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Dissertation

The Role of Intermediaries in Solving System Problems in Regional Innovation Systems

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“THE ROLE OF INTERMEDIARIES IN SOLVING SYSTEM PROBLEMS IN REGIONAL INNOVATION SYSTEMS”

Dissertation submitted in part fulfillment of the requirements for the degree of Doctor of Philosophy in Business Competitiveness and Economic Development of University of Deusto (European Ph.D. Degree).

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ABSTRACT

Competitiveness builds across the boundaries of Innovation System´s components, innovation-relevant organizations and entrepreneurs. Accordingly, the System Innovation stream of economics claims interaction to be a central feature of integrated systems. However, the latter characteristic does seldom occur automatically, denoting the existence of various problems that curtail development potentials. Importantly, problems constitute opportunities for the intermediary outlook. Intermediary organizations encompass an increasing role in overcoming them while they facilitate knowledge interchange among dissimilar organizations and institutions. Still, the literature does not adequately recognize the great influence intermediaries have on the connectivity of innovation environments.

The dissertation produces a methodology set out to assess potential system problems as well as the association between these problems and the existence -or absence- of specialized intermediary organizations. First, we estimate integration by means of the assessment of four different system problems which have mainly been described in a theoretical fashion, although not yet systematic. We operationalize four sets of quantitative indicators which integrate in the interpretative framework of the dissertation. Consequently, the so-called *“human resource gaps”, “openness and learning gaps”*, *“technological gaps”* and *“financial gaps”* are identified within a logical examination. Second, leveraging on empirical evidence, the dissertation categorizes intermediaries according to the specific system problems they tap into. This clear-cut sorting produces *“pairs”* between system problems and intermediary categories, while it nurtures simplicity and precision in the functional and structural definition of the latter. We also operationalize four sets of quantitative indicators that permit the assessment of the

relational density of the categories. Besides, the existence of commonalities in the purpose and activity performed by the categories suggests the possibility to arrange them in a common framework. These categories will also be aggregated in a new *"Associative Component"* which will be projected as a central –piloting- new subsystem of Innovation Systems.

The empirical analyses are based on *ad hoc* data exploitations stemming from various surveys conducted by the Spanish Official Statistical Institute and the Spanish Venture Capital Association. First, we conduct a Multiple Factor Analysis to reduce dimensionality. Then, Cluster Analyses lead to the presentation of typologies. The first one sorts systems according to their level of integration. The second arranges them according to the relational density levels of their *"Associative Components"*. Second, we conduct a Canonical Correlation Analysis to explore relationships among the outputs of the assessments. This calls into question a potential association between the density level of *"Associative Components"* and the integration of Regional Innovation Systems. As it will be explicated, the statistical output of the study has proven that the relational density of the *"Associative Component"* could be a valid predictor to explain integration across Spanish regions (i.e. Navarre, Basque Country, Catalonia or Madrid). On the other hand, we also find that inactive or inexistent *"Associative Components"* come together with disintegrated Regional Innovation Systems (i.e. Andalusia, Extremadura, Murcia).

JEL classification: O18, O21, O38, R15, R50, R58

Keywords: regions, Innovation Systems, system problems, intermediaries, Associative Component, Spain, Multiple Factor Analysis, Canonical Correlation Analysis.

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To mom and dad

Xabier Alberdi

April 28, 2014

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LIST OF ACRONYMS

AC	**Autonomous community**
AGR	**Agriculture**
ASCRI	**Spanish Venture Capital Association**
BA	**Business angel**
BRIC	**Brasil, Russia, India and China**
CA	**Cluster Analysis**
CCA	**Canonical Correlation Analysis**
CDTI	**Centre for Industrial Technological Development**
CIP	**Competition and Innovation Framework Programme**
CIS	**Spanish sociological research center**
DG	**Directorate General**
DUI	**Doing, Using and Interacting**
EIB	**European Investment Bank**
EIF	**European Investment Fund**
EU	**European Union**
FTE	**Full Time Employees**
GDP	**Gross Domestic Prdouct**
GVA	**Gross Value Added**
GVC	**Global Value Chain**
IAIF	**Institute of Industrial and Financial Analysis**
IND	**Industry**
INE	**Spanish National Statistical Institute**
IS	**Innovation Systems**
KIBS	**Knowledge Intensive Business Services**
MFA	**Multiple Factor Analysis**
MINT	**Mexico, Indonesia, Nigeria and Turkey**
NATO	**North Atlantic Treaty Organization**

NIS	**National Innovation Systems**
OECD	**Organization of Economic Co-operation and Development**
PAB	**Public Administrative Bodies**
PCA	**Principal Components Analysis**
R&D	**Research and Development**
RIS	**Regional Innovation System**
SERV	**Services**
SME	**Small and Medium sized Enterprises**
SNA	**Social Network Analysis**
STI	**Science, Technology and Innovation**
TTA	**Technology Transfer Agency**
UN	**United Nations**
VC	**Venture capitalist**
WTO	**World Trade Organization**

CHAPTER 1: INTRODUCTION

1.1. AIM OF THE THESIS

Innovation almost never takes place in isolation (Edquist, 1997: 1). Instead, it comprises the outcome of habitual interaction across the boundaries of innovation-relevant organizations (i.e. universities, private firms, regional agencies, and the like) and institutions (Hauknes and Nordgren, 1999; Lundvall and Borrás, 1997; Asheim and Coenen, 2006; Edquist, 2001 and 2011; Moodysson and Zukauskaite, 2014). Consequently, the *"system innovation"* stream of economics claims interaction to be a central characteristic of well integrated systems (Lundvall, 1992; Etzkowitz, 1994; Cooke *et al.,* 1998; Nauwelaers and Wintjes, 1999; Isaksen, 1999; Kostiainen, 2002; Howells, 2006; Hollanders *et al.,* 2009; Parrilli *et al.,* 2010; Cooke, 2011; Howells and Edler, 2011; Edquist, 2011; Nauwelaers, 2011; Chaminade *et al.,* 2012; Asheim and Parrilli, 2012; Martin and Trippl, 2013; Parrilli, 2013). This happens to be the case when the seminal works of influential authors provide with definitions where it is taken for granted. Both at regional and national levels, Innovation Systems (ISs) are sometimes defined as:

- ***"The networks of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987).***
- ***"The elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge" (Lundvall, 1992).***

- ***"National systems of Innovation are constituted by "interconnected agents" that interact influencing on the execution of the innovation in the national economy" (Nelson and Rosenberg, 1993).***
- ***"Firms and other organizations are systematically engaged in interactive learning" (Cooke et al., 1998).***
- ***"A system of innovation networks and institutions (…) defined by strong, regular, internal interaction promoting innovativeness" (Kostiainen, 2002).***

Studies reveal these definitions –though ideally accurate- only apply to a small number of advanced regions [1] (i.e. Baden-Württemberg (Germany), Silicon Valley (USA), and the like). Even so, together with the presentation of definitions, academic research could also be motivated by the need for design of appropriate methodological tools facilitating the assessment of Regional Innovation Systems (RISs) and their connectivity. Indeed, improved procedures could bring up more precise diagnoses guiding the orchestration of less favored regions towards unique paths of regional advantage[2] (Asheim and Parrilli, 2012:

1 These definitions might describe certain 'success stories' (Saxenian, 1996; Isaksen, 2001).

2 The concept of "construction of advantage" can be defined as the process of devising ways to valorize specific knowledge-assets at the regional level. In this process, it is crucial to understand that "regional advantage has to be constructed on the basis of uniqueness of the capabilities of firms and regions rather than solely on the basis of R&D efforts" (Asheim and Parrilli, 2012: 2). Thus, we claim this complex process should lead regions to create unique paths of development leveraging on a learning process and interplay across innovation-relevant organizations and institutions.

2). An important cornerstone of these paths comes down to the identification and assessment of system problems across systemic environments. The latter have been defined as *"systemic imperfections that might slow down or even block interactive learning and other activities that are crucial parts of innovation processes in a certain system of innovation"* (Woolthuis *et al.,* 2005; Chaminade *et al.,* 2012). Thus, these problems could constitute the starting point for designing and legitimizing regional innovation policy intervention (Lundvall and Borrás, 1997; Georghiou, 2001; Tödtling and Trippl, 2005; Edquist, 2011; Martin and Trippl, 2013).

As interactivity gains prominence across the outlook of policy intervention, *"intermediaries"* (Nauwelaers and Wintjes, 1999; Bessant and Rush, 2000; Howells, 2006; Acworth, 2008; Parrilli *et al.,* 2010; Cooke, 2011; Nauwelaers, 2011; Tödtling and Trippl, 2012) develop towards more sophisticated practices and rationales. These organizations design, facilitate and catalyze interaction within systemic frameworks. Still, they have not been adequately framed or assessed, which demands for academic attention. Building on the need for identification and assessment of systemic problems and intermediary organizations, the aim of this dissertation would be the following:

To produce a methodology set out to assess potential system problems as well as the association between these problems and the existence/absence of specialized intermediary organizations that operate in RISs.

Before this potential association between system problems and intermediaries can be estimated, the dissertation taps into other important objectives that need to be accomplished:

- ***A procedure guiding the assessment of system problems.***
- ***A procedure guiding the assessment of intermediaries.***

The first procedure set out to analyze a macro-category of system problems that relate to *"learning processes and accumulation of capabilities"* (Marzucchi, 2010: 6). This category could aggregate a number of system problems that have been studied by various schools of thought. First, innovation management studies describe the lack of capabilities of managers and executives to operate private organizations and external networks (Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon 1998). A second collection of studies illustrate their lack of technological capabilities and the complex relation between the former and technological infrastructures (Fagerberg, 1987; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010; Nauwelaers, 2011). Additionally, the financial literature presents how venture capitalists (VCs) and business angels (BAs) facilitate private organizations overcome their lack of financial capabilities (Beck and Demirguc-Kunt, 2006; European Commission, 2011).

Importantly, the framework facilitated by the work of Nauwelaers and Wintjes (1999) (Appendix 1) introduces the possibility to rearrange all these studies together under four innovation barriers, or simply *"gaps".* These gaps are *"Human resource"* gaps, *"Openness and learning"* gaps, *"Technological"* gaps, and *"Financial"* gaps (Nauwelaers and Wintjes, 1999); and will be developed in the second chapter of the dissertation. *"Human resource"* and *"openness and learning gaps"* occur at the level of markets. Firms often lack knowledge, capabilities and also networks to make right managerial decisions as a consequence of their lack of size, or their location and/or resource limitations. Additionally,

"technological" gaps take place when firms and universities or other research organizations do not collaborate as a means to raise the technological level of the former to the current state-of-the-art. Finally, *"financial"* gaps originate when territories lack policy instruments to support the investment of firms in innovation-related projects.

A second procedure assesses the presence -or absence- of intermediary organizations taping into these system problems presented above. In doing so, we set four intermediary categories that specialize in each of the problems; creating *"pairs"* (Table 2.3). Then, these categories will also be aggregated into a new system *"component"* which is conceived as a –policy- tool to help monitor the activity these organizations perform in innovation environments.

1.2. MOTIVATION

The dissertation is motivated and influenced by several projects conducted in the Basque Country between 2007 and 2011. The author of the dissertation has developed his job career in the Basque region during this time period. He belonged to private cluster consultancies that devoted their activity to the activation of partnerships and collaborative projects among distinct organisms and institutions. This often requires overcoming cognitive and physical distances which are essential for learning and innovation (Boschma, 2005; Frenken *et al.,* 2007).

