small number of alliance partners will suffice to

reach their goals. Moreover, the needs in terms of ties between the alliance partners will differ depending on an alliance strategy. If the strategy aims at acquiring various types of knowledge in multiple locations, the ties needed for such endeavors will likely be weak. Conversely, when clusters seek in-depth cooperation in very specific areas, they will need to develop stronger bonds with their alliance partners. Describing the Silicon Valley/Israel hi-tech connection, Engel (2015) contends that the strength of the bonds between two counterparts led to the creation of a Super-Cluster-Of-Innovation. Such a cluster emerges through partnerships between "two geographically separate COI [*clusters of innovation*] with sufficient ties and bonds to be characterized and function as a single cluster, such as the Israel/Silicon Valley high-tech COI" (Engel, 2015: 47). Based on these insights we formulate the following proposition:

*Proposition 3. A cluster's alliance needs will be determined by its associated knowledge acquisition goals.*

Other potential strategic objectives of inter-cluster alliances include improving the legitimacy and reputation of the cluster's knowledge base (Zyglidopoulos, DeMartino & Reid, 2006). Young clusters suffer from liability of newness (Stinchcombe, 1965). Such clusters might develop an alliance strategy to improve their global legitimacy in their industry. Previous research has pointed out that high-quality alliance partners can enhance the reputation of an organization (Stern, Dukerich & Zajac, 2014), especially if this organization is young. Therefore, when clusters lack international recognition and legitimacy, they will aim to ally with high-quality clusters to improve their global competitiveness. On the other hand, established clusters might wish to ally with young clusters, to monitor their knowledge-intensive activities and establish ties in the hope of future benefits as the young clusters develop. In addition to allying with established clusters, young clusters will likely aim to ally with multiple alliance partners, because a broader network of cluster partners will enhance their legitimacy and reputation. A large alliance portfolio sends the market positive signals about the desirability of a particular cluster as a partner; it can be considered as the social capital of a cluster (Koka & Prescott, 2002). Therefore:

*Proposition 4. A cluster's alliance needs will be determined by its associated image and reputation building goals.*

A cluster's alliance needs will depend therefore on the goals it sets for inter-cluster alliances, within the framework of its alliance strategy. Scales could be designed to measure the extent to which a cluster aims to acquire knowledge and develop its image and reputation.

*Environmental conditions*. The third set of conditions that shape inter-cluster alliance portfolio configuration is environmental. Industry conditions, such as volatility (Ansoff & Sullivan, 1993; Park, Chen & Gallagher, 2002; Westhead, Wright & Ucbasaran, 2004) and the rate of technological change, strongly impact the need for cooperation (Bathelt et al., 2004; Koka, Madhavan & Prescott, 2006). In volatile, rapidly changing environments, clusters cannot rely on their existing capabilities to prosper, but need to ensure constant renewal. Inter-cluster alliances are an important way for clusters to stimulate such renewal. We therefore propose:

*Proposition 5. A cluster's alliance needs will be determined by the rate of technological change in the industry(ies) in which it operates.*

To establish alliances, clusters need partners. Partner characteristics are instrumental in a cluster's portfolio configuration (Brouthers, Brouthers & Wilkinson, 1995; Wassmer, 2010). The resource endowment and knowledge capabilities of potential cluster partners strongly influence the formation of alliances in knowledge-intensive industries. Moreover, diverse knowledge bases in different clusters will encourage a greater number of alliances. A wide variety of alliance partners leads to less overlap and redundancy, and consequently a more effective portfolio (Baum et al., 2000). Therefore, we formulate the following proposition:

*Proposition 6. A cluster's alliance needs will be determined by the characteristics of potential cluster partners, most notably their resource and capability endowment.*

