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Les mécanismes qui sous-tendent les dynamiques territoriales d'innovation ou le rôle caché des connaissances architecturales

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Résumé

Cet article explore les mécanismes qui sous-tendent les dynamiques territoriales d'innovation en se focalisant en premier lieu sur les capacités de combinaison au sein des clusters. Nous étudions en particulier la première phase de l'innovation, c'est-à-dire lorsque les partenaires négocient et établissent un projet d'innovation localisé en collaboration. Tandis que la plupart des travaux s'intéressent au rôle de la proximité géographique sur le processus d'accès aux connaissances dans les clusters, cet article se focalise sur le processus de combinaison des connaissances entre acteurs hétérogènes dans les clusters. Cette recherche est conduite dans une démarche qualitative avec une étude de cas de type *grounded theory* reposant sur deux clusters rassemblés au sein du pôle de compétitivité SCS « solutions communicantes sécurisées » : l'un opérant dans le secteur de la microélectronique et l'autre dans celui des TIC. Les résultats nous ont permis d'élaborer un « modèle théorique enraciné » explicatif des moteurs et freins rencontrés par les organisations dans leur processus de formation de projets d'innovation localisés. Le modèle met en lumière un élément clé spécifique pour le succès de ces projets : la présence de connaissances architecturales au niveau du cluster dans leurs trois dimensions relationnelle, technique et de marché.

Mots clés : Cluster, base de connaissances, Innovation collaborative, Projet de R&D Collaboratif, Connaissances architecturales

Abstract

This paper examines the mechanisms underlying territorial innovation dynamics, focusing specifically on the collaborative localised innovation projects they generate. Most research on regional clusters focus on how clusters facilitate diffusion and *exchange* of knowledge. This paper rather focuses on how clusters facilitate the *combination* of knowledge among heterogeneous actors, which appears to be a critical point to foster successful local innovation collaborations.

We apply a qualitative methodology (grounded theory) based on a case study research design to two high-tech clusters: one in the microelectronics sector and the other operating in the information and communication technology sector.

The main revelation of our study is the discovery of architectural knowledge at the cluster level as an important underlying mechanism affecting the territorial innovation dynamics, the type of collaborative innovation projects fostered and the capacity of firms to get involved in these projects. We present a grounded emergent model explaining the mechanisms enhancing successful integration of clusters' members into collaborative localised innovation projects. This study has implications on how scholars conceptualize innovation dynamics of clusters and how they understand firms' capacity to successfully integrate collaborative localised innovation projects.

Key Words: Cluster, Open Innovation, Collaborative R&D Project, Architectural Knowledge

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1. Introduction

For several years, researchers and policymakers have been interested in regional clusters and networks for their influence on innovation (Kogut, 2000; Maskell and Lorenzen, 2004; Nooteboom, 2005; Rychen and Zimmermann, 2006; Lauriol *et al.* 2008). From a Schumpeterian perspective, Nelson and Winter (1982) treat innovation as a search process that explores the space of possible combinations of pieces of knowledge to create new or better alternatives. Nahapiet and Goshal (1998) emphasises two main processes of knowledge creation: exchange and combination; and these two processes depend directly on the social context. In the same line, Maskell and Lorenzen (2004) argue that the social proximity produced by cluster and network relations favours knowledge creation by enhancing exchange and combination of pieces of knowledge. This view sees the development of knowledge and innovative capacities within clusters as resulting from the interactions among actors (Maskell, 2001), and as “a shift from a static analysis of innovation networks and actors as repositories of knowledge to a more dynamic position that stresses (social) practice of knowledge creation in “action” ” (Coenen *et al.*, 2006:399).

Central to this process of knowledge creation are collaborations in which knowledge are not only exchanged among firms but also combined. However, in some regional clusters contexts, cluster's members are successful in their process of building effective collaborations of innovation while in others they are not. To achieve a greater insight into the mechanisms underlying the social patterns of collaborations of innovation, Coenen *et al.* (2006) emphasize the need to engage in more qualitatively inclined case studies of innovation projects, which reflect successful knowledge interactions. We suggest that the territorial innovation dynamics are significantly different from a cluster to another and innovation policies could be improved by the identification of the territorial innovation specificities of the clusters they promote.

This present paper examines the mechanisms underlying the territorial innovation dynamics (TID), focusing specifically on the combinative capabilities of clusters. We analyse the front-end innovation process, which is the stage when partners negotiate and establish collaborative localised innovation projects (CLIPs). While most research focus on how clusters facilitate access to new knowledge, this paper focuses on how clusters facilitate the combination of knowledge among heterogeneous actors.

This article contributes to the literature on territorial innovation dynamics in two ways. First, unlike previous studies we focus on increased knowledge combination through collaborative

localised innovation projects, which could have relevance for the debate on open innovation. Love and Roper (2009) highlight that it is in the early stages of the innovation process, and particularly when knowledge is generated through exchange and combination, that openness may be most beneficial. Second, we explore the nature and role of cluster-level architectural knowledge (CAK), and how it enhances the combinative capabilities of clusters. Andersson *et al.* (2008) note that few, if any, studies examine the specific role of AK in inter-organizational innovation.

The paper is organized as follows. Section 2 presents the conceptual framework; Section 3 describes the two clusters analysed and the method adopted. We use a case-study-based research design and an inductive methodology to capture the richness of the phenomenon and to identify patterns for theory generation. Section 4 presents the results of our empirical analysis of two distinct cluster knowledge dynamics and their effects on the development of collaborative innovation projects. Section 5 enriches this first analysis by building a grounded emergent model of territorial innovation dynamics that displays the dynamic processual relationships among concepts that emerged from the study. Section 6 discusses this grounded model and suggests areas for future research.

2. Clusters and Knowledge Dynamics

2.1. Cluster and network effects

Knowledge dynamics in clusters are based on two complementary effects: clustering and networking (Lorenzen and Maskell, 2005; Visser, 2009). According to Visser (2009:168), “clusters refer to spatial concentration processes involving a set of related activities in which context firms may, but need not, cooperate (...) whereas networks refer to dynamic cooperation in the form of knowledge exchange between firms and others actors that may, but need not, develop these links at the local or regional level”. In other words, the concepts are not synonymous although clusters are frequently based on networks. We briefly describe each of these effects that shape the knowledge dynamics of clusters.

The positive effects of the spatial concentration of related industries on innovation have been analysed in detail and three main effects can be emphasised: **clusters** favour (1) local spin-offs, (2) knowledge spillovers through the local labour market, (3) knowledge exchange through the development of informal social interactions and trust among members (Audretsch and Feldman, 1996; Breschi and Lissoni, 2001; Malmberg and Power, 2005). They also facilitate face-to-face interactions, which allow the exchange of tacit knowledge. Storper and Venables (2003) claim that the “local buzz” is a prime knowledge flow channel. This applies particularly to tacit knowledge,

which is regarded as “sticky” and “context-laden” (Asheim and Gertler 2005) and requires physical proximity for its transmission.

Numerous studies focus on the main features of innovation capabilities in **networks**. The types of links and the position in the network (Burt, 1992; Powell *et al.*, 1996) enable access to the knowledge required for innovation. The types of links, whether strong or weak (Granovetter, 1985), have an influence on the outcomes of networks. Capaldo (2007) describes the superior performance of innovative capabilities deriving from a “dual network” structure, or a network structure where a small core of strong ties is integrated within a larger periphery of weak ties.