The Basque Country is an autonomous community (AC) of northern Spain. It includes three Historical Territories or Basque Provinces named Bizkaia, Gipuzkoa and Araba. It has slightly over 2 million inhabitants representing about 4.7% of the total Spanish population

(Morgan, 2013: 108). The region is characterized by a polycentric urban system with three main cities, capitals of the introduced provinces that make up the autonomous community, located 100 km away from each other: Bilbao (350.000 inhabitants), San Sebastian (180.000) and Vitoria (230.000) (Navarro *et al.* 2008). The Basque country currently is the wealthiest region in Spain, being the GDP per capita a 33% higher than Spain´s average in 2010 (Eustat, 2012), it has outstandingly improved in the last two decades from 90% of the European Union (EU) average in 1990 till 141% in 2007 (Navarro *et al.* 2008). Its industrial activities were traditionally centered on steel and shipbuilding, giving origin to the great weight that industry has in its economic structure, comprising 30% of all employment, compared with the average of 20% for EU-27 countries (Navarro *et al.* 2008). Besides, the Basque Country is a special unit within Spain and EU enjoying complete autonomy when it comes to taxation and definition of industrial and innovation policies (Parrilli, 2013).

Back in 1990s, this autonomy led policy makers to conduct pioneering top down practices leveraging on its industrial tradition and heading towards its specialization. These approaches dealt with the establishment of a Porterian[3] *"cluster policy"* which is still operative.

3 Porter (1998) defined a cluster as "a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities". We basically follow this definition here because it is the widely accepted one by the Cluster Policy of the Basque Country. Porter and his colleagues of Monitor Company visited the Country in 1991. The Basque Government followed their recommendations which described and analyzed the competitiveness of the region and recommended fostering several clusters associations.

The main focus of the new design concerned fostering the competitiveness and productivity of firms through cooperative projects with regards to three identified areas of improvement: *"internationalization", "quality management"* and *"technology"*. The operationalization of these practices is conducted by several *"cluster associations*" financed by a mix of public and private sources; the former incoming from the Department of Industry, Trade and Tourism (DITT), and the latter from membership fees correlated with firm´s size (Aranguren, 2010: 92). Nowadays, around 30% of the Basque industry is associated to these associations in the Basque Country (Ibid: 91).

Cluster associations have managed important achievements during the last decades. By means of a relatively small financial investment (about 2 million Euros) the Basque Cluster Policy generates precious mechanisms enhancing cooperation among distinct public and private agents; this gave rise to a better adaptation of the public policies to the needs of the private companies and a better acknowledgement of the policies by the latter (Ibid: 93). Notwithstanding these important achievements, and the good will of the -public and private- organizations involved, it is important to notice the lack of formal course of cooperative action among cluster associations (Ibid: 93). Projects

fostering *"related variety"* (Frenken *et al.* 2007) are still scarce[4]. To date, there´s little evidence of inter-cluster collaboration in the Basque Country, and several sectors are suffering risky positions deriving from lock-in situations[5] (Nauwelaers and Wintjes; 1999, Isaksen, 1999; Tödtling and Trippl, 2005; Martin and Trippl, 2013; Morgan, 2013).

Thus, back in 2007 there was an extensive entrepreneurial opportunity for intermediary organizations by fostering horizontal projects across clusters and sectors (i.e. changes and opportunities associated to the electric vehicle), while also helping Small and Medium Enterprises (SMEs) overcome complex situations, whether they were associated or not to formal cluster associations. In this manner, the projects carried out by the author pursued several objectives. First, consultants aimed to group SMEs as a means to promote their *"critical mass"*[6] (Brusco, 1982; Piore and Sabel, 1984; Becattini, 1990). In average, 92% of European enterprises employ between one and nine workers. This percentage is

4 Frenken et al. (2007) state that variety and diversification consist of related and unrelated variety, arguing that not simply the presence of different technological or industrial sectors will trigger positive results, but that sectors require complementarities that exist in terms of shared competences. This need induces a distinction in related and unrelated variety because knowledge spill-overs will not transfer to all different industries evenly, due to the varying cognitive distances (Boschma, 2005) between each pair of industries. Consequently, the existence of these spill-overs across the sectors of a region renders related variety a valuable feature of well-functioning RISs.

5 Lock-in situations occur when the system is too closed and the networks are too rigid.

6 Critical mass would represent the minimum number of companies (that could change depending on the sector and location) necessary to foster collective efficiency and guarantee an impact in local economic development.

slightly higher in some countries such as Spain (93,1%) (Eurostat, 2005). Of course, the small size of the firms provides markets with several benefits such as flexibility or specialization. However, the lack of critical mass might prevent these organizations from better managerial, technological or financial resources. Consequently, by collaborating with independent cluster consultants, SMEs could overcome their lack of managerial capabilities, or *"human resource"* gaps (Nauwelaers and Wintjes, 1999; Bessant and Rush, 1995 and 2000). For example, it was frequent that SMEs did not have resources to foster projects geared towards the diversification of their sales among new international markets. Most of these organization´s sales occurred either in the Basque Country or some other neighboring Autonomous Communities (ACs). Consultants helped SMEs designed collaborative strategies geared towards their participation in national and international fairs. They could even accompany SME´s managers abroad in order to ease communication with potential customers. These collaborations also brought about some other benefits such as improved project and quality management techniques or improved business-model implementation.

Cluster consultants also helped private SMEs to overcome their *"opening and learning gaps"* (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999). Due to their size limitation, SMEs usually focused on what they did best. The truth of the matter is that the lack of size of these organizations often prevented their managers from the chance to participate in social events and congresses. The participation in these events usually helps firms enlarge their social capital by creating new acquaintances while improving their current participation in networks. Accordingly, these

collaborations lead SMEs and their managers to contact unrelated *"peers"* they could share problems and interests with.

These projects were also geared towards facilitating a closer interaction between SMEs and research organizations. Cluster consultants could link together SMEs and SME groups with other intermediary organizations (i.e. business and trade associations) that could facilitate SMEs tapped into "*technological gaps"* (Nauwelaers and Wintjes, 1999; Dalziel, 2009; Parrilli *et al.,* 2010). Without their intermediation, these practices would have seldom taken place. First, SMEs felt no interests or understanding on the part of research organizations which appeared to be more focused and interested in large organizations. On the other hand, intermediation could also induce research organizations to adapt their language and experiences to the specific needs of small organizations. Research organizations sometimes felt SMEs were not interested in investing resources or even sharing their problems with them. Thus, intermediaries (i.e. Knowledge Intensive Business Services (KIBS) such as cluster consultants) could facilitate the emergence of trust networks between organizations that were sometimes cognitively distant in several dimensions (Boschma, 2005; Frenken *et al.,* 2007).

Independent cluster consultants also informed SMEs about the existence of public grants and investors. Policies where occasionally designed to promote SME´s investment in innovation projects. The size of some of these projects sometimes demanded the participation of certain –informal- investors (i.e. business angels (BAs)) that could support capital investments. Thus, cluster consultants could facilitate SMEs got in contact with certain intermediaries who specialize in helping them overcome their lack of financial capabilities (Nauwelaers

and Wintjes, 1999; Beck and Demirguc-Kunt, 2006; European Commission, 2011).

As a matter of fact, the author of the current dissertation claims that *"Small and fast"* –run by ideas- independent cluster consultancies would sometimes be in competition with some *"big but slow"* –run by hierarchies- cluster associations. Some cluster association´s –more generalists- projects were better designed to represent and defend the needs of large firms, sometimes neglecting SME´s opinions and demands. Importantly, path dependency led some of these associations to reinforce already existing networks over time. Their comfortable –and partially financed- position prevented change, treating clusters as *"private domains"* where specialized consultancies were seldom welcomed. In a society like the Basque, where position, power and hierarchy dominate decision making processes (Karlsen *et al.,* 2011), these years of experience motivated the author of the current dissertation to find several hidden interests (i.e. keeping status quo, managing privileged information, lobbying public sectors, etc…) and strong boundaries that protect the aims and wills of –just- a few. The acceptance of demand-sided and horizontal processes was of course, as difficult as provocative.

These experiences opened new questions on the research of system problems and their potential relation with intermediary organizations in systemic environments. In fact, the experiences, together with a deep academic literature review and debate, facilitated the identification of certain research development opportunities which are listed below and constitute important aspects that also motivated the dissertation:

First, the thesis taps into a number of conceptual gaps found in the literature. As stated, a number of system problems or *"gaps"* had been

identified by different strands of the literature, but there was little communication among them (Fagerberg, 1987; Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon, 1998; Martin and Scott, 2000; Beck and Demirguc-Kunt, 2006; Parrilli *et al.,* 2010; Dalziel, 2010; Nauwelaers, 2011; European Commission, 2011). Therefore, we present an interpretative framework that enshrines these problems along with the components they relate to. The framework is also proposed as a means to overcome the imprecision on how these problems should be identified in innovation environments (Edquist, 2011; Chaminade *et al.,* 2012). Second, we complete the framework with the incorporation of several intermediary *"categories"* that tap into these *"gaps".* We present a novel categorization that creates *"pairs"* between the gaps and *"peer"* intermediary profiles at different layers [7] of ISs (Table 2.3). This categorization permits setting system problems together with the components and intermediary organizational categories they relate to (Figure 2.2). Third, intermediary *"categories"* are aggregated into a new *"Associative Component"* which will also be contained in the last evolution of the conceptual framework (Figure 2.3). The existence of commonalities in the purpose and activity performed by these categories suggested the possibility to arrange intermediary organizations together. Thus, we set them in a –new- system component. The *"Associative Component"* includes all intermediary organization profiles. This development will set up appropriate

7 We employ the term to interpret - metaphorically - several interactions that coexist in a given RISs. Some of these –main- interactions will be exemplified in the figures 2.1-2.3. For example, the interaction between the universities and firms would establish one of these layers.

boundaries across intermediary *"categories",* the collection of system problems, and the innovation subsystems they liaise with. This evolution will also contribute to prevail over the *"fuzziness* [8] *"* (Nauwelaers, 2011) that the current systemic "*complexity"* returns to the functions of intermediary organizations[9].

Likewise, the dissertation faces the challenge of producing a methodology set out to assess both *"system problems", "intermediary organizations"* and importantly, the association among them. Leveraging on the systemic logic of the conceptual framework that we have introduced, the dissertation establishes a theoretical and empirical bridge between neoclassic and evolutionary-systemic approaches, facilitating the identification of mismatches between innovation policies, intermediaries and the existence of system problems. First, it puts together a number of indicators to analyze system problems across Spanish ACs. The analysis returns, to our best knowledge, the first typology assessing system problems across Spanish regions. Second, the dissertation arranges a number of indicators to analyze *"Associative Components"* across Spanish ACs. The analysis also feeds back a novel typology that provides information regarding the activity of these

8 "Fuzziness" is the term employed by Nauwelaers (2011) to describe the concept of regional innovation intermediaries which, she states, covers a wide diversity of specific organizations that, in most cases, grown lacking strategic governance (: 467).

9 As Howells (2006: 724) put it, "In distributed innovation systems, intermediaries are increasingly involved in more complex relationships, such as "many-to-one-to-one", "one-to-one-to-many", "many-to-one-to-many", or even "many-to-many-to-many" collaborations, forming both vertical and horizontal relationships in increasingly distributed innovation networks".

components across the regions. Third, the dissertation focuses on analyzing the relation between both outputs by the employment of multivariate statistical tools. All in all, this study completes previous studies and literature strands; while enhances communication and establishes a bridge between their assessment practices and rationales.