Environmental conditions that influence portfolio configuration include the alliance portfolio characteristics of other clusters competing in the same industry or operating in similar (innovation) ecosystems. Ecosystem, as a concept, differs from that of industry, insofar as it incorporates both production- and use-side participants (Autio & Thomas, 2014; Moore, 1996). Demil, Lecocq & Warnier (2018) contend that the ecosystem is the part of the environment with which an entity interacts. In our research, the notions of industry and ecosystem are both relevant. Many scholars use terms such as industry clusters (Birkinshaw & Hood, 2000) or industrial clusters (Feldman, Francis & Berkovitz, 2005; Leroux & Bero, 2010; Padmore & Gibson, 1998), emphasizing the industry as the boundary condition for understanding how clusters operate. On the other hand, clusters serve a certain set of users and are connected to a variety of different agents outside their industries, which indicates the importance of the notion of ecosystem and, in the case of knowledge-intensive activities, the notion of innovation ecosystem in particular.

If most clusters operating in the same industry, or similar innovation ecosystems, are highly connected, the focal cluster will also be motivated to develop strong connectivity. Because the ability to access local resource endowments in other locations is a key aspect of cluster competitiveness (Cantwell & Piscitello, 2015), clusters aiming for global competitiveness will not wish to be less connected than others are. Clusters operating in the same industry monitor each other closely and mimic each other's activities (Porter, 2000), including alliance activity. In designing their alliance portfolios, clusters will therefore be influenced by the alliance behavior of other clusters operating in the same industry or in similar ecosystems. For example, automotive clusters in Europe have similar alliance portfolios in terms of numbers of alliance partners, density, structural dimension, and level of internationalization[3]. Accordingly:

*Proposition 7. A cluster's alliance needs will be determined by the characteristics of alliance portfolios of clusters competing in the same industry or in similar innovation ecosystems.*

Clusters and their alliances can also be influenced by public policy incentives (Fornahl & Hassink, 2017; Porter, 2000). This can be observed in Europe, with the European Commission's funding for inter-cluster

3. Personal interview with Marc Charlet, Head of International Operations for the French automotive cluster Mov'eo, January 8, 2016.

cooperation. European policies have triggered several inter-cluster partnerships in Europe, providing funding for joint R&D and innovation on specific, large-scale projects. Similarly, the Japanese government's cluster policies have prompted alliance formation between Japanese clusters and foreign counterparts. This suggests that policies can trigger alliances that extend beyond the duration of a particular program. We therefore formulate the following proposition:

*Proposition 8. A cluster's alliance needs will be determined by public policy incentives targeting inter-cluster linkages.*

Therefore, we propose that environmental conditions, and more precisely the rate of change in the technological environment, potential cluster partners' characteristics (in particular their resources and capabilities), the portfolio characteristics of other clusters operating in the same industry, and policy incentives, influence inter-cluster alliance portfolio configuration. In terms of measurements, studies could use scales evaluating environmental turbulence (e.g. Zahra, 1993), potential cluster partners' distinctive technologies or patents filed in a given period of time, size, and partner dimension of other clusters' portfolios (relational and structural dimensions being difficult to examine from the outside), and available policy instruments targeting cluster connectivity.
Table 1 summarizes different conditions (factors) that determine inter-cluster alliance portfolio configuration. It shows the theory (or literature stream) underlying each factor, and how it applies to our conceptual framework.

| Theory (T) or literature stream (LS) | Factor | Application to inter-cluster alliance portfolio |
|---|---|---|
| RBV (T), dynamic capabilities (T) | Resources and capabilities | A cluster's resources and capabilities determine its alliance capacity. |
| Network theory (T), RBV (T), dynamic capabilities (T) | Diffusion of alliance outputs | A cluster's ability to spread alliance outputs impacts its alliance capacity. |
| RBV (T) | Knowledge acquisition goals through partnerships | Knowledge acquisition goals influence a cluster's alliance needs. |
| RBV (T), network theory (T) | Image and reputation building through partnerships | Image and reputation-related goals influence a cluster's alliance needs. |
| Impact of the environmental conditions on firm operations (LS) | Rate of technological change | Rate of technological change impacts a cluster's alliance needs. |
| RBV (T) | Resources and capabilities of potential alliance partners | Resources and capabilities of potential alliance partners impact a cluster's alliance needs. |
| Analysis of the competition (LS) | Alliance portfolios of clusters competing in the same industry | Alliance portfolios of clusters competing in the same industry impact a cluster's alliance needs. |
| Impact of public policies on clusters (LS) | Policy incentives | Policy incentives influence a cluster's alliance needs. |