The innovative capabilities of networks also depend on the position of the actors in the network. Powell *et al.* (1996) show the importance of a central position; centrality is based on the number and importance of the strategic alliances connecting organizations. Carbonara (2004) enriches this work showing that the development of firms with a leader position favours learning mechanisms at the level of single firm but also at the level of the firm’s system.

The work referred to above describes the necessary complementarity between cluster and network effects, pointing to the need for a combination of these effects for successful local innovation, and the interest of focussing on localised networks of firms in geographical clusters. These existing works have some limitations. First, they focus mainly on knowledge exchange. Since innovation increasingly involves open collaboration, analysis of cluster level combination mechanisms is particularly relevant, but few studies examine this process in the context of clusters. Second, the literature mostly distinguishes between tacit and codified knowledge, but deeper analysis of the nature of the cluster’s knowledge base is required.

2.2. Cluster knowledge base

Cooke (2006) shows that clusters, by accumulating knowledge from a specific value chain, over time, build a richer knowledge base. Asheim and Coenen (2005) argue that territorial innovation dynamics (TID) are strongly shaped by this knowledge base available. This knowledge base influences the innovation dynamics of the cluster in two ways.

First, the variety of the knowledge base highlights the significance of cognitive distance. On the one hand, variety influences the potential combinations of knowledge and facilitates radical innovation (Visser, 2009). However, variety increases cognitive distance and the risk of misunderstandings and communication chaos between the actors (Nooteboom, 2005). Cognitive distance necessitates information transfer and an understanding of diverse cognitive categories, or investment in combinative capabilities. On the other hand, a specialized knowledge base favours cognitive proximity, which is the foundation for shared understanding, but it reduces the potential for knowledge combinations and results in cognitive lock-in (Visser, 2009).

The second characteristic of a cluster's knowledge base is its complexity. Complexity is defined in terms of the level of interdependence inherent in the subcomponents of a piece of knowledge (Sorenson *et al.*, 2006): the more complex the knowledge base, the more difficult it will be to transmit the knowledge. In the case of very complex knowledge bases, knowledge flows involve only some firms of the cluster, leaving others cognitively isolated from these flows (Giuliani and Bell, 2004). Sorenson *et al.* (2006) show that the transmission of knowledge between proximate actors is easier if the underlying knowledge base is only moderately complex.

These studies on the variety and the complexity of the cluster knowledge base address the question of diffusion and exchange of knowledge (how actors have access to local knowledge). However, few studies have examined knowledge combination related to complex knowledge bases and how cluster can play an effective role. Carrincazeaux (2001) provides some preliminary insights, suggesting that the complexity of the knowledge base in R&D projects explains why firms agglomerate. He develops the notion of critical interfaces, which emerge when combination of pieces of knowledge is complex. Management of these critical interfaces requires spatial proximity.

The degree of interdependence between diverse combinations of knowledge, in other terms the number of critical interfaces, is related to the architecture of these combinations (Sorenson *et al.*, 2006). This architecture is not fixed and needs to be managed. For example, modularization, which isolates interdependencies within substructures, decreases combinative complexity (Sorenson *et al.*, 2006) and then the need for spatial proximity.

2.3. Emergence of the concept of “Cluster level AK”

The researches on the complexity and architecture of a cluster's knowledge base can be enriched by the concept of “architectural knowledge”. In a preliminary work, Henderson and Clark (1990) distinguish two types of knowledge, “Component” versus “Architectural Knowledge” (AK). AK originally was used to refer to the technical understanding in product development (*ibid*, 1990:9). In this context, “architectural knowledge may be defined as knowledge about components of a complex system and how they are related” (Baldwin, 2010:2). After a process of learning about alternative configurations, AK tends to become stable and a design emerges that characterizes the specificity of an innovation (Henderson and Clark, 1990). At this stage, AK relates to the organization of a system, and the structure and routines required to organize its component knowledge for productive use (Matusik and Hill, 1998).

Building on this, Pinch *et al.* (2003) and Tallman *et al.* (2004) extend the concept of AK to clusters, to include the routinization of network interactions, interdependencies and common interests among members. AK is related mainly to the relational aspects of a cluster's social system: how its members relate to one another as they exchange component knowledge,

cooperate, compete and develop interactive learning. According to Tallman *et al.* (2004:266) “cluster-level architectural knowledge will enhance the transfer, absorption, and application of component knowledge across firm boundaries within the regional cluster”. But does the cluster-level AK enhance the combinative capabilities of the cluster? i.e. does AK foster the development of localised collaborative innovation projects? Few works have studied these aspects.

Drawing on Henderson and Clark’s (1990) original formulation of AK, Andersson *et al.* (2008:20) describe the role of AK in inter-organizational innovation projects and define AK as “the knowledge developed and enacted in innovation processes of aligning heterogeneous business and technical elements”. They identify four dimensions of AK: technology capability awareness, use context sensitivity, business model understanding, and boundary-spanning competence. According to Andersson (*ibid*), these dimensions possess explanatory power that can help to identify the conditions for network-centric innovation. The first three dimensions define the AK that supports the innovation produced by a project. The fourth refers to the ability to develop this AK across diverse organizational knowledge.

3. Research Setting and Methods

We use a qualitative methodology based on an exploratory case study research design (Eisenhardt, 1989). A case study research design is particularly well-suited to our objective to analyse the mechanisms underlying the local dynamics of innovation and to provide greater insight into local innovation project development (Yin, 2003). We chose an inductive methodology, which follows established research practices (Goia, 1994; Nag *et al.*, 2007; Gioia *et al.* 2010; Clark *et al.*, 2010). As such, we adopted an interpretative research approach, which gives voice in the interpretation of events in a first order analysis to the people experiencing them. As researchers we then assumed the task of formulating deeper, more theoretical second order interpretation in light of both contextual factors and existing literature, in order to develop an emergent grounded model (Glaser, 2004).

3.1 Research context

The research context is the French *Pôle de Compétitivité* policy. This innovation policy, which was announced in 2005, focuses on R&D to reinforce national assets. It encourages the creation of specialized R&D-led innovation clusters in several areas of expertise, to strengthen regional economies, and achieve global visibility. In 2010, there were 71 competitiveness poles in different regions of France, and in several different areas of expertise, which provides a unique opportunity to collect detailed data on the innovation projects developed by local actors. Our study focuses on the Pole SCS (Pole Secured Communicating Solutions), created through the merger of two local

clusters in the southeast of France. The MRG (Marseille/Rousset/Gemenos) cluster, located near Marseille, was established as a result of the 1970 government strategy to develop the microelectronics sector. It includes three main firms: STMicroelectronics, ATMEL, and GEMALTO (formerly Gemplus), and is one of the main pools of microelectronic activity in Europe. The NSA (Nice Sophia-Antipolis) cluster is located near Nice in the Sophia-Antipolis Science Park, which was the result of a 1980 government strategy to decentralize activities to the regions. Several telecom and computer companies have branches in Sophia-Antipolis, including IBM, Amadeus, HP, France Telecom and Cadence. These two clusters have evolved as a result of the pressures exerted by the economic crisis, which forced them to specialize. These clusters created out of exogenous resources now have distinct endogenous innovation dynamics (Dang and Longhi, 2009). The Pole SCS provides an excellent context to study rich micro processes at work in two different clusters, and provides access to exhaustive data on the R&D projects launched by pole SCS actors.

3.2 Data collection

We use two main types of data: quantitative and qualitative data. Quantitative data were collected through a project database, while qualitative data were collected through interviews.