1.3. RESEARCH QUESTION

In a context where information distributes asymmetrically, intermediary organizations widen and specialize to adapt to specific needs across systems, their organizations and institutions. However, a more unorthodox outlook might demand clarifications on their functional and structural arrangement. It could be very interesting to research on whether these organizations respond to system demands (i.e. system problems), to a passing fad, or if at all, some of them constitute executive arms of political and economic –more or less clear- agendas and interests. Importantly, these organizations receive public funds and loans to –at least partially- support their activities (Aranguren, 2010; Nauwelaers, 2011). Consequently, after a period of *"letting a thousand of flowers blossom",* both their individual and their collective effectiveness is being called into question. Public authorities are faced today with an urgent need to optimize a system of intermediaries that has in most cases grown in a somewhat anarchic way, lacking strategic governance (Nauwelaers, 2011: 467).

The domain of innovation intermediation has been observed through many different lens and perspectives through the last decades, which demanded for summaries that facilitated discussion and comprehension. The latter created a need for a better understanding of their role, mission and functionality (Howells, 2006; Nauwelaers, 2011).

First, a –novel- review of the literature synthesized previous research approaches and aggregated them into several complementary literature strands (Howells, 2006). This work permitted the creation of a research field of its own, which also leveraged on a much wider and holistic approach to the understanding of intermediary organizations. A second and complementary seminal work summarized the contrasted features of innovation within traditional and systemic-evolutionary frameworks (Nauwelaers, 2011).

However, while external and internal challenges produce distress and change, it is still necessary to –empirically- assess whether intermediary organizations accomplish the crucial role of shaping variable geometries of information networks across system problems and time-based requirements. The dissertation aims at making a contribution at this particular gap by proposing a more straightforward and comprehensive approach. In doing so, the dissertation aims at complementing previous seminal. Thus, by leveraging and relying on previous developments (Howells, 2006; Nauwelaers, 2011), our slightly different and complementary approach will bring forward an important contribution to the literature. Categorizing intermediary organizations will permit -a novel- empirical assessment on their performance over RISs. A possible way to assess the activity and effectiveness of intermediary organizations asks for an observation of their presence –or absence- in system problems and innovation environments. First, we need to systematize a procedure to analyze the size and comparative relevance of system problems in RISs. Second, we need to categorize a set of complementary intermediary organizations which specialize in each problem under assessment, creating *"pairs"*. Third, both intermediary categories and system problems need to be framed

together as a means to operationalize a number of variable sets that could induce assessments.

In order to do so, we bring in the question of whether a RIS lacking system problems is also a system where intermediary categories behave effectively, and vice versa. In other words, the underlying research question of the dissertation would be the following:

- ***Does a dense intermediary network predict well integrated RISs?***

In order to answer this question, we need to respond to other individual queries of importance for the dissertation:

- ***How can we measure integration in RISs?***
- ***How can we measure the presence –or absence- of the intermediary networks in each RIS?***

1.4. CONTRIBUTION

The dissertation makes a number of conceptual, methodological and empirical contributions. First, regarding the theoretical background, we present an interpretative framework (Figure 2.1: System problems and RIS components) that evolves through three stages of development to satisfy the empirical requirements of the thesis. As stated, our construction contributes to a tradition of seminal works that study a number of system problems (Nauwelaers and Wintjes, 1999; Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon 1998; Howells, 2006; Beck and Demirguc-Kunt, 2006; Parrilli *et al.,* 2010; Dalziel, 2010). Its first stage of evolution places these problems together with the system

components they relate to (i.e. *"regional policy"*, *"knowledge exploration"* and *"knowledge exploitation subsystems"*). In addition, a crucial benefit of the framework comes down to its employability in the operationalization of a number of quantitative variable sets that will permit the empirical assessment of the problems. Its second stage of development (Figure 2.2: Intermediary categories, system problems and RIS components) enhances the picture with the incorporation of a number of intermediary categories that tap into the system problems. Consequently, new quantitative variable sets are included to facilitate the empirical assessment of these categories in RISs. Last stage aggregates intermediary organizations in a new *"Associative Component"* (Figure 2.3: The *"Associative Component"*). This component is introduced to assemble all intermediary organizations which design, facilitate and catalyze systemic interaction within systemic frameworks (i.e. NISs, RISs, and the like). This development will set boundaries among distinct intermediary organization categories, the system problems they tap into, and regional components (i.e. *"knowledge exploration"* and *"exploitation subsystems"*). This evolution will also contribute to prevail over the *"fuzziness"* (Nauwelaers, 2011: 467) that the current systemic complexity returns to the functions of intermediary organizations.

Second, regarding the methodological background, we add up to a recent literature tradition that builds on the use of econometric techniques to analyze several characteristics of RISs. This tradition gathers typologies that seize the diversity and the variety of innovation and efficiency patterns (Coronado and Acosta, 1999; Susiluoto, 2003; Martínez-Pellitero, 2007 and 2007; Buesa and Heijs, 2007; Zabala-Iturriagagoitia *et al.,* 2007; Zabala-Iturriagagoitia, 2008; Navarro *et al.,* 2009; Navarro and Gibaja, 2012). However, while analyses measure

input and output additionalitity (i.e. Research & Development (R&D) investment and its results), the system innovation framework requires the assessment of the behavioral additionalitity (in terms of new innovation culture, new collaboration patterns, change in companies organizations towards innovation, for example) (Nauwelaers, 2011: 471). Accordingly, this strand of literature leaves significant space to complementary contributions. However, these approaches are not mutually exclusive. Each approach has its limitations and pitfalls and missing out on one of them is likely to hamper effective policy-making (Hauknes and Nordgren, 1999: 21). An inspiring example of an assessment conducted under system innovation rationales would be the work of Chaminade et al. (2012) whose methodology is, to our best knowledge, an important attempt to estimate mismatches between innovation policies and problems. In this line, the present dissertation leverages on the use of econometric procedures to build on the assessment of systemic problems and importantly, the behavior of intermediary organizations that solve them.

Our analysis will bring forward two complementary typologies of Spanish regions. The first one will group Spanish regions in terms of the existence -or absence- of system problems in their RISs. The second typology will arrange the regions according to the presence –or absence- of intermediary organizations solving system problems. All in all, the procedure rounds up literature strands. While theoretical studies often lacked foundations to refute their analyses empirically (Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon 1998; Nauwelaers and Wintjes, 1999; Woolthuis *et al.,* 2005; Howells, 2006; Beck and Demirguc-Kunt, 2006; Dalziel, 2010; Nauwelaers, 2011), econometric studies did not pursue an exhaustive description or examination of RIS –interactive- practices. The

dissertation blends most significant aspects of both schools in order to deepen their scope.

1.5. SUMMARY OF CONTENTS

We finish the chapter with the overview of the most significant empirical contributions of the dissertation. To begin with, we present typologies of Spanish ACs. The first one creates groups of Spanish regions according to the integration of their ISs. The second groups Spanish regions according to the presence -or absence- of *"Associative Component"* networks solving system problems. Therefore, while the former adds to a modern tradition of studies that present regional typologies, the second constitutes, to our best knowledge, the first attempt to create a typology that classifies regions according to the behavior of just one of their components. As explained, this *"Associative Component"* will also be introduced in this dissertation. These findings are completed with a second –main- achievement. After these analyses have been completed, what remains unfold is the exploration of any existing relationship among their outputs. This calls into question a potential relationship between the presence/absence of *"Associative Components"* and the level of integration of RISs. As it will be explicated, **the statistical output of the study has proven the relational density of the *"Associative Components"* to be a valid predictor to explain the level of integration of RISs across Spanish regions.**

The dissertation establishes that the level of integration of a RIS can be predicted through the analysis of the density of its *"Associative Component"*. The former statement is built on two essential achievements of the study. First, the integration level of a RIS can be

appraised by means of a compilation of system problems (i.e. *"gaps"*). Second, the adequate running of an *"Associative Component"* can be reckoned by dint of the analysis of the presence –or absence- of a number of specific intermediary organizational profiles over the system problems (from intermediary category number 1, to intermediary category number 4). These developments facilitate grounding the hypothesis of the study: **Dense *"Associative Components"* would predict well integrated (Spanish) RISs.**

All in all, the current introductory chapter presents the aim of the dissertation, its motivation, its research question, and its main contributions. Chapter two begins with an overview on innovation studies and an introduction to the evolutionary and system innovation literatures and their rationales. This background sets the theoretical background of the dissertation. After the presentation of these theories, a collection of system problems are integrated into an interpretative framework composed of key innovation subsystems. Second, this framework is completed with the incorporation of the intermediary *"categories"* that solve system problems. Third, intermediary *"categories"* are aggregated into a new *"Associative Component"* which will also be contained in the last evolution of the framework. This development will set up appropriate boundaries across intermediary *"categories",* the collection of system problems, and the innovation subsystems they liaise with. The systemic logic of the framework will ease the advancement of empirical examinations.

Chapter three presents the methodology of the dissertation. It introduces the Spanish background and a number of empirical studies that have assessed its innovative and efficiency patterns across its regions. It also presents the data sets and variables necessary to

produce empirical assessments. We operationalize an array of quantitative indicators devoted to the analysis of system problems and intermediary *"categories"* across Spanish regions. These indicators stem from various surveys conducted by the Spanish National Statistical Institute (INE) and the Spanish Venture Capital Association (ASCRI). We conduct Multiple Factor Analysis (MFA) (Escofier and Pagès, 1990, 1998; Pagès, 2004) to reduce the dimensionality of the data sets, and Cluster Analysis (CA) to categorize and summarize results. The procedure suggests two new typologies. First, regions will group together in accordance with their integration level. Second, regions will arrange in terms of the density levels of their *"Associate Components".* We also explore the relation between the former categories. Canonical Correlation Analysis (CCA) (Hotelling, 1936; Thomson, 1984; Luthans *et al.,* 1988; Sherry and Henson, 2005; González *et al.,* 2008; Graham, 2008; Oslund, 2010) unfolds this relationship, as it permits stressing correlations between the indexes created to assess the system problems and intermediary *"categories"* aggregated in the *"Associative Component".*

Chapter four presents the findings of the dissertation. The first typology distinguishes among groups ranking from *"inexistent"* to *"integrated"* RISs. The second typology differentiates among groups ranking from *"inexistent"* to *"active Associative Components".* The analyses prove asymmetric responses not only within, but also across the regions. In addition to the former, the correlation between system problems and intermediary *"categories"* recommends for the approval of the hypothesis which stated that dense *"Associative Components"* predict well integrated RISs (i.e. Navarre, Basque Country, Catalonia or Madrid). On the other hand, we also find that inactive or inexistent *"Associative Components"* come together with disintegrated RISs (i.e.

Andalusia, Extremadura, Murcia). These results have been completed by the investigation of possible patterns of relation between specific system problems and peer intermediary *"categories"*, leading to inconclusive results which also open new avenues for framing research. The latter leave space to elaborate on more specific and focalized indicators that could facilitate further steps towards better-tuned assessments and policy recommendations.

Chapter five concludes the dissertation. The chapter summarizes the thesis with the review of its main theoretical and empirical findings and brings up general conclusions. It also presents some general policy implications and recommendation for each of the groups that stem from the analysis. After these recommendations, the dissertation concludes with the presentations of some new research possibilities and questions.