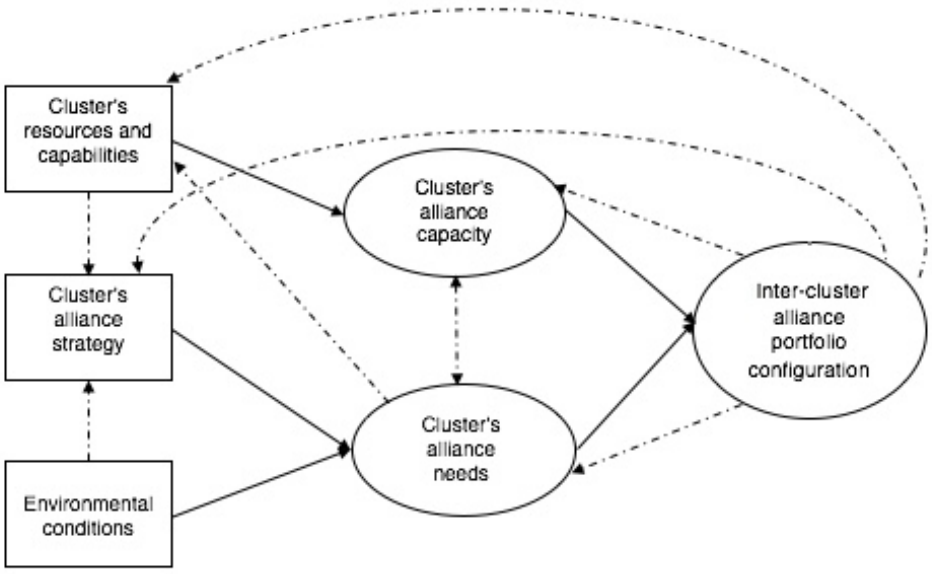
Table 1 - Theories, literature streams, and factors influencing inter-cluster alliance portfolio configuration

The three sets of conditions therefore influence either the cluster's ability or its need to form inter-cluster alliances. The alliance portfolio configuration should consider the cluster's alliance capacity and needs (Figure 1). Accordingly, we formulate our final proposition:

*Proposition 9. The inter-cluster alliance portfolio configuration will be determined by the cluster's alliance capacity and alliance needs.*

DYNAMIC INTERACTIONS BETWEEN THE FACTORS IN THE MODEL

As discussed above, the influence of the three types of factors (cluster's resource endowment, cluster's alliance strategy, and environmental conditions) on the cluster's alliance capacity and alliance needs, and the effect of capacity and needs on inter-cluster alliance portfolio configuration, constitute the main static relationships in the model. However, in addition to these relationships, the variables are also interrelated dynamically, especially when the cluster's alliance activity develops. To take our analysis one step further we outline these interactions to underscore the dynamic interplay between the factors in the model.




Note: Solid lines indicate main relationships in the model (static perspective). Dotted lines refer to other relationships – dynamic interplay between the elements of the model.

Figure 1 . Conceptual model:
Determinants of inter-cluster alliance portfolio configuration

*Resource endowment, environmental conditions, and cluster strategy*. The first area of dynamic interactions relates to how the cluster's resource endowment and environmental conditions relate to its alliance strategy. The cluster's strategy is strongly determined by its existing resources and capabilities. This resource base will indeed guide strategic thinking within the cluster and the ensuing alliance strategy. If clusters need to improve their knowledge base significantly, they will probably choose an aggressive alliance strategy, leading to greater alliance needs. Similarly, environmental conditions, such as the alliance portfolio

characteristics of other clusters in the same industry or the rate of change in the technological environment, will impact the cluster's alliance strategy.