- *Quantitative data:*

We built a comprehensive database of all the local innovative projects funded by the Pole SCS from 2006 to 2009, a total of 190. This allowed us to examine the links between actors, their nature, location and type of project.

- *Qualitative data*

To obtain more fine-grained insights, we conducted a series of 28 semi-structured interviews with small and medium sized enterprises (SMEs), multi-national firms (MNFs), directors of cluster associations and people involved in governance of the Pole. Interviews lasted 45-120 minutes and were recorded (over 25 hours in total) and transcribed (335 pages). In the first part of the interview, questions focused on firm type, activities, location and director's education background. The second part of the interview investigated the links between firms and their territory: the companies they worked with, the nature of the knowledge exchanged and sought, and attachment to the territory. In the last part of the interview we discussed project involvement, motivations and difficulties encountered in the process.

3.3 Data Analysis

While the quantitative analysis conducted allowed to identify preliminary characteristics of territorial innovation dynamics (TID) and collaborative innovation projects developed inside each cluster, the qualitative analysis constitutes the main research method used and aimed to analyse

more deeply these TID. We cycled among data (quantitative and qualitative), emerging theory, and relevant literature to develop a deeper understanding of the underlying mechanisms of the territorial innovation dynamic involved in the cases. For example, the concept of Architectural Knowledge rose from the data and guided us towards further analysis in another iteration of the cycle process (data/emerging theory/relevant literature). This iterative approach allowed concepts to continue emerging until we had a clear sense of the developing relationships among categories and their related themes and until additional analysis failed to reveal new relationships (Gioia *et al*, 2010). As such, this iterative process analysis aimed to constantly verify and adjust Grounded Theory developed to the data to achieve fit, relevance and workability (Glaser, 2004)

We moved from the data to grounded theory by applying constant comparison (Glaser and Strauss, 1967; Glaser, 2004). To systematize data coding and comparison, we used the computer-based qualitative analysis program, *Nvivo*. Our approach follows several steps. We first double coded the interviews and identified similar ideas and key elements, which we categorized into first-order concepts expressed by short phrases. Links between first-order concepts emerged and then we merged them into second-order concepts, which are more abstract concepts but still use the informants' terminology (Gioia, 1994). These second-order concepts were then assembled into aggregated concepts, a step that enables the different phenomena deriving from the data to be linked around the over-arching dimensions. This long and progressive abstraction process is depicted in the data structure Figure 1 and show how researchers engage in conceptual generalizing (Glaser 2004).

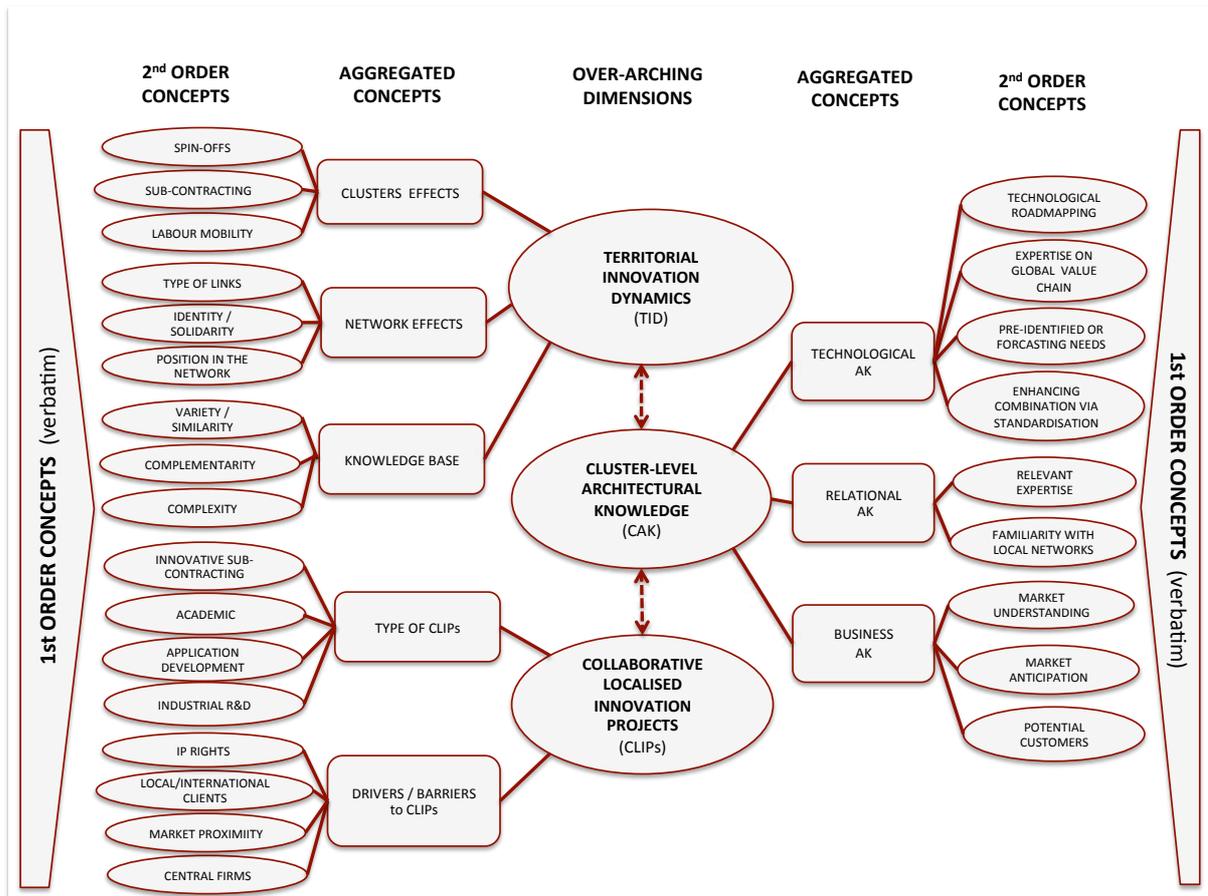


Figure 1: Emerging Data Structure

In sum, the process of conceptual generalizing follows two main steps (Nag *et al.*, 2007), presented in section 4 and 5 which results in different level of abstraction (Glaser, 2004):

- The *first-order results* stay very close to the data. Two different *narratives* are presented. They describe the specificities of the TID identified within each cluster (MRG and NSA). These narratives draw on the first-order and second-order concepts (cf. data structure Fig.1).
- The *second-order results* present a conceptual study of the underlying mechanisms of the TID identified through the first step. This in-depth conceptual analysis draws on the aggregated concepts and the over-arching dimensions (cf. data structure Fig.1) and helps elaborating a grounded model of successful integration of cluster members' into CLIPs.

To ensure the trustworthiness of the findings we adopt additional techniques: first a double coding, second the two authors were involved into the actual data analysis so that the findings would not rely solely on the interpretation of a single analysis. Third we conducted “member checks” with key informants at each step of the conceptual generalising process.

4. First-Order Results: the emergence of two divergent narratives

We present our findings on the Pole SCS case study through two narratives relating to the two clusters: MRG and NSA. As depicted on Figure 1, two “overarching dimensions” have emerged from our analysis as relevant for understanding the development of innovative projects within clusters: the *Territorial innovation dynamics (TID)* and the *Collaborative Localised Innovation Projects (CLIPs)*. These two overarching dimensions capture key critical insights into the success or eventual failure of the actors’ involvement into CLIPs. They have emerged based on the first, second-order and aggregated concepts (cf. Figure1). These 3 levels of concepts form the two narratives. Each narrative first present the TID, second, the CLIPs developed (the overarching dimensions illustrated in Figure 1). They include representative quotes from informants. When findings are not explicitly captured by a representative quote, we provide a data table (in annexes), containing representative supporting data for each second-order concept.