CHAPTER 2: CONCEPTUAL BACKGROUND

2.1. INNOVATION: A LITERATURE REVIEW

Innovation has become a trendy scholarly literature category over the last decades. It is nowadays discussed by a variety of disciplines in the technical and scientific literatures, in history, sociology, management, arts and humanities (...) and also in economics. Indeed, innovation gathers attention as it becomes a powerful attribute that helps scholars explain differences across countries, their technological progress and the success of their business organizations. There's an extensive acceptance that it constitutes a key element leading to economic development and competitiveness. Most advanced countries develop through the innovative capabilities of their organizations as they sell more competitive and attractive products and services in the global market. These activities bring increased revenue streams which actually lead to better job opportunities and increased Gross Domestic Products (GDP) (European Commission, 1996), creating institutional dynamics (Lundvall and Borrás, 1997; Asheim and Coenen, 2006; Edquist, 2001 and 2011; Moodysson and Zukauskaite, 2014) that reinforce the tendency of these countries to rely on innovation as a source of international recognition, growth and welfare. Several reports rank countries according to their performance on the topic. The *Global Innovation Index* is among the best known ones. Its latest presentation ranks Switzerland, Sweden, United Kingdom, Netherlands and the United States of America, as top 5 innovative countries in the world. By

contrast, World Economic Forum´s *Global Competitiveness Report* ranks Switzerland, Singapore, Finland, Germany and the United States as the most innovative regions.

However, innovation is still an underdeveloped concept. The criteria behind the construction of these rankings, along with the definition of the notion itself, remain open questions. Innovation has often been defined a complex mix of creativity, design, and invention in processes, services, technologies or ideas that are readily available to markets, governments, society and the environment. The term also associates with others such as change, customers or knowledge. Joseph Schumpeter is considered to be one of the first and most influential authors on the issue. He claimed innovation to be a *"dynamic force"* that causes transformations of social, economic and institutional structures. The author acknowledged five different types of innovation (Schumpeter, 1934):

- ***Implementation of goods (products) that are new to consumers, or higher quality than their previous counterparts;***
- ***Implementation of production methods (processes) that are new to specific industries and economic activities in which they are used;***
- ***Opening of new markets;***
- ***Use of new sources of raw materials;***
- ***Implementation of new forms of competition that lead to structural changes in the industries of their implementation.***

According to Fagerberg (2013: 11), another significant contribution attributed to Joseph Schumpeter is the classification of innovations

according to how radical they are. Continuous improvements are often characterized as *"incremental"* as opposed to *"radical"* innovations or *"technological revolutions",* which may have a very far-reaching impact across industries and economies (Schumpeter, 1934 and 1942). Radical innovation is about making major changes in something established, whereas incremental innovation is less ambitious in its scope and often offers less potential for returns; but consequently the associated risks are less important. The author also differentiated between *"innovation"* and *"invention".* Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into markets. Schumpeter explains how the innovator needs to master certain capabilities, skills and resources that go beyond others related to invention. For example, the innovator needs to know the market and be able to facilitate financial resources, among others. Consequently, in the early works of the author, the innovator or *"entrepreneur"* was presented as a leader and visionary *"hero"* who disturbs the equilibrium, and was considered the prime cause of economic development and growth. Schumpeter was arguing that, through entrepreneurship, innovating organizations could challenge optimizing ones, and thereby drive changes in the economy. Later works of the author recognize the weaknesses of the visionary entrepreneur when they aim to succeed against social *"resistance to new ways"*, as he emphasizes the vast importance of large firms, focusing on the tendency of innovation to cluster in certain industries and time periods (Schumpeter, 1942).

In economics, most of the focus has been devoted to product and process innovations (Fagerberg, 2013:10). Through product innovations, organizations can gain competitive edge by differentiating their output and increasing the quality and variety of goods, which

allows them to increase the demand side and open up opportunities for growth. On the other hand, process innovations allow organizations to improve the quality of the products, or attain improvements in the efficiency of their production. Thus, product innovations are more focused on markets and are mainly customer driven, whereas process innovations are primarily driven by efficiency (Utterback and Abernathy, 1975). The focus on products and processes could be explained by the excessive importance provided to technological change. In fact, technological supremacy has sometimes been claimed to spur global dominance, as during the years of Cold War by the United States of America (Fagerberg, 2009: 3). Nevertheless, other forms of innovation have also been claimed to be crucial to the development of nations. While useful for the analysis, product and process innovations should not lead us ignore other important aspects of innovation which include organizational or market betterments (OECD, 2005). New business model designs, among others are crucial aspects of innovation.

Arguably, innovation is also a beautiful *"catchword"* that aims to explain too much, while some irreplaceable questions remain hidden and need to be studied. Nevertheless, and due to its growing importance, scholars and key organizations have provided with some extensive definitions that aim to grasp the concept in a more specific manner. In other examples, we find that scholars and organizations prefer to provide with more simple and *"all inclusive" definitions that gather its significance at many different layers. All in all, most accepted definitions of innovation are introduced by the Organization of Economic Co-operation and Development (OECD). This organization defines innovation as "all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new*

or improved manufactured products, the commercial use of new or improved processes or equipment or the introduction of a new approach to a social service" (OECD, 1981). More open definitions have defined it as *"new creations of economic significance"* (Edquist, 1997: 1). Following this wider path, in our view, it could also be basically described as any change motivated by research that brings in improved outcomes. However, most widespread definitions describe innovation in more complex ways such as *"the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations".* Table 2.1 summarizes a classification provided for the concept (OECD, 2005).

Table 2.1 Innovation Classification

	Application	Description
Product innovation	Innovations related to goods and services	Significant improvements in the technical specifications, components and materials in the embedded software, in the degree of friendliness to the user, or other functional characteristics
Process innovations	Implementation of new or significantly improved methods of production or delivery of the product	Significant changes in technology, production equipment or software
Marketing innovation	Implementation of new methods of marketing, including significant changes in design or packaging of the product during its storage, market promotion and market-based prices	Improved degree of consumer satisfaction, creating new markets or new, more favorable market positions to increase sales

Organizational innovation	Implementation of new forms and methods of organization of business companies, the organization of jobs and external relations	Implementation of new business practices in the organization of workplaces or in its external relations as a result of strategic decisions
Source: adapted from Oslo Manual, 3rd edition (2005)		

As a matter of fact, the complexity that innovation entails demands cutting across an important amount of activities, organizations and time spans. Innovation requires participation from many different actors and inputs form a multitude of sources, whether public or private. However, first explanations on how inventions were translated into innovations were described by the dominating perspective that coined the process as the *"linear model".* This model was based on the assumption of the existence of well-defined stages. These stages began in research and should finish in the commercialization and marketing of new products and services. The problems associated with the transformation of inventions into innovations were either ignored, or assumed to be relatively easy to handle, depicting the process as smooth and unidirectional. On the contrary, most innovations do not stem from scientific breakthroughs (Fagerberg, 2013: 23). In fact, the experience of users, not science, is claimed to be the most important source of innovation (von Hippel, 1988; Lundvall, 1988; Jensen *et al.,* 2007; Chaminade *et al.,* 2012). Importantly, the linear model ignores very essential aspects. Innovation is complex, uncertain and subject to many changes and feedback loops among actors. In a nutshell, the process of innovation must be viewed as a series of changes in a complex system not only of hardware, but also of the market environment, production facilities and knowledge and the social contexts of the innovation organization (Kline and Rosenberg, 1986).

THE EVOLUTIONARY THEORIES OF INNOVATION AND TECHNOLOGICAL CHANGE

The evolutionary theories embody the growing recognition of the difficulties that equilibrium theories presume (Dosi and Nelson, 1994: 154). These theories present a number of new –main- principles and applications to the social and the economic domains (Nelson and Winter, 1982; Nelson, 1992, 1995 and 2004; Nelson and Rosenberg, 1993; Dosi and Nelson, 1994; Metcalfe, 1995; Cooke *et al.,* 1998; Malerba, 2009; Uyarra, 2010). First, economic organizations will no longer be considered *"optimizing innovators".* Second, endogenous, systemic innovation and technical change will imply that there is no longer any well-defined optimum allocation of resources. Third, the importance of learning will be underlined. Fourth, evolutionary theories will describe innovation as an uncertain process that roots in the interaction among dissimilar and complementary organizations. Fifth, the territorial dimension will take a leading role in the process of innovation. Sixth, the importance of the institutional framework will also be outlined as consubstantial to the evolution and progress of territories. Last, networks will be considered central to the process of innovation and technological change.

As stated, economic organizations are no longer considered *"optimizing innovators".* Under the new paradigm, they are considered heterogeneous and bounded rational *"behavioral innovators"* that act according to their competences and peculiar cognitive and strategic aspects (Nelson and Winter, 1982; Metcalfe, 1995; Marzucchi, 2010). The game of economic competition changes character from the neoclassical unique sets of optimal behavior and perfect rationality, to optimization that is contingent on local characteristics, to *"bounded*

rationality" (Hauknes and Nordgren, 1999:14). Consequently, the future of an organization can no longer be predicted, it cannot be *"rationally anticipated"*, and its course can be changed by luck or human will.

Second, innovation and technical change implies there is no longer any well-defined optimum allocation of resources (Hauknes and Nordgren, 1999:15). The evolutionary approach enhances framework-conditions so that systemic environments can be better self-organized[10] (Metcalfe, 2005; Marzucchi, 2010). Policy is not justified simply by an under-supply of knowledge, but by areas of systematically weak performances (i.e. system problems).

Third, the importance of learning is underlined. The state around which neoclassical economics builds their models may be described as a state where there is no incentive to learn. All expectations are fulfilled and *"business as usual"* is the best kind of rule to follow. Thus, the fact that most economically useful kinds of knowledge have a tacit dimension and that such knowledge can only be obtained in a social process of interaction is completely disregarded (Lundvall and Borrás, 1997: 49). On the contrary, technological advance and innovation are characterized by constant interplay and mutual learning between different types of knowledge and organizations. Change and evolution can be seen as gradual and cumulative learning processes which lead

10 Policy has to set the framework conditions in which innovation systems can better self-organize themselves and enhance innovation opportunities and capabilities. As systems are defined by components interacting within boundaries, policy needs to address failures due to missing components, missing connections, and misplaced boundaries (Metcalfe, 2005; Marzucchi, 2010).

to a relatively ordered pattern of innovations. Firms build upon their existing knowledge base when they search for new innovation opportunities, but they also use external sources of knowledge in this search (Metcalfe and Georghiou, 1998, Carlson and Jacobsson, 1997; Hauknes and Nordgren, 1999).

Fourth, evolutionary theories describe innovation as an uncertain process that roots in interaction among dissimilar and complementary organizations (Lundvall and Borrás, 1997; Edquist, 1997; Nauwelaers and Wintjes, 1999; Parrilli *et al.,* 2010; Howells, 2006; Zabala-Iturriagagoitia, 2008; Nauwelaers, 2011; Asheim and Parrilli, 2012). The overall performance *"is not only dependent on how specific actors perform but also on how they interact with others"* (Hauknes and Nordgren, 1999: 7). Empirical studies of innovation (Susiluoto, 2003; Buesa and Heijs, 2007; Zabala-Iturriagagoitia *et al.,* 2007; Martinez-Pellitero, 2007 and 2008; Zabala-Iturriagagoitia, 2008; Navarro and Gibaja, 2009, 2010 and 2012; Navarro *et al.,* 2009; Chaminade *et al.,* 2012) declare that firms need to interact and cooperate. Intensive communication and collaboration between different actors is said to be required, both among private firms and also among private firms and other organizations such as universities, standard-setting bodies, innovation centers, financing institutions, industry associations, government agencies, etc…

Fifth, territories turn a primordial dimension of the theory, facilitating the understanding of the innovation process and the technological evolution and change. As a matter of fact, the exchange of tacit knowledge requires from trust and cultural understanding, which develops through geographical proximity (Landabaso, 1995; Lundvall and Borrás, 1997; Boschma, 2005; Zabala-Iturriagagoitia, 2008). The latter explains that

the role of a particular institution can differ among countries, and this is why the territorial dimension constitutes such an important dimension. For example, R&D institutes may be important in some countries but not so much in others. Likewise, legal systems, rules, norms, values also differ (Hauknes and Nordgren, 1999; Lundvall and Borrás, 1997; Asheim and Coenen, 2006; Edquist, 2001 and 2011; Moodysson and Zukauskaite, 2014). Hence, the ideal learning environment is characterized by a predictable institutional framework and by incentives that make it attractive to learn in interaction with others (Lundvall and Borrás, 1997:59).