*Alliance capacity, resource endowment, and alliance needs*. In the previous section, we explained how inter-cluster alliance capacity and needs impact alliance portfolio configuration. However, these factors also influence one other. A cluster's greater alliance capacity will lead to greater alliance needs, while greater alliance needs will stimulate the cluster to improve its alliance capacity, for example by employing one or more experienced managers to manage inter-cluster alliances. Consequently, alliance needs can also affect the cluster's future resource endowment.

*Alliance portfolio configuration, resource endowment, alliance strategy, alliance capacity, and alliance needs*. As mentioned previously, alliances in knowledge-intensive industries are developed to improve the cluster's knowledge base (Cuypers & Martin, 2010; Garrette, Castañer & Dussauge, 2009). A well-configured alliance portfolio will provide maximum gains. Such improvements in the knowledge base will directly impact the cluster's resource endowment, as well as its future alliance strategy. An improved knowledge base will therefore impact the cluster's alliance capacity and alliance needs.

In summary, alongside the main links identified in our model, as the alliance activity of the cluster unfolds, a number of dynamic relationships between different elements of the model will develop, as depicted in Figure 1.

## CONCLUDING REMARKS

In this exploratory, conceptual research, we studied inter-cluster alliances. Our research builds on the RBV, the dynamic capabilities approach, social network theory, and observations from the business world, to argue that in addition to person-based and organization-based linkages, cluster connectivity includes cluster-level linkages. We thus extend the notion of connectivity by highlighting the existence of this third type of inter-cluster link. We also propose that achieving connectivity goals requires a number of alliances, that is, an alliance portfolio.

Our discussion of the inter-cluster alliance phenomenon led us to develop a model of determinants of inter-cluster alliance portfolio configuration. We developed a set of propositions related to: 1) a cluster's resource endowment; 2) its alliance strategy; and 3) environmental conditions. These three types of conditions determine both a cluster's alliance capacity and its alliance needs. In turn, alliance capacity and alliance needs determine alliance portfolio configuration.

Our conceptual study adds to the literature in two ways. Firstly, we extend the notion of connectivity to include cluster-level connectivity. Cluster-level connectivity is different from and complementary to person-based and organization/firm-based connectivity, in that it focuses on the whole cluster. Despite their presence worldwide, cluster-level linkages have received little attention from scholars. Secondly, we advance the cluster literature by shedding light on the phenomenon of inter-cluster alliance portfolio configuration, proposing a model of its determinants (and indications of how they can be measured) to guide future research.

Our research also has policy implications. Policies targeting cluster formation and development in different parts of the world stress the need for clusters to boost their innovative performance by creating cross-cluster

links (see European cluster policies[4], Japan's cluster policies[5], and an overview of cluster policies in OECD countries, in OECD, 2007). Many national policies include guidelines, targets, and incentives for building inter-cluster linkages. However, understanding of the challenges associated with building an inter-cluster alliance portfolio remains very poor. Moreover, policies emphasize portfolio size, encouraging clusters to connect to a great number of partners in many different countries. Our research points to the fact that alliance portfolios should be aligned with a cluster's resources and capabilities, its alliance strategy, and environmental conditions. Consequently, some clusters should strive for a relatively small portfolio but with strong ties between the partners, while others will target larger portfolios with a variety of different cluster partners. In other words, each cluster needs to find its optimal portfolio configuration by investigating the determinants that we propose in our conceptual model. Policy should help clusters to reflect on this and encourage them to design portfolios that best suit their specific features. Policies should also provide clusters with concrete tools to help them develop their cluster-level connectivity. At managerial level, our model could be used as a tool to guide clusters through their alliance portfolio configuration.

Cluster-level connectivity is still an emerging and poorly understood phenomenon. Although cluster practitioners have been dealing with inter-cluster partnerships for a number of years now, academics have afforded such connectivity very little attention. More research is needed on inter-cluster alliances – cluster-level links – which will undoubtedly become an important way for clusters to boost their innovative performance, particularly in knowledge-intensive industries.

4. See European cluster observatory: ec.europa.eu/growth/industry/policy/cluster/observatory_en

5. Industrial Cluster Policy: www.meti.go.jp; Knowledge Cluster Policy - www.mext.go.jp

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