The narrative highlight the direct link between the type of TID, the type of CLIPs they generate, and the drivers and barriers encountered. However, our results show that the interplay among these dimensions is not as linear as suggested. The types of CLIPs developed have recursive effects on the TID. The analysis of *drivers and barriers* to the formation of CLIPs lead us to identify an underlying mechanism to the successful formation of CLIPs: the existence of cluster-level Architectural Knowledge (AK) at the centre of the data structure.

4.1 Narrative 1: the cluster of Marseille-Rousset-Gemenos (MRG)

4.1.1 Territorial Innovation Dynamics of the cluster MRG

4.1.1.1 Cluster effects

In the cluster MRG, three main multinational firms (MNFs), Gemplus, STMicroelectronics and Atmel, operate in the microelectronics sector. The “fab” (microelectronics chips production) constitutes the core of the cluster activity and acts as a focal point to which several small supplier companies and universities are attracted to develop complementary or related activities. “*There are a lot of fields involved in “fab”: gas purification, automation, mechanics, it’s an amazing ecosystem of activities!*” (STEricsson’s Innovation Manager).

Over 30 years, these MNF have underpinned numerous high-tech spin-offs supporting the fab. The manager of Realviz said that “*Large firms create SMEs (...) specialized in side areas of expertise that are not core to the competence of MNFs*”. He added: “*MNFs have a strong spreading effect: a lot of SMEs have started to work for them.*” The manager of ARCSIS (the main professional association in MRG) noted that, “*new spin-offs account for the existence of a*

relatively mobile and specialised labour market totally linked with the development of the three MNFs". Events such as "ARCSIS microelectronics meetings", "Pole SCS Forum for SMEs" etc., bring together the employees from different companies, and enable a shared understanding and interpretative framework within the cluster.

4.1.1.2 Network effects

The MRG cluster is characterized by the centrality of a few large firms (Gemplus, STMicroelectronics, Atmel), which have developed an ecosystem of complementary SMEs, and universities that act as innovative providers. This structure creates strong ties and local interdependence: *"Most actors (...) perceive their network as something oriented towards the MNF decision-makers. Recently in a Pole SCS meeting, we observed that there are top decision makers that leverage the development of a network of SMEs derived from clearly defined technical requirements, or from know-how nurtured by some individuals in a MNF and developed in small firms or from a small firm to another"* (Pole SCS' SMEs department director). The director of ARCSIS stressed the domination of the three MNF, *"as far as they give a lot of work to companies..."* and the stability of relationships: *"here, cooperation relations are very well established and stabilized"*.

Within MRG, network and cluster effects are self-reinforcing and have led to the development of an eco-system where the survival and success of each actor depends on that of their counterparts. This may explain the solidarity within the cluster. The ARCSIS director gave an example: *"ATMEL had a technical problem: a machine was broken due to an empty pump. ATMEL called ST and the company lend ATMEL a pump. ATMEL will definitely return the favour"*.

4.1.1.3 MRG cluster's knowledge base: diversified and complementary

The variety in MRG's knowledge base is striking: *"Universities and companies position themselves on complementary services for foundries. These actors enrich MRG's knowledge base with specific knowledge from several areas of expertise applied to fabs"* (The manager of YLS, an SME). However, the ARCSIS director noted that, *"the specialization (of each actor) is associated with a huge pool of complementary knowledge (...) The manufacturing field has attracted specific types of activities (...) based on materials, chemical products, maintenance, machine conception for smartcards production, implementation tests etc... All the mentioned domains of expertise are focused on the same objective (the success of manufacturing processes) and the same main actors (the 3 MNFs)"*.

The variety and the nature of MRG cluster knowledge demonstrate the complexity involved in combining the knowledge components. However, the stability of the knowledge base allows combinative capabilities to be accumulated. STEricsson's innovation manager told us: *"There is a*

high level of stability both in terms of companies and knowledge, this is not common to all other area of competencies". Several informants highlighted that the processes of knowledge combination in MRG is very dependent on a few economic actors: the MNFs. The MNFs decide which parts of the process should be developed collectively. This point is crucial and will be further developed in the next section.

4.1.2 Collaborative Localised Innovation Projects (CLIPs) in the MRG cluster

The data point up main features of MRG's CLIPs illustrating how they emerge in the cluster. We first present their type (specialisation, role of projects' leading actors, type of relations) and second, the drivers and barriers to their development.

4.1.2.1 The Type of CLIP

First, using the projects database (2006-2009), we analysed the type of funding and the type of actors. There are three main categories of projects, based on funding types: "ANR" (Agence Nationale de la Recherche), which are academic-oriented innovation projects funded by the Ministry of Research; "DGE" (Direction Générale des Entreprises), which are industry oriented innovation projects funded by the Ministry of Finance; and "CR" (Conseil Régional), which are funded by the Regional Council Administration. The data show that most CLIPs of the MRG cluster are funded by DGE. This ranking has significance as it shows that the MRG cluster is **most heavily involved in industry-oriented projects** (DGE funding (44.2%)) compared to academic projects (ANR funding (20.5%)). Regional funding (CR funding (35.2%)) are also important which demonstrates MRG's actors' **close links to the territory**. The types of actors involved in MRG CLIPs are mostly industrial partners - 67% of all relations (45% SMEs and 22% MNFs) compared to 55% in NSA. Academia (32%) and associations (2%) represent only 34% of total relations (in NSA 45%). This shows the high involvement of industrial rather than academic partners in the CLIPs of MRG. The data finally show that MRG has been more successful in achieving project funding than NSA (42% compared to 34%).

Second, while interviewing the Pole SCS vice-president, he acknowledged the high proportion of CLIPs **targeting the microelectronic sector** built in MRG and successfully funded (47 microelectronics-oriented projects over 190 successful projects). These projects particularly address the "fab" industry *« until mid-2009 all the microelectronic "fab" projects are led by MRG actors, only one is led by NSA. On the contrary the microelectronic design projects are in majority led by actors from NSA »* (ARCSIS director).

Third, these projects often derive from **former spin-off or sub-contracting relations** in which actors have maintained relatively hierarchical relations, typical of relations between ordering

parties and providers. From the start, the ordering parties orient the innovation idea. This is representative of MRG's TID and configuration of interactions described before. The ordering parties are mainly MNFs as emphasised the Pôle SCS Vice-President: *“Here are some statistics on projects (2006-2009) in which the MNFs are involved: (...) 8 projects out of 11 submitted with Atmel as partner have been selected; 13 out of 16 submitted with Gemalto as partner have been selected; 24 out of 33 submitted with STMicroelectronics as partner have been selected ».*

However, it is worth noting, as particularly stressed the Director of ARCSIS: *“even though most partners of MNFs in the projects were subcontractors they are very innovative and constantly maintain their innovation activities”.* In fact far from being simple subcontractors, (mostly SMEs and universities) the one partnering the projects hold specific competencies, and they are led to develop them over time along with the innovation projects in which they are involved.