Last, under the evolutionary scheme, networks are considered central to the process of innovation and technological change. Learning processes stem from networking rather than through hierarchies and markets. Networks, as non-market and non-hierarchical forms of industrial organization, reduce the costs of communication and transaction, and facilitate interactive learning across different organizations and institutions (Lundvall and Borrás, 1997: 103). Communication, co-operation and coordination between actors are conceived as essential elements of these processes (Ibid: 108). These networks span from local to international dimensions. Following the authors (Ibid: 105) the regional dimension of innovation networks is crucial for a number of reasons: (a) The capacity for developing human capital, as well as interactions between firms, schools, colleges and those responsible for vocational training is normally localized; (b) Networks of formal and, more usually, informal contacts between network members are made possible through casual or planned meetings, information exchanges and customer-supplier relationships; and (c) Synergies, or an innovative *"surplus",* can emerge from the

shared cultural, psychological or political perspectives of those engaged in the same specialization in the same economic space or region.

All in all, and due to the influence of evolutionary theories, innovation-studies abandon the linear model of innovation to embrace more holistic and systemic approaches. These studies aim at explaining how innovations emerge and diffuse, what influences the processes (including the role of policy) and what the social and economic consequences are (Fagerberg, 2013: 3). The strand builds on the work of several authors that believe in the interdisciplinary nature of innovation. More and more it has been formulated as a multifaceted process that takes place between institutional and organizational elements aggregated in *"systems of innovation"*. These *"systems"* represent a widespread approach introduced by a number of seminal works seeking to capture both the political and the economic determinants underlying innovation and socio-economic progress (Freeman, 1987, Lundvall, 1992; Nelson, 1992; Nelson and Rosenberg, 1993; Edquist, 1997).

The strand of the literature shares a common will which deals with achieving an improved understanding of the processes that relate to innovation, the production and the diffusion of knowledge. However, its main authors present some differences and variations that we present in the following lines. First, Christopher Freeman was one of the most outstanding and eminent researchers in innovation studies and evolutionary economics, and probably one of the most influential. He directed the Science Policy and Research Unit (SPRU) of the University of Sussex, and founded the journal *"Research Policy",* establishing it as the leading journal in the field. He underscored the importance of technical change in the transformation of economies. His work also

focused in the socio-institutional environment as a factor that may spur or prevent dynamic adjustment processes. He contributed substantially to the revival of the neo-Schumpeterian tradition, and mentored several generations of economists and social scientists.

Second, Bengt-Ake Lundvall was one of his best known mentees, together with Daniele Archibugi, Giovanni Dosi or Jan Fagerberg. Lundvall´s work is best known because of the development of the idea of innovation as an interactive process and the idea of *"the learning economy"* (Lundvall and Johnson, 1994). He defines NISs as broad structures, without well defined limits. In his definitions, the productive and institutional structures constitute the most important elements of the system.

Third, Richard R. Nelson is one of the leading figures in the revival of evolutionary economics thanks to his seminal book *"An Evolutionary Theory of Economic Change"* (1982), written jointly with Sidney G. Winter. His outlook, more empirical, underscores the importance of R&D departments, universities and laboratories with regards to technical change and the evolution of nations.

Last but not least, Charles Edquist is one of the founders and first Director of the Center for Innovation Research and Competence in the Learning Economy (CIRCLE), at Lund University. The author emphasizes the importance of the relation between organizations and institutions, and provides sound definitions of the latter. His work also focuses on *"innovation policy"* and *"entrepreneurship".* He justifies and underscores the importance of studying these elements from a system Innovation outlook.

These authors share the concept of *"systems of innovation"* when describing a number of principles that could be considered the grassroots of this strand of the literature. These principles have been suitably established (Edquist, 1997); as system innovation literature strand inherits them from evolutionary economics. In a nutshell, innovation and learning mechanisms are described as crucial elements of economic success. Second, systems are constituted by heterogeneous organizations and institutions that evolve and change; and thus are said to be *"dynamic"* (Lundvall and Borrás, 1997; Asheim and Coenen, 2006; Edquist, 2001 and 2011; Moodysson and Zukauskaite, 2014). Third, knowledge creation is explained as a longitudinal cumulative process that creates inertia and "*path dependency*[11]*"* across territories. Fourth, the *"systems of innovation"* approach is considered holistic and interdisciplinary in the sense that it encompasses a wide array of determinants of innovation. While technological innovation is vindicated as a crucial drive for development and growth of economies, the importance of other forms of institutional, organizational, social and political betterments are also underlined.

While conceptually attached to nations, *"systems of innovation"* were soon adapted to regions and their dissimilar dynamics. Though interdependency among the regional, national and international levels grows endlessly, the incremental relevance of regions has been underlined (Landabaso, 1995; European Commission, 1996; Porter,

11 Following the "path-dependency" logic, depending on the particular interfaces that are nurtured in ISs, the future development of the region itself would be different (Nelson and Winter, 1982).

1990; Lundvall and Borrás, 1997; Porter, 1998; Cooke *et al.,* 1998; Asheim and Isaksen, 2002; Asheim and Coenen, 2005; Uyarra, 2010; European Union, 2013; OECD, 2013). As a matter of fact, the role and importance of the region as a point of reference is changing rapidly and is still evolving within the EU area. This has resulted in a process of competence devolution to the regions in several EU countries, which gives them room to develop their own policies (Landabaso, 1995; Zabala-Iturriagagoitia, 2008). The *"regionalization"* argument describes how innovative performance is intimately bound up with place-specific *"sticky"* factors whose cost of transmission rises with distance[12] (Porter, 1998; Asheim and Isaksen, 2002; Tödtling and Trippl, 2005). These factors can be industry and policy related. First, industries concentrate in specific locations. The experience of agglomeration explains successful performance of many businesses (Schmitz, 1995, Schmitz and Nadvi, 1999). Improvements take place as a consequence of a

12 While the cost of transmitting information may be invariant to distance, knowledge is embedded in specific contexts where shared institutions are fundamental.

number of external economies[13] that have been conveniently revised (Marshall, 1919; Becattini, 1989; Porter, 1990). Second, the regional level adapts better to decentralized policies that apply in these industrial placements (Porter, 1990).

Regional and national ISs can be considered twin concepts[14]. Choosing the study of the former or the latter frameworks will depend on the specific characteristics and subjects that need to be analyzed by academics and policy-makers. The literature provides examples of case studies where both national (Freeman, 1987; Lundvall, 1992;

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13 In economics, a positive externality (also named "external benefit or "external economy") could be interpreted as an effect arising from the production or consumption of goods and services for which no appropriate compensation is paid. For example, increased education can lead to broader benefits in the form of greater economic productivity or a lower unemployment rate. Good examples of external economies could be found in the literature of clusters and industrial districts where organizations gain a number of benefits related to their location. Marshall emphasized the importance of this industrial atmosphere as it enabled people learn the industry as if it was "in the air" (Marshall, 1890: 169). There are different types of external economies which may affect the transmission of information, innovation and technology. They could also affect the labor market, providing specific and generic training characteristic of the dominant activity in the cluster or district. All in all, when the costs are shared by different firms, industrial production could become more efficient than competitors based in large companies.

14 Following Zabala-Iturriagagoitia (2008: 19), "the NIS approach puts more emphasis on state issues, such as the education system, institutional learning and the interaction among national actors (i.e. personnel mobility, market transfers, co-operation agreements, etc), while the RIS is more oriented towards regional social features comprising identity matters and hence, has more direct impact on the policy-making sphere".

Chaminade *et al.,* 2012) and regional frameworks (Asheim and Isaksen, 2002; Buesa *et al.,* 2002; Zabala-Iturriagagoitia *et al.,* 2007; Navarro et al., 2008; Navarro and Gibaja, 2012) have been employed to conduct assessments. However, when it comes to Europe, it is important to notice that the Directorate General (DG) for Research and Innovation launched the idea of *"constructing regional advantage"* as the new way of taking on and combating the challenges of regions (Asheim *et al.,* 2006; Asheim and Parrilli, 2012). The latter means that the regional would be the most adequate level when it comes to facing certain challenges which, like spurring connectivity, are crucial for innovation.

More specifically, the regional outlook is claimed to be very useful for the study of the innovation and economic performance, and for the design and implementation of regional innovation policies[15] (Asheim and Coenen, 2005; Navarro and Gibaja, 2009). These policies complement the *"market failure"* rationale (Nelson, 1959; Arrow, 1962). The systemic and evolutionary outlook focuses on organizations in an innovation system and their interaction, not in their investments in R&D or the output of the system itself (Hauknes and Nordgren, 1999: 20). Under the new scheme, system problems constitute the new rationale for policy design and intervention (Lundvall and Borrás, 1997; Tödtling and Trippl, 2005; Martin and Trippl, 2013). However, *"market"* and *"systemic failures"* are not mutually exclusive since both require the attention from policy makers (Hauknes and Nordgren, 1999: 21).

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15 Coming to terms with the dissertation, it is important to underline that countries like Spain require a regional outlook in their assessments (Acosta y Coronado, 1999; Buesa et al., 2002). Institutional variety renders the regional outlook a very useful perspective to assess diversity and variety patterns across ACs.

Consequently, innovation policies share the RIS approach and conceptual framework (Cooke and Morgan, 1998; Asheim and Isaksen, 2002; Buesa *et al.,* 2002; Trippl and Tödtling, 2007; Zabala-Iturriagagoitia *et al.,* 2007; Cooke, 2011; Navarro and Gibaja, 2012). The RIS approach also inherits the evolutionary principles we have introduced to provide an alternative view from neoclassic paradigm of the innovation process, such as the role of the interactions among players, the learning processes at the level of both the individual and the institution, the dynamism of the innovation process, the technological change inferred by this dynamism, etc (Zabala-Iturriagagoitia, 2008: 13).

The dissertation adopts the systemic and evolutionary outlook of RISs as the most suitable conceptual framework for the analysis of system problems and intermediary organizations for a number of reasons. First, this outlook supports that outside the firms, the economic, institutional, regulatory, cultural and social contexts have a deep influence on firm´s attitudes and strategies towards innovation (Nauwelaers, 2011: 468). Second, the regional level permits an augmented observation of a number of system problems that –so far- have only been observed separately. This conceptual framework will lead us exceed the lack of systemic outlook of some studies that observe these problems (Fagerberg, 1987; Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Hagardon and Sutton, 1997; Hagardon, 1998; Martin and Scott, 2000; Beck and Demirguc-Kunt, 2006; Dalziel, 2010). Third, the RIS framework can lead to interesting policy designs and implications since the exchange of tacit knowledge requires from trust and cultural understanding, which develops through geographical proximity. Fourth, the systemic approach incorporates the idea that firms do not overcome

system problems in isolation (Nauwelaers, 2011: 468). On the contrary, the establishment of innovation intermediaries is particularly popular at the regional level (ibid: 467). Since the dissertation aims at assessing the relation between intermediaries and these specific system problems, the RIS provides a context for assessment that also facilitates comparisons and benchmarks across ACs. As stated, it is necessary to observe how different innovation systems work in order to understand how a specific initiatives influence innovation process (Metcalfe and Georghiou, 1998, Hauknes and Nordgren, 1999).