4.1.2.2 Drivers and barriers to the formation of CLIPs in the MRG cluster

The study of the involvement of actors into the CLIPs described above reflects specific drivers and barriers. Four main drivers are highlighted: first, as acknowledges an SME of the cluster *“...talking about collaboration leads us to think about the Industrial Property issue: how to protect an innovation. In microelectronic manufacturing sector, IP is clearly defined before the start of the project”* (Invia Director) capturing the value that may derive from the projects is relatively easy thanks to easy-to-define IPRs. Second, the existence of local clients in the cluster is also a key driver: MNFs are actually both the initiators of projects and the main clients (as described in the previous part). For projects participants the outcome that may derive is therefore easier to anticipate. The MNFs being the clients implies a short time-to-market for the project's output, which stimulates clusters' members' motivation and (financial) capacity to take part to projects. Finally, these drivers underline one as key: the presence of central firms mastering the innovations developed in the projects. In fact, the data show that MNFs are central actors in the process of building CLIPs in many ways, but in particular and of most significance and interest, behind all these drivers, we identified one particular that is: the combinative capabilities or *Architectural Knowledge* held by MNFs and unfolding at different dimensions of the project. These central MNFs know how to master them at three different levels.

- First of all, informants highlighted the complexity related to the **technical combination** of knowledge: MRG's knowledge base is diversified with very distinctive competencies and distributed among firms and universities. But the opportunities for them to be combined are made possible thanks to two specific aspects. (i) On the one hand, a main strength of the MRG-cluster's central firms is precisely their exhaustive **global overview of the value chain** related to microelectronic fab processes. This implies that they both have a control on the

technologies that are at the heart of their activity, and also have the capacity to identify critical technologies that need to be developed on the value chain and create their complete architecture including with competencies that are far from their own core competencies: “*The MNFs are more differentiated and know better how to manage several sectors, multiple-technologies and expertise at the same time*”; “*the integrators here are mainly the MNFs: they know how to combine different needed technologies*” (Pôle SCS Director). (ii) On the other hand, the MNFs have also made the effort to formalise the value chain related to the fab process through what informants refer as the “**technology roadmap**”. The Pole SCS R&D projects director notes that MNFs “*...develop a technological roadmap and this is necessary and very helpful for SMEs*”. For example “*they can distinguish between the activities that need to be maintained from the activities that are becoming obsolete*” (Director YLS company). The MNFs have specific knowledge about the products, services and the technology roadmap and thus are best placed to decide about future technological developments at the local level. This upstream technological orientation is particularly helpful for firms of the cluster as it enables them to anticipate their R&D activities. All the more as the 3 MNFs not only formalise it but also unveil the roadmap informally in meetings and/or formally in conferences. Therefore it is shared among actors of the cluster and constitutes “*a great incentive to be part of collaborative projects*”. A roadmap provides enough stability to enable firms eager to innovate to develop their own strategic internal roadmap while taking into consideration the market tendencies, the coming technological focus, thus avoiding many pitfalls.

- Second of all, the MNFs have a fierce knowledge of the local network. The increasingly composite nature of the microelectronic sector, involving more and more specialised stakeholders and heterogeneous technologies is underlined by the interviews: the formation of CLIPs require a good knowledge of local networks and available expertise. Precisely, as pioneers in the cluster, the MNFs have attracted and stimulated the creation of a community of engineers and have maintained them in the cluster spurring a network of small firms and spin-offs revolving around them. The director of ARCSIS adds: “*The MNFs have a very good knowledge of the industrial fabric surrounding them! Have a look on STMicroelectronics, when the company has an innovation idea, before the project has started they almost already know with which SME or University they could collaborate*”. Consequently, MNFs have become **familiar with local networks and know how to make the different organizations work together**. This relational combinative knowledge facilitates the integration of partners, such as SMEs. As noted by Pole SCS vice-president: “*There are innovative actors that don't have to wonder how to get integrated into innovative projects as they know their role and place a priori. The cost of entry is therefore diminished*”. MNFs organize and structure the

possible boundaries between the needs related to their core activities, and the knowledge that will be contributed by other local actors.

- Third of all, in the MRG cluster the value that could be derived from collaboration is easily perceivable thanks to the business orientation of CLIPs: MNFs have a deep **understanding of the market** and business models associated with the innovation outcome. A main point is the existence of **potential customers**. MNF are generally the targets of innovations. Hence, the client can be identified before the start of the R&D project. According to ARCSIS director firms and particularly *“SMEs are looking for this type of collaboration: they will try to involve MNFs in projects as far as they want to develop innovations that will meet MNFs’ needs. MNFs are their first client and first tester”*. Short time-to-market and the extent to which the value created can be captured is a great incentive for firms to get involved into CLIPs.

Overall, the three dimensions of AK accumulated at the cluster-level and mastered by the MNFs underpin the success of CLIPs at MRG. Behind the main drivers identified and described formerly, the technical, relational and business dimensions of AK appear as powerful underlying mechanisms that conditions the formation of CLIPs.

However, there are some barriers that need to be overcome. We have shown that three main actors dominate the exchange and combination of knowledge within the cluster. This may be a barrier to integrating into CLIPs, as firms need to be involved in exclusive interactions with MNF. Also, the centrality and stability of the knowledge base may lead to incremental and modular innovation and decrease the potential for radical innovation and ultimately result in cognitive lock-in (Visser, 2009).

4.2 Narrative 2: The Nice-Sophia-Antipolis cluster (NSA)

The results for NSA cluster’s type of TID, CLIPs, and drivers and barriers to the formation of CLIPs are presented following the same format as in narrative 1.

4.2.1 NSA’s Territorial Innovation Dynamics (TID)

4.2.1.1 Cluster effects

The NSA cluster was developed based on resources from the French policy of decentralization, and attracted MNF branches (IBM, Texas Instrument, Infineon etc.). After the 1990s crisis, some MNF decided to close down their branches although many (France Telecom, Amadeus, HP...),

continued in order to be close to European standards institutions such as ETSI. The closure of some MNF branches left a pool of highly qualified employees keen to stay in the same area. Many created their own companies and several ‘constrained’ spin-offs (Longhi, 1999) were created in this period, followed by academic spin-offs such as Realviz “*one of INRIA-Sophia’s main success*” (Realviz director). Rather than specialization of activity, this development is better described as R&D-orientation and cluster infrastructures that attracted and kept actors on the site. Most activities remained within the boundaries of firms leading to a situation of pure co-location without local interactions. To make up for this potential weakness, a huge number of clubs emerged to foster social networking, including “*Fondation Sophia-Antipolis, Club des Dirigeants de Sophia, Telecom Valley, Sophia Start-ups, SAME, SAM, Paca-Est incubator and many others...*” (SAM business intelligence manager). However, NSA doesn’t have a leading association similar to ARCSIS for MRG, nor a particular specialization. The number of associations in NSA has improved social interactions, but has not produced a real local innovation dynamics (Lazaric *et al*, 2008).

4.2.1.2 Network effects

There are no dominant types of linkages in NSA nor is there a dominant local network. NSA encompasses a wide variety of networks without strong linkages that have built over time. There are three main types of relationships that can be distinguished; they are transversal to sectors and activities.

The first type of network consists in subcontracting relations, but totally different from those in MRG. In NSA they are “*exclusively computing service companies. Subcontractors are not required to be highly specialized, innovative, or to have knowledge on IP. On the contrary, MNFs would protect themselves from the risk of having their know-how deprived*” (Trusted Logic Director). The interest is in the flexibility of work contracts: consultants are provided when human resources are needed.

The second type of network consists in innovative actors revolving around universities, but without any local embeddedness. Academics are relatively important actors in NSA. They initiate most innovative collaborations. An Expert at System’s VIP (an academic spin-off) says NSA “*conveys a scientific and academic culture*” originating spin-offs, and reinforcing worldwide relations. Academics work with a few local innovative SME and MNF in some projects, but cannot be described as focal actors stimulating local innovation.

Third, there are a very few complementary linkages between MNFs and highly specialized SMEs with a strong scientific background. Trusted Logic director describes it as: “*We develop high added value layers of software and we patent them to smartcards manufacturers. This is not the same as local firms such as ASK, Gemalto or Oberthur, but complementary*”. But it avoids

becoming “*followers of large influent regional firms. We would certainly work for MNFs, but with the goal to have references and become leaders. So it’s a totally different way of thinking!*” (compared to MRG). This third kind of network is very similar to the network characterizing the MRG cluster. However, two main differences can be noted: 1) the network is small in size and localized; 2) it is initiated and developed around innovative SMEs and not MNFs.

Despite the existence of these networks “*in Sophia, the lack of an innovation dynamic is still predominant (...) we are still in logic of exchange: social networking, exchange of tips etc. But there is no logic of cooperation yet. Main cooperation are still with external actors*”, stated SAM business intelligence manager.

4.2.1.3 NSA cluster’s knowledge base: diversified but loosely coupled

The NSA knowledge base is mainly based on scientific knowledge: a huge community of 20,000 researchers and numerous major research labs are located in the cluster. This cluster fosters a wide range of activities and sectors: software, multimedia, telecom and microelectronics design (not fabs). However, it is not possible to identify a real leading sector or cluster orientation: “*In Sophia, the software sector is quite predominant, but multimedia and telecoms sectors also (...) as well as microelectronic design*” (Realviz Director), “*development of software solution such as in the security field*”, or “*consulting branch*” (Trusted Logic Director). Lack of a common orientation or focused objective results in high cognitive distance. Software, telecom and multimedia companies are driven mainly towards development of technology applications and uses. However, technological knowledge can be combined with a wide portfolio of activities: actors constantly look for potential complementarity. The knowledge base is diversified, and only loosely coupled.

The NSA cluster is characterized by the presence of international standards organizations such as ETSI (European Telecommunications Standards Institute), ERCIM (European Research Consortium for Informatics and Mathematics) and W3C (World Wide Web Consortium). They contribute to the codification of knowledge - through standards - to make it less sensitive to distance-decay, thus facilitating collaboration at the global level based on shared conventions and scientific language (Coenen *et al.*, 2006). These organizations are aware of the critical interfaces and resolve them through codified standards. In NSA, knowledge from scientific and standard organizations derives from relations with worldwide actors not necessarily involved in local networks but interested in long-term global co-ordination. In sum, this knowledge base doesn’t foster local R&D collaboration.

4.2.2 Collaborative Localised Innovation Projects (CLIPs) in the NSA cluster

In contrast to MRG's TID where only a main type of project is formed, in NSA, the data highlight 3 different types of CLIPs. We first present each type of CLIP (their features and type of actors involved) before presenting the drivers and barriers to their development

4.2.2.1 Type of CLIPs

NSA cluster appears to secure more "ANR" project funding (48.1%) than MRG, indicating that the cluster's projects are more academic-oriented and purely research-based. NSA secures only 7.4% of "Conseil General" (CR) funding, which address projects that would benefit the regional economy and which would involve only local actors. This suggests that NSA's local embeddedness is weaker than that of MRG. The types of actors involved in NSA are academics (39%) and associations (6%), compared to 34% in MRG. In NSA, MNFs (25%) and SMEs (30%) represent 55% of relations compared to 67% for MRG.

But more particularly, the data highlight that NSA is involved in three main types of CLIPs that according to their main features, we called: *Academic projects*; *Application Development projects* and *Industrial R&D projects*.

The first type, *Academic projects*, is characterised by four main features: typically, they are developed with a global perspective as they aim at influencing the advancement of international research. Also, they are long-term innovation projects, far from the market: the exploitation of results is not a priority nor is the identification of potential target customers.

The second type of project, *Application Development projects* address the development of new applications of existing technologies. Interestingly, they are representative of the dynamic of collaborations in NSA: very rich and diversified knowledge with high potential complementarity. The Pole SCS Vice-President gives an example: "*Domenec company together with Neurecom have a common project to develop a cochlear implant for hard-of-hearing people. This is typically an application of technology where you need to know perfectly many things about the technology the area of application, including the whole system's functioning, which is really complex*".

The third type of project is the "*Industrial R&D project*". We called them "Industrial" because they are mostly oriented towards client and market demands, they address microelectronic sector (but mostly design activities rather than fab as in MRG) and are often initiated by innovative high-tech SMEs. They are also embedded locally, the SMEs leader forming their own small innovative "sub-clusters". For instance, Trusted Logic an SME specialized in software, is involved in seven CLIPs, including, MAXXSIM (Secure Solution for Mobile Internet Multimedia) which "*is the largest project of the Pole SCS. It is a microelectronics design project which objective is to*

improve smartcards. It is currently initiated by Gemalto, but Trusted Logic had the idea and brings in the most valuable contribution” (STEricsson innovation director).

4.2.2.2 Drivers and barriers to the formation of CLIPs in the NSA cluster

The study of the involvement of actors into the 3 types of CLIPs described above reflects specific drivers and barriers that vary for each of them.

The NSA cluster is particularly favourable to *Academic projects*. NSA includes a dense agglomeration of scientific actors and European standards organizations, which provide access to newly developed scientific knowledge. NSA benefits from a rich knowledge base, bridging all sectors, which attract firms and increases the opportunities for knowledge creation and potentially favour the formation of collaboration. Several barriers are however highlighted: there are difficulties involved in anticipating the value that might be created. *Academic projects* address long-term objectives, far from the market and that may even not be commercializable. This deters some actors from getting involved, particularly SMEs. Besides, scientific actors tend to focus on global knowledge networks when they get involved in collaborations rather than local opportunities for partnerships. Therefore most projects are set up with actors external to the cluster and finally they don't benefit to the TID. In fact, behind the drivers and barriers described above the data show that a main reason is that this type of project is based on existing AK, yet standardised in nature. This is underlined mainly through the role of standardisation institutes who have a strong influence in the cluster: they enhance technical combination via standards agreed among global actors in order to favour collaboration and coordination of technological innovation at a distance and that could be easily combined once developed. Indeed, academic projects are developed in a modular design allowing dispersed actors to develop innovations independently that would contribute to sub-groups of innovations and can be re-arranged into various combinations, according to the researcher's objectives and capabilities, without any need for geographical proximity. On the other hand, shared language and codes among academics constitute drivers to these projects as they facilitate the relational combination of different distant knowledge. Nevertheless, this tends to exclude firms and particularly SMEs not able to integrate academic networks and who are not familiar with the design of academic projects (different work practices, time horizon etc.).