2.2. INNOVATION SYSTEM CONSTITUENTS, COMPONENTS AND FUNCTIONS

ISs consist of two kinds of constituents. In the first place, systems are disaggregated into its main *"components"* (Ingelstam, 2002; Edquist, 2005). These components aggregate organizations with regards to the role they accomplish in the system. A first tradition of authors sum organizations in *"knowledge exploitation"* and *"knowledge exploration"* subsystems (Morgan and Cooke, 1998; Autio, 1998; Isaksen, 1999; Asheim and Gertler, 2005; Gielsing and Nooteboom, 2006). The former represents the production structure, consisting of firms. The latter represents the support infrastructure, and consists of colleges, Technology Transfer Agencies (TTAs), vocational training organizations, etc. This aggregation was later complemented (Tödtling and Trippl, 2005; Trippl and Tödtling, 2007; Martin and Trippl, 2013). Three more components were added to bring about a closer distinction of the main roles accomplished in the systems. These new components are the *"policy subsystem",* the *"socio-institutional factors"* and the

"linkages" with other systems. Building on these traditions, we will adopt a total of three components to set our general framework; as follows:

- ***The production structure or "knowledge exploitation" subsystem, which consists mainly of firms, especially where these display clustering tendencies (Cooke and Morgan, 1998; Autio, 1998; Isaksen, 1999; Asheim and Gertler, 2005; Cooke, 2005; Gielsing and Nooteboom, 2006).***
- ***The support infrastructure or "knowledge exploration" subsystem, including colleges, TTAs, vocational training organizations, etc...(Cooke and Morgan, 1998; Autio, 1998; Isaksen, 1999; Asheim and Gertler, 2005; Cooke, 2005; Gielsing and Nooteboom, 2006).***
- ***The "policy" subsystem composed of government organizations and development agencies (Tödtling and Trippl, 2005; Trippl and Tödtling, 2007; Martin and Trippl, 2013).***

Complementarily, a number of scholars have focused in the definition of the main functions that ISs should deliver (Edquist and Johnson, 1997; Johnson, 1998 and 2001; Jacobsson and Johnson, 2000; Alkemade *et al.,* 2007; Hekkert *et al.,* 2007; Jacobson and Berger, 2004; Edquist, 2011). These system functions are related to the character of the components of the IS (Hekkert and Negro, 2009), and helps scholars gain insight in the relation between structure and performance and the dynamics of the system itself (Alkemade *et al.,* 2007; Hekkert *et al.,* 2007; Jacobson and Berger, 2004).The functions are defined as a contribution of a component or a set of components to a system's performance (Johnson, 1998 and 2001; Jacobsson and Johnson, 2000).

Following Hekkert and Negro (2009), the following could be introduced as a typology presented by the literature strand:

- ***Function 1: Entrepreneurial activities. The authors underline the importance of entrepreneurs in ISs. They claim that, without the latter, innovation would not take place, as entrepreneurs turn the potential of knowledge development, networks and markets into concrete action and take advantage of business opportunities;***
- ***Function 2: Knowledge development (learning). The authors claim that the mechanisms of learning are at the heart of any innovation process. They include R&D activities, "learning-by-searching" and "learning-by-doing" practices;***
- ***Function 3: Knowledge diffusion through networks. The authors claim that network activity can be regarded as a precondition to "learning-by-interacting" and "learning-by-using" in the case of user-producer networks;***
- ***Function 4: Guidance of the search. The authors refer to the process of definition of priorities amongst the variety of available technological options;***
- ***Function 5: Market formation. The authors claim that a new technology often has difficulties to compete with embedded technologies. Consequently, when new technologies are developed, the system has to create a need for transition to new regimes and new usages;***
- ***Function 6: Resource mobilization. The authors claim that both financial and human capital are necessary as a basic input to all the activities within ISs;***

- ***Function 7: Creation of legitimacy and counteracting resistance to change. The authors denounce the existence of parties with vested interests that will often oppose "creative destruction". Consequently, advocacy coalitions can function as a catalyst to create legitimacy for the new technology and to counteract resistance to change.***

Similar lists of functions have been introduced. Rickne (2000) developed a list of functions through an empirical study of the biomaterials industry. Edquist brings forward a number of *"activities"*[16] which are the determinants of the development and diffusion of innovations (Edquist, 2011: 1728). In this occasion, the author aggregates ten activities in four main groups[17]. Its proposal is also similar to the functions developed above.

16 The author underlines that "functions" could also be an alternative term for "activities". Nevertheless, he chose the latter to avoid the connotation of "functionalism" or "functional analysis" as practiced in sociology. Importantly, the term "activities" is used as equivalent to "determinants" of the innovation process (Edquist, 2011: 1728).

17 The author proposes four main groups of activities: (a) Provision of knowledge inputs to the innovation process; (b) Demand-side activities; (c) Provision of constituents for ISs; (d) Support services for innovating firms (Edquist, 2011: 1729).

Secondly, meaningful interaction among the components has also been emphasized as a crucial constituent[18] (Ingelstam, 2002; Edquist, 2005). Interaction among dissimilar organizations facilitates the production of new knowledge which could also lead to the exploitation of novel opportunities (Lundvall, 1992; Lundvall and Borrás, 1997; Woolthuis *et al.,* 2005; Tödtling and Trippl, 2005; Asheim and Gertler, 2005; Jensen *et al.,* 2007; Edquist, 2011; Chaminade *et al.,* 2012; Martin and Trippl, 2013; Innerarity, 2013). Plural dynamic interplays and transformations of tacit and codified knowledge forms constitute essential inputs to nurture both organizational adaptation and systemic upgrading (Nonaka and Takeuchi, 1995; Asheim and Gertler, 2005).

Consequently, as stated, the system innovation stream of economics claims interaction to be a central feature of well-functioning and integrated ISs. However, interaction does not necessarily occur in an automatic fashion. Knowledge is a broken mirror scattered over multiple chains and networks of private and public organizations and science and technology infrastructures of the geography of innovation. It can be thought of as a ubiquitous and fragmented *"stock"* that changes constantly and grows exponentially (Asheim and Isaksen, 2002; Edquist, 2011). For these reasons, system innovation and evolutionary scholars stress the capacity and value of learning. On the top of the existence of different –exploitable- knowledge bases in the system,

18 Both these components and relations should form a coherent whole. Systems shall also have a function, i.e. they shall perform or achieve something. Lastly, it shall be possible to discriminate between the system and the rest of the world; i.e. it must be possible to identify the boundaries of the system. The latter is a key aspect when it comes to making empirical studies of specific systems (Ingelstam, 2002).

learning has been claimed to be an essential *"flow"* that contributes to add more knowledge to the existing *"stock"* (Edquist, 2011). Thus, interactive learning constitutes a decisive positive feature of well-functioning and integrated environments, which often stems from internal research and close collaboration with science and technology organizations (STI mode of learning), as well as from daily routines, i.e., learning by doing, using and interacting [19] (DUI mode of learning) (Jensen *et al.,* 2007; Chaminade *et al.,* 2012). Therefore, in order to nurture both STI and DUI learning dynamics, there is an implicit need for systemic adjustment. Hierarchies need be adapted into more collaborative ecosystems (Innerarity, 2013: 2), engaging components and organizations together under increasing levels of innovation collaboration. Even so, the fact that these -interactive learning- dynamics are not always habitual denotes the existence of various problems that restrain development potentials. These problems will be developed onwards.

2.3. SYSTEM PROBLEMS: SETTING A FRAMEWORK FOR POLICY INTERVENTION

The system innovation literature has gained prominence and wide acceptance, especially from European researches (Nelson, 1992, 1993 and 1995; Freeman, 1995; Lundvall and Borrás, 1997; Edquist, 1997 and 2001; Asheim and Isaksen, 2002; Asheim and Gertler, 2005;

19 Examples of successful countries (Jensen et al., 2007) show that most innovative organizations combine STI mode with DUI mode of learning as they are both essential to their innovation process.

Woolthuis *et al.,* 2005; Tödtling and Trippl, 2005; Chaminade and Edquist, 2006; Zabala-Iturriagagoitia *et al.,* 2007; Uyarra, 2010; Chaminade *et al.,* 2012; Asheim and Parrilli, 2012; Parrilli, 2013). While neoclassics focused on allocating resources to firms in an efficient manner[20], system innovation and evolutionary approaches enhance framework conditions[21] so that systemic environments can be better self-organized (Metcalfe, 2005; Marzucchi, 2010). Under the former construct, market mechanisms may fail to lead to an optimal and Pareto-efficient allocation of resources to innovation-related activities, and the State intervenes to correct these inefficiencies (Nelson, 1959; Arrow, 1962). Due to the –private- underinvestment in research and innovation, governments ought to support the production of knowledge, either through subsidies or through its own production in public

20 The neoclassic school of economics is built on the foundation laid by the 18th century theories of Adam Smith and David Ricardo, which were followed and refined in the 19th and 20th century by other authors such as Alfred Marshall, Irvin Fisher or Vilfredo Pareto. This theory is based on the belief that competition leads to an efficient allocation of resources, and regulates economic activity establishing equilibrium between demand and supply through the operation of markets.

21 As stated, the ideal learning environment is characterized by a predictable institutional framework and by incentives that make it attractive to learn in interaction with others. In this sense, the learning economy concept also gives priority to the creation of framework conditions rather than to detailed intervention (Lundvall and Borrás, 1997).

organizations such as universities[22] (Lundvall and Borrás, 1997). This support would compensate *"market failures"* and under-investment problems; particularly when related to R&D efforts.

The new rationale for public intervention goes beyond that, identifying other areas and forms of action on the basis of new and broader types of system problems. Policy intervention is not simply justified by an under-supply of knowledge, but by areas of systematical weak performance (Lundvall and Borrás, 1997; Metcalfe, 2005; Marzucchi, 2010). Thus, the new paradigm takes into account the interactive and systemic nature of innovation processes, going beyond concepts such as *"market failures", "externalities"* and *"spill-overs",* which tend to focus on just one side of the learning economy[23] (Lundvall and Borrás, 1997: 42). The system innovation literature strand has largely been adopted by policy makers in both developing and developed countries since this perspective appears to be more appropriate to model reality than

22 The common approach in the field was based on the introduced a linear model of innovation whereby investment in basic science was regarded as an input into technology development to be introduced later on by business. The further away from the market the more legitimate was government intervention (Lundvall and Borrás, 1997).

23 The authors claim that a major reason why the neoclassical vision of the world is inadequate in the globalizing learning economy is that the formation of and access to tacit and shared knowledge has now become the key to economic success. The process of interactive learning will not take place in pure markets where individually optimizing agents meet; there will be no general equilibrium and the ability to learn is not the same across individuals and organizations. The learning process is socially embedded and organizational forms and institutional set-ups are crucial to the outcome of interactions.

traditional markets and hierarchies (Isaksen, 1999; Nauwelaers and Wintjes, 1999; Tödtling and Trippl, 2005; Nauwelaers, 2011).

The evolution of innovation environments demands for strategies that nurture interactive learning across dissimilar system components, innovation-relevant organizations and entrepreneurs as a crucial drive to prevail over system problems. These strategies shall fall back into the knowledge and field experience of policy makers[24]. However, the exponential growth of data and information wrecks the assumption that governments possess the best knowledge of any situation. The latter is highly dispersed through society (Innerarity, 2013: 1) and thus, threatens purposive views of innovation environments as able to change its own destiny via policy intervention (Uyarra, 2010: 124).

This limitation entails that the significance of the information fed back by traditional indicators might be decreasing over time till the point of becoming a narrow, scarce, unsatisfactory or inconsequential input both for policy intervention and academic observation. Of course, adapting current indicators along the design and implementation of new ones constitutes a circular and time-consuming evolutionary process that might explain the reasons why innovation policies are occasionally copied from unrelated environments (Lundvall and Borrás, 1997; Nauwelaers and Wintjes, 1999; Tödtling and Trippl, 2005; Uyarra, 2010). The latter could be a good explanation to understand the reason why policy makers shall be in the position of taking crucial decisions at

24 As stated, intervention is justified when the system cannot achieve objectives supporting the development, diffusion and use of economically useful knowledge and innovations (Lundvall, 1992; Edquist, 1997; Chaminade et al., 2012).

their expense (Edquist, 2011; Chaminade *et al.,* 2012). More often than not, some of these efforts may have ended up being *"one-size-fits-all"* policies, clearly overseeing the importance of organizational and institutional set ups (Nauwelaers and Wintjes, 1999; Lundvall and Borrás, 1997; Tödtling and Trippl, 2005; Uyarra, 2010; Edquist, 2011; Chaminade *et al.,* 2012).

Innovation policies based on the system innovation approach often collide with the old paradigm, its rationales and its instruments (Intarakumnerd and Chaminade, 2007; Chaminade *et al.,* 2012). The old dominance of neoclassical economics still has a negative impact upon the policy debate through its lasting imprint on terminology and conceptual frameworks (Lundvall and Borrás, 1997:42). Table 2.2 presents an illustration of both neoclassic and evolutionary-system innovation policy approaches, their terminology and their main differences.

Table 2.2 Policy Intervention Modes

Paradigm	Focus	Involvement	Dynamics	Rationales	Linkages	Indicators
Neoclassic	Market failure	Exploitation subsystem & exploration subsystem.	Linear, top down (normative & exclusive)	Allocation of resources (optimality)	Markets, hierarchies	Input-output *"R&D".* Firm and Technology centered.
System innovation	System problems	All system components	Polygonal, complex (adaptative and participatory)	Enhance framework conditions and improve system functionality	Clusters, networks	Interactive. Focused on the behavioral assessment of multiple organizations and institutions

On the contrary, a system innovation approach needs to be experimental and adaptative (Metcalfe, 1995; Chaminade *et al.,* 2012). Rather than starting from scratch or copying from best practice, policy makers need to follow a guideline based on certain crucial aspects:

- ***To stimulate learning institutions[25] and economic actors (Lundvall and Borrás, 1997).***
- ***To develop integrative and coordinated policy visions and instruments for enhancing innovation (Lundvall and Borrás, 1997).***
- ***To adapt intervention to the heterogeneity and idiosyncrasies of diverse institutional settings and knowledge bases[26] prevailing in each system (Tödtling and Trippl, 2005; Uyarra, 2010; Martin and Trippl, 2013).***
- ***To take existing competences and specialization as building blocks for intervention (Frenken et al., 2007; Uyarra, 2010).***
- ***To base intervention on innovation challenges and opportunities deeply linked to different systemic trajectories, while also heading it towards spurring related***

25 Both "hard" ones such as laws and regulations, and "soft" ones like norms, conventions and routines (Martin and Trippl, 2013: 3).

26 These dynamics shall stimulate unique analytic, synthetic and symbolic knowledge mixes (Trippl and Martin, 2013: 7) are put together to promote individual solutions.

variety[27] and construction of regional advantage (Cooke, 2006; Frenken et al., 2007; Asheim and Parrilli, 2012).

- ***To constitute bridges linked to the global dimension (Edquist, 2011).***
- ***Of course, with particular regards to the dissertation, to capture system problems specific to regions.***

For these reasons, policy makers need to have a good understanding of system´s performance and of how it operates (Edquist, 2011). Governance requires more complete and adapted diagnoses of IS´s inner driving forces. Indicators accountable for specific institutional settings, knowledge bases, global challenges and system problems constitute compulsory and essential inputs that might facilitate the design of innovation policy approaches bound to current diversity. Thus, policy formulation and implementation shall be the result of intensive communication, close interaction and consensus building between all

27 We claim interactive dynamics shall be specific and thought out. Usually, the normal tendency is to reinforce patterns of connectivity and linkages which are already there. Bringing policy-makers into close dialogue with groups of industrialists who command a common position in the economy will normally reinforce these tendencies (Lundvall and Borrás, 1997), and advance policies need to overcome them. Too strong ties between innovation-relevant organizations can lead to serious lock-in (Nauwelaers and Wintjes; 1999, Isaksen, 1999; Tödtling and Trippl, 2005; Martin and Trippl, 2013).

stakeholders[28] in policy networks. Policy makers are just one actor amongst others in these networks meaning the latter do not innovate in isolation, but interacting with other actors. The former implies manifold changes in the behavior of the constituent components and institutions of the system, by the implementation of adequate mixes of short, medium and long term innovation policy programs based on trial-and-error criteria. The key role governments play shifts from direct intervention towards stimulation, intermediation, brokering, promoting dialogue and building up social capital, across different levels of policy, including non-state actors such as firms, non-governmental organizations, professions and other actors, engaged in a collective process of negotiation and compromise (Tödtling and Trippl, 2005; Uyarra, 2010).

Under the new scheme, the definition provided for system problems[29] (Woolthuis *et al.,* 2005; Chaminade *et al.,* 2012), demands a sharp view of system´s performance as a means to overcome them. First, one has to open the boxes of its subsystems (Fischer, 2001). Second, one needs to identify the constituent elements (Ibid.). Third, one has to

28 From an evolutionary perspective, the capability to identify and nurture stakeholder participation shall be considered a crucial input to design these policies (Tödtling and Trippl, 2005; Foray and Van Ark, 2007; Acworth, 2008; Foray, 2009a; European Commission, 2011). New knowledge created in participatory processes might become a shared asset to science and technology infrastructures, private organizations and other stakeholders involved in its generation and development.

29 Just to recall, system problems are defined as: "systemic imperfections that might slow down or even block interactive learning and other activities that are crucial parts of innovation processes in a certain system of innovation".

specify the interactions between and within the subsystems that matter (Ibid.). Following the discourse, studying system performance and its connectivity could leverage on the assessment of specific interactive *"densities"*[30] among innovation-relevant actors.

Significant as these might be, the system innovation literature strand has provided with several system problem typologies over the last years, bringing forward important achievements. First, essential illustrations have been presented (Nauwelaers and Wintjes, 1999; Woolthuis *et al.,* 2005). Second, Chaminade et al. (2012) have conducted an empirical measurement applied to the Thai IS. Before this approach, system problems were only superficially sketched out. Most of this sketching had been primarily theoretical, and where empirical evidence was provided it was more illustrative than systematic. Nonetheless, classifications often overlap, and there is still no agreement on how problems should be named or framed (Edquist, 2011; Chaminade *et al.,* 2012).

Importantly, two key macro-categories have been established. The first pertain to those problems that affect the *"structure and configuration"* of the system environment as a whole (i.e. lack of infrastructural investment) (Marzucchi, 2010). The second category relates to *"learning*

30 A well-functioning system should stand out for its high integration level, both between and within its components; which could also be explained by the absence of the introduced systemic problems. Therefore, the number of interactive projects, operations, or more generally, interactions among organizations and institutions constitutes an outstanding property that shall be observed to analyze systemic integration.

processes and accumulation of capabilities" (i.e. lack of human capital in firms). All in all, system problems constitute a key hampering factor that hinders systemic performance at different layers of systemic performance.

Regarding the first macro-category of system problem, the literature has identified and defined an important number of –wide- failures that prevent the evolution and growth of modern economies. These problems –failures and dilemmas- sometimes overlap in the typologies presented by the authors. We onwards present the most outstanding studies and the system problems they have identified, as follows: (a) the exploitation-exploration dilemma; (b) the integration/flexibility dilemma; and (c) the diversity-harmonizing dilemma (Lundvall and Borrás, 1997). (a) Infrastructural provision failures; (b) transition failures at firm level; (c) lock-in failures at the system level; or (d) institutional failures (Smith, 2000b); or more generally, (a) organizational thinness, (b) lock-in, or (c) fragmentation problems (Isaksen, 2001; Tödtling and Trippl, 2005). (a) Learning failures; (b) Exploration-exploitation and variety-selection trade-offs; (c) Appropriability traps; and (d) Dynamic complementarities failures (Malerba, 1998 and 2009). (a) Infrastructure problems; (b) Capability problems; (c) Institutional problems; and (d) transition and lock-in problems (Chaminade and Edquist, 2006; Chaminade *et al.,* 2012). (a) Infrastructure failures; (b) Capability failure; (c) Institutional failure; and (d) interaction failure (Woolthuis *et al.,* 2005).

Additionally, we identified a number of system problems that could aggregate in the second macro-category presented (Marzucchi, 2010). Various schools of thought have studied a number of –more specific- problems. First, innovation management studies describe the lack of

capabilities of managers and executives to operate private organizations and external networks (Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon, 1998). A second collection of studies illustrate their lack of technological capabilities and the complex relation between the former and technological infrastructures (Fagerberg, 1987; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010; Nauwelaers, 2011). Additionally, the financial literature presents how venture capitalists VCs and BAs facilitate private organizations overcome their lack of financial capabilities (Beck and Demirguc-Kunt, 2006; European Commission, 2011). Importantly, the framework facilitated by the work of Nauwelaers and Wintjes (1999) (Appendix 1) introduces the possibility to rearrange all these studies together under the four "gaps" presented onwards:

Gap 1: the first system problem originates as an aftereffect of the lack or poorly developed management capabilities of private firms, especially present in smaller and less experienced ones, when developing innovation processes (Nauwelaers and Wintjes, 1999; Bessant and Rush[31], 1995 and 2000). These innovation processes would not be successful or long-lasting if firms do not show proper inner competences (i.e. marketing, organizational, strategy, distribution, commercial, etc…). Consequently, at some point, firms would need to look for external support and inputs that would help them adapt the state-of-the-art to their own situations (Bessant and Rush, 1995 and

31 The authors name these as "managerial gaps" (Bessant and Rush, 1995 and 2000).

2000). These authors explain how external interaction provokes that firms exceed their deficiencies by exploring and articulating internal needs for innovation, developing business, product and manufacturing strategies, providing assistance with selection and investment appraisal and justification, implementation support and project management, and the advice on marketing and human resources (Ibid.).

Gap 2: the second system problem is named *"openness and learning gaps[32]"* and occurs when firms lack new *"antennas"* or networks outside (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999). Firms occupying a favored network position are likely to perform better because of their superior access to novel information and knowledge (Burt, 1992; Hagardon y Sutton, 1997; Hagardon, 1998). In this sense, in addition to being in condition to achieve higher productivity and quality standards, interaction permits these organizations see early, more broadly, and translate information across groups, helping them learn faster and be *"more productively creative"* (Burt, 2004: 357). Examples and practices related to former assumptions could also be found in the literature. To this regard, Saxenian (1996) researches regional networks in Silicon Valley and Route 128. She describes how companies compete intensely while at the same time learn from one another about changing markets and technologies through informal communication and collaborative practices.

32 Some authors name these gaps as "structural holes" (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998).

Gap 3: thirdly, the *"technological gap"* could be described as the lack of technological capabilities of private firms (Fagerberg, 1987; Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Olazaran *et al.,* 2009; Parrilli *et al.,* 2010; Dalziel, 2010). Examples related to *"technological gaps"* demonstrated decades ago that there exists a close correlation between the level of economic and the level of technological development. Actually, technology gap models of economic growth were found to explain a large part of the differences in growth rates, both between countries and periods (Fagerberg, 1987). Still, the gap remains even if there are grounds for believing that linkages between technological and business worlds will start to multiply (Yusuf, 2008: 1168). Nowadays, we still witness disparity in goals and performance measures that prevent organizations from effective interactions that would provoke valuable learning and innovation outcomes (Parrilli *et al.,* 2010; Dalziel, 2010). The literature also provides evidence collecting excellent interactive practices (Hagardon and Sutton, 1997; Hagardon, 1998; Burt, 2004; Howells, 2006; Acworth, 2008; Morgan, 2013).

Gap 4: lastly, available finance supporting private activity is a desirable feature of well functioning –financial- markets (i.e. banks). Nonetheless, the latter often prefer secure investment (i.e. housing). Thus, financial constraints usually prevent private sectors from fostering new innovation projects and operations. In addition, there is substantial evidence that small firms face larger constraints and have less access to formal sources of external finance (Beck and Demirguc-Kunt, 2006; European Commission, 2011). Due to these constraints, it is crucial that regions develop tools to overcome the financial gap. Policy intervention is often considered an alternative solution to bridge this gap thanks to the partial public funding of venture capital organizations.

Consequently, there would be a *"financial gap"* when the *"regional policy"* component hasn´t developed tools to help firms overcome this difficulty (Nauwelaers and Wintjes, 1999).

This taxonomy of *"gaps"* presents three basic limitations. First, studies have observed these problems separately and consequently, there´s little space for cross-reference and communication, which demands for academic attention. Second, the managerial orientation of some of these studies prevents the observation and specification of the institutional dynamics and their influence on the behavior of organizations (Lundvall and Borrás, 1997; Asheim and Coenen, 2006; Edquist, 2001 and 2011; Moodysson and Zukauskaite, 2014). Third, linked with the latter, managerial orientations also prevent scholars from the development of an aggregated –economic- outlook that would induce the assessment of other important multiadic interactions across new units of analysis (other than business and markets) such as regions or nations. Most of these studies evidence interactions between two firms, or between a firm and technological infrastructures (i.e. universities); preventing scholars from the observation of the influence of other crucial components (i.e. *"regional policy subsystem"*) and other profiles of -public and private- organizations[33] (i.e. intermediaries).

Consequently, we onwards set a schematic illustration that may induce an augmented observation of these systemic problems. Figure 2.1 is intended to facilitate the examination of the interactions that shall be

33 The study of Parrilli et al. (2010) constitutes an important exception that could be better framed in system innovation environments due to the agents included and their treatment in the study.

assessed as a first input to capture these problems. The figure leverages on previous frameworks (Nauwelaers and Wintjes, 1999; Woolthuis *et al.,* 2005). Nonetheless, while these frameworks offer great potential for the identification of new rationales for government support policy design and intervention, they lack the *"spatial dimension"* Figure 2.1 sums. This dimension could be very helpful at different levels of examination.

First, setting a frame for the identification of new gaps is considered critical. We claim these problems could take place at the level of firms, but also affect other components and organizations (i.e. *"exploration subsystem"*). Importantly, while *"human resource"* and *"openness and learning"* problems occur in the *"knowledge exploitation subsystem"; "financial"* and *"technological"* gaps involve other components. This figure might also facilitate the identification of new gaps at the micro and meso levels of analysis. New hypotheses and research questions could be settled with regards to the existence of other *"innovation barriers" "in"* and *"between"* other components and/or organizations (Fischer, 2001; Tödtling and Trippl, 2005). Some of the latter might have not been so far addressed either by the literature or by policy makers (Isaksen, 1999; Smith, 2000a; Nauwelaers and Wintjes, 1999; Tödtling and Trippl, 2005; Woolthuis *et al.,* 2005; Chaminade and Edquist, 2006; Marzucchi, 2010; Edquist, 2011; Chaminade *et al.,* 2012; Martin and Trippl, 2013).

Second, and linked to the former, the introduced spatial dimension could spur the design, adaptation and accurate framing of new indicators that would help scholars and policy makers evaluate systemic integration at different layers. Novel data shall exceed the current firm-centered and technological focus. As stated, a shift from traditional –

neoclassic- perspectives towards a more system-centered approach of innovation policy is required (Georghiou, 2001; Tödtling and Trippl, 2005).

System problems are not -only- owned by firms. These gaps embed in systems that, as introduced, are composed of distinct components. The latter implies these problems are sometimes shared among organizations that belong to different components, not only firms. Firm´s innovation constitutes a crucial aspect for innovation policy-bound decision making. Nonetheless, a systemic view demands for the analysis of all innovation-relevant organizations to build decision making on strategies that step on the ground and adapt to existing specific insights and requirements. All in all, our scheme displays a framework where RIS *"gaps"* could be assessed by the quantity –and quality- of interactions that occur between and within its three main *"spheres"* or subsystems represented. It enshrines system problems along with the components they relate to. This fact contributes significantly to ease setting empirical analyses while it also helps to overcome the imprecision on how these problems should be identified in innovation environments (Edquist, 2011; Chaminade *et al.,* 2012).

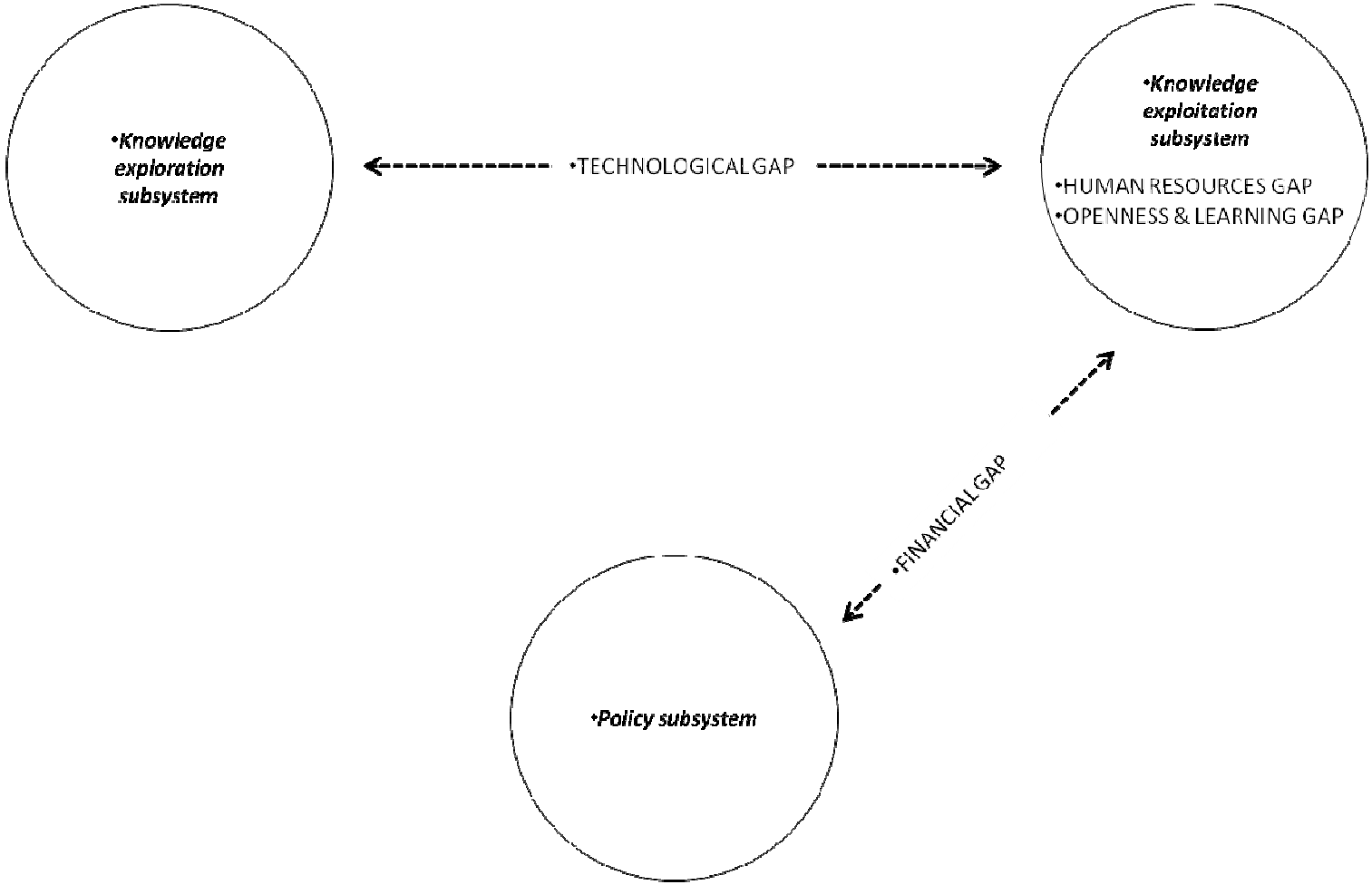


Figure 2.1 System problems and RIS components

2.4. INTERMEDIARY ORGANIZATIONS: EVOLUTION AND RELEVANCE

Complexity and uncertainty grow in innovation environments[34]. The latter makes *"Intermediaries[35]"* (Lundvall and Borrás, 1997; Nauwelaers and Wintjes, 1999; Bessant and Rush, 2000; Howells, 2006; Acworth, 2008; Parrilli *et al.,* 2010; Cooke, 2011; Nauwelaers, 2011; Tödtling and Trippl, 2012) encompass an increasing role spurring interaction among components and institutions. Still, the literature does neither frame nor assess these organizations rigorously, which demands for academic attention. System innovation frameworks such as ISs (Freeman, 1987; Lundvall, 1992; Edquist, 2005; Edquist, 2011; Chaminade *et al.,* 2012),

34 One of the most dramatic changes in the learning economy is the growing importance of networking and inter-firm co-operation in connection with innovation. It reflects the growing pace of change, but also the growing complexity of the innovation process (Lundvall and Borrás, 1997: 156).

35 Literature has named these organizations in various ways: "third parties" (Woolthuis et al., 2005), "knowledge brokers" (Hagardon and Sutton, 1997; Hagardon, 1998), "intermediate organizations" (Bessant and Rush, 1995), "innovation brokers" (Nauwelaers and Wintjes, 1999), "intermediary organizations" (Isaksen, 1999), "innovation intermediaries" (Hauknes and Nordgren, 1999; Howells, 2006; Dalziel, 2010; Nauwelaers, 2011), "intermediate agents" (Parrilli et al., 2010), "intermediary agencies" (Uyarra, 2010), "catalysts" (Cooke, 2011; Parrilli, 2013), "intermediate institutions" (Morgan, 1997; Altenburg et al., 1998; Pietrobelli and Rabellotti, 2011), "bridging institutions" (OECD, 1997; Martin and Scott, 2000), "networking partners", (Cooke and Morgan, 1994; Cooke and Leydesdorff, 2006), or "brokers" (Asheim and Parrilli, 2012), to name some.

RISs (Cooke and Morgan, 1998; Asheim and Isaksen, 2002; Buesa *et al.,* 2002; Trippl and Tödtling, 2007; Zabala-Iturriagagoitia *et al.,* 2007; Cooke, 2011; Navarro and Gibaja, 2012), the GVC construct (Gereffi *et al.,* 2005; Morrison *et al.,* 2008), the *"systemic competitiveness"* (Altenburg *et al.,* 1998), or the *"triple helix model"* (Etzkowith and Leydesdorff, 1998 and 2000), do not adequately recognize the great influence these organizations have on the overall systemic interactivity. As a result, the dissertation meets the need for introducing a number of developments that might ease their