As far as *Application development projects* are concerned, if the potential complementarity of knowledge is high, their effective combination is particularly complex. Informants emphasize several barriers: this type of projects is mainly developed in telecom, software and multimedia industries. In these sectors IP rights are difficult to define as the new use or application has yet to

be identified, therefore a priori delineation of IP is particularly challenging. Also, patenting innovations is not possible in the software industry: contributions are not clearly delimited which makes the collaboration more risky. The motivation for involvement in CLIPs therefore is lower. Besides, if innovative combinations are potentially valuable, outcomes for technology applications are unclear and address worldwide customers rather than local markets. These insights ultimately show that in this kind of project, the Architectural Knowledge are particularly necessary for the combination of heterogeneous knowledge that don't belong to the same value chain. However, the territorial dynamic of NSA didn't allow them to be accumulated at the cluster-level: "*the very first years I was working at Trusted Logic I didn't have any single local contact. Even the ones I get to know now, such as ARM, I met them in Cambridge before knowing they had an office here*" (Trusted Logic Director). In each area of expertise, the actors will have a wide range of applications available to them: it is therefore difficult to anticipate the need or application to address. The Pole SCS Vice-President notes: "*In fabs the need is easy to anticipate. For applications of technology, such as in health domain for example, it is far more difficult. This may explain why there are few applications of technology projects*". This outlines that AK in their business dimension are particularly complex to develop in this type of project. Moreover, the great variety of possible technology applications conducts actors to an ever-ending search for possible complementarity. Currently, there is no orientation in the cluster to address applications in a specific area such as the health domain. While these projects particularly require AK in their three dimensions, here the lack of specialisation in the cluster prevent it from accumulating AK at the cluster level.

Regarding *Industrial R&D project*, the drivers highlighted are the same as for the CLIPs fostered in the MRG cluster: capturing the value that may derive from the projects is relatively easy thanks to easy-to-define IPRs, the existence of local clients mainly MNFs in the microelectronics sector which implies a short time-to-market for the project's output, which stimulates clusters' members' motivation and (financial) capacity to take part to projects. But interestingly, in this case of CLIPs these drivers underline the role of central firms, not MNFs, but high-tech SMEs mastering the innovations developed in the projects. In fact, the data show - even though it is a marginal case - that SMEs are the central actors in the process of building CLIPs, but in particular they are the one who have developed and accumulated the *Architectural Knowledge* and unfold them at different dimensions of the project: at the technical level, SMEs who are able to build *Industrial projects* know how to "push" and pre-integrate their new technologies at consumers (MNFs). At the relational level SMEs have accumulated relational AK through the effort in "*creating its own ecosystem, (which) gives more value to a product, reduce investment costs, because the company*

pre-integrate with partners” (Trusted Logic Director). The SME thus also have a good market understanding and combinative capabilities at the business level including with the management of IP issues as notes Trusted Logic: “*Our company has a strong IP culture - 30 innovation patents that delineate our expertise and therefore make the capture of value and profitability easier.*” In sum, similarly to the MNF in MRG, SMEs manage the knowledge distributed among heterogeneous actors, and know how to integrate them into their innovation processes. “*Those who have the mission to combine frequently have an academic background with high qualifications,*” says Trusted Logic Director, it is about “*things that don’t exist yet. This has nothing to do with the engineering way of thinking: receive specifications and develop them is no longer enough*”. In short, these SMEs have developed their own small “sub-cluster” in microelectronics design and they master the AK at the three different levels identified.

Overall, in the NSA cluster except the marginal case of these “sub-clusters”, there is no central neither than local organization that may help in the combination of knowledge. Unlike the situation in some famous high tech clusters that have developed around renowned academic actors (e.g. Cambridge, UK) who stimulate local interactions and enhance knowledge combination, universities in the NSA cluster are not central in the cluster and don’t stimulate local innovation: “Here, in Sophia, (...) there is no logic of local cooperation yet, neither than any leading scientific leader to impulse a real innovation dynamic” (Business intelligence manager at Nice department council). A local lead organization has yet to emerge.

5. Second-Order Results and Emerging Grounded Model of TID

The study of NSA and MRG clusters shows the strong interrelation between the characteristics of their territorial innovation dynamics (TID) and the propensity of actors to successfully set-up projects. While the key concepts were described in the narratives, here we extract the dynamic relationships among them. These developments allow building a grounded model of successful integration of cluster members’ into CLIPs. This model, illustrated in Figure 3, depicts two types of dynamics (ecosystem or co-location) and particularly emphasizes the role of *Cluster-level Architectural Knowledge (CAK)* unfolding at three dimensions that emerged during the analysis as a pivotal underlying mechanism explaining drivers and barriers to CLIPs. This is explained thereafter, following the structure shown on figure 3 from the upper part (TID 1 ecosystem) to the lower part (TID 2 co-location).

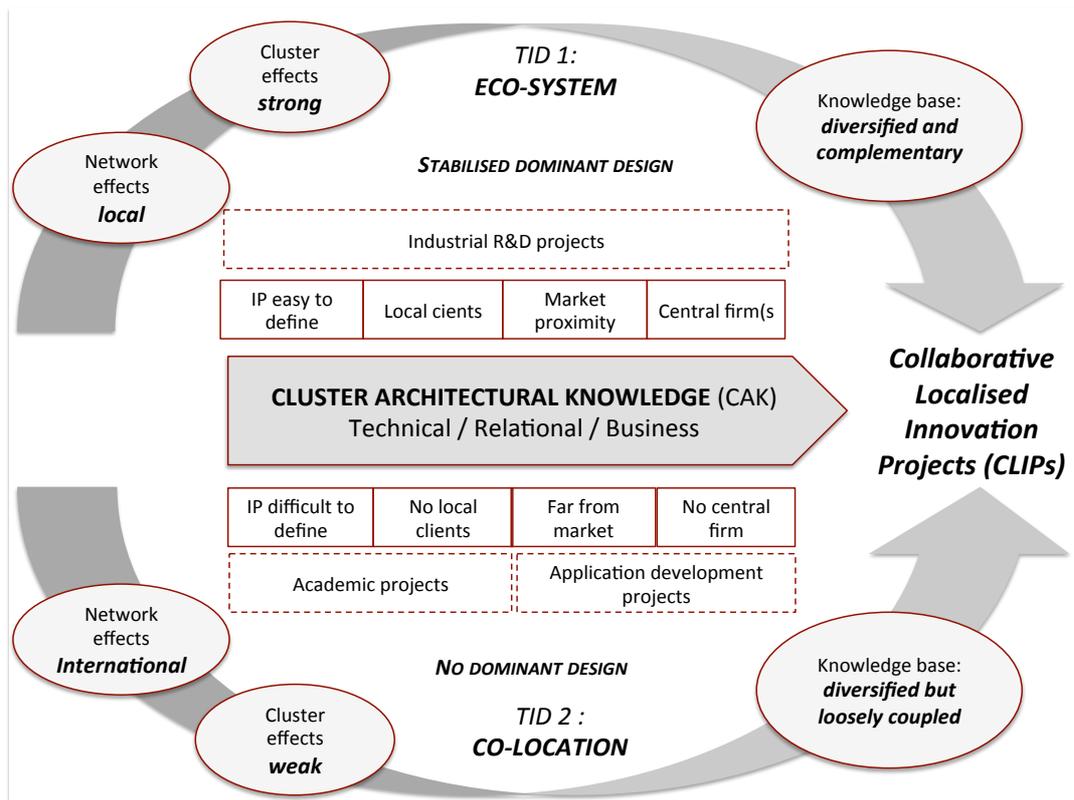


Figure 3: Emergent grounded-model of successful integration of cluster members' into CLIPs

5.1 Eco-system with stabilised dominant design (TID 1)

In the cluster MRG as in the microelectronic design sub-clusters identified in NSA, the analysis of the TID shows that a real eco-system is thriving in the cluster, enhancing firms' propensity to create CLIPs: the convergence of strong cluster effects and local network effects with a diversified but consistent knowledge base, has entailed a « stabilised dominant design » (Henderson and Clark, 1990:14) resulting from the presence of complementary actors and local interdependence as described above. In this type of TID (eco-system) central firms (MNFs in MRG and SMEs in NSA) plays a key role mastering the combinative capabilities, i.e. AK, and control the three main dimensions of AK:

- Technical AK (TAK); they hold the technology capability awareness or a global view of the value chain. Central firms control the overall architecture of the sector. This is crucial as far as the knowledge and expertise of CLIPs' contributors only have an added value if perfectly integrated in the value chain.
- Business AK (BAK); the central firms know what the business opportunities are linked to each business models.

- Relational AK (RAK); they have competences to identify what resources and practical skills are required for engaging in collaborative innovation.

In this type of cluster, members willing to engage in CLIPs only need to bring their component knowledge: the knowledge invested in the project is clearly delineated and distinct from the other members of the project. As a result, the definition of the IPRs surrounding the project is facilitated. As far as MNFs are the first clients (NSA), or the clients and the initiator of the project (MRG), this shortens the time to market and the outcome is easier to anticipate. The existence of cluster AK and the emergence of a stabilised dominant design thus foster the establishment of CLIPs.

5.2 Co-location without a dominant design (TID 2)

At the opposite situation, the analysis of the NSA's TID shows that despite a strong scientific culture, the existence of a pool of skilled labour and a diversified knowledge base offering rich combination opportunities, no local eco-system has emerged (except within microelectronic design sub-clusters). The absence of convergence between network and cluster effects conducts to a situation of *co-location* of actors without interaction: the propensity to build CLIPs is very weak. This type of TID fosters academic projects in which the TAK are standardized and shared through agreements negotiated through organizations such as ETSI, and formalized via research publications. The existence of shared and standardised TAK makes collaboration easier. This reduces the reliance on RAK and facilitates firm involvement in Academic projects. Moreover, these projects are far from the market, decreasing the need of BAK. However, these types of projects are not CLIPs: they tend to involve a majority of global partners and tend to be less locally embedded.

In *Application Development projects* all three dimensions of AK are required. There are many opportunities for innovative knowledge combinations. Indeed, TAK and BAK are required to cope with the scope of possible applications and to identify relevant markets. RAK is critical for bridging between local actors through the development of strong collaborations to facilitate knowledge matching. Thus, even when all forms of AK is successfully developed for an application project, the next technology application will require new investment from each partner to mobilize and coproduce new AK. Moreover, the IPRs are difficult to determine. Besides, IPRs are particularly ill-suited to software. This last aspect also enhances the difficulty for firms to anticipate the value created. In these types of projects, the AK is specific to each application, and needs to be rebuilt for each project; this notably increases the cost of entry to this kind of project.

In both types of projects the absence of a focal organisation able to master the CAK prevents actors from getting easily involved into CLIPs. This constitutes a real barrier for SMEs.

6. Discussion and conclusion

Our study contributes to research on territorial innovation by (1) enriching the concept of cluster-level architectural knowledge (CAK) and (2) improving the understanding of the role of space on processes of collaborative innovation.

6.1 Enriching the concept of Cluster-level AK: their nature and distribution

While a whole strand of literature (Malmberg et Maskell, 2002 ; Storper et Venables, 2002 ; Asheim and Gertler, 2005 ; Preissl, 2003 ; Rychen and Zimmermann, 2006; Torre, 2006; Longhi, 2008) appear to have assumed that the *exchange* of knowledge in clusters is the crucial mechanism accounting for successful local innovation, our study demonstrated that it is rather the **capacity to combine that appears to be core**. These capacities to combine are based on the AK and more particularly at the cluster level. As such, our study is consistent with recent works emphasizing on the role of the capacity to combine knowledge at the industry level (Jacobides, 2006) or at the firm level (Zhang et al., 2007) but we **extended the concept of AK at the cluster level (CAK)**.

Our findings contributes to the studies on territorial innovation by showing that architectural knowledge actually thrive in clusters as underlined by Pinch *et al.* (2003), et Tallman *et al.* (2004). Yet, our study provides more fine-ingrained insights into the nature of these CAK showing that they unfold at three dimensions: relational, technical and business, and not only in their relational dimension as previously described by the authors.

Our work also contributes to the question of the **distribution of AK inside a cluster** in two ways. First, we show that AK even though existing at the cluster-level are not always a public good, as shown by previous work (Pinch *et al.*, 2003; Tallman *et al.*, 2004). Our study also shed light on the fact that AK are both held by key actors and specific to the cluster as defined by Tallman et al. (2004): “This type of knowledge is tacit, path-dependent, presents causal ambiguity, cluster embeddedness and is non-transferable among cross-clusters” (Tallmann et al. 2004:264).

Second, our study outlines that the private nature of CAK doesn't prevent cluster's member to benefit from them. On this point our results differ from existing studies: Jacobides refers to combinative capabilities at an industry level as a private good and the firms holding them “keep a large part of the industry profits by carving out a comfortable position in their sector”

(2006:1205). Similarly, Zhang et al. (2007) show that firm's architectural knowledge is private and therefore benefit in priority to the firm that hold them. Our study shows that AK can be hoarded and managed by one or a group of actors, making more comparable to a "club" good (i.e. a good with excludable benefits), as it was demonstrated in the case of "ecosystem clusters". Moreover, we highlight that the actors possessing AK have a deep knowledge of local networks and contribute to the stability of local relationships, which results to asymmetry in AK flows at cluster level. This is in line with Carbonara's (2004:18) study of the role played by one or more hub actors – MNF - in systemic innovation.

6.2 The role and utility of space depends on the nature of CAK

Our understanding of the role of space – or spatial proximity - is also enhanced as we direct our research less toward the role clusters play on the exchange of knowledge and more toward the role clusters play on the combination of knowledge. Former studies have outlined this issue only partially stating that the more complex the knowledge base is, the more spatial proximity is needed for successful combination of knowledge (Sorenson *et al.*, 2006). Our research provides a deeper understanding by showing that the role of space actually becomes more important depending not only on the complexity of the knowledge base but also on the nature of the AK thriving in the cluster. Two situations have been discerned. On the one hand, the role of space is important when AK are characteristic of the cluster and not standardised like the case of MRG cluster (ecosystem TID). On the other hand, the role of space is less important when the AK are standardised and globalised like the case of NSA (co-location TID).

6.3 Limitations and future research directions

This work is inevitably limited by several considerations that can serve as the base for future studies: First, given the aim of this paper, the research has focused on CLIPs formation but not on CLIPs development. Therefore, we describe the role of AK in building CLIPs but not the role of AK in terms of managing on-going R&D projects. Second, we acknowledge that focusing on two clusters might limit the transferability of our findings. We feel, however, that the conceptual findings developed in the emergent-grounded model are usable in other clusters' contexts in which the development of local collaborations is a critical point, but a comparative study on more settings would enrich and refine the model.

Finally, the findings in this paper suggest that the propensity of firms to take part to CLIPs is influenced by the nature and the distribution of CAK, and this appears to be particularly true for SMEs. Indeed, SMEs have more difficulties into integrating CLIPs as they generally lack of time

and resources to work on potential valuable innovation collaborations. Our case showed that if the CAK is stable and dominated by one or a few large players, SMEs' involvement into CLIPs is facilitated: SMEs need only to develop their specific technological knowledge as the combination of knowledge and the coordination of the project is managed. It would be fruitful to gain more insight into small firms' involvement into CLIPs.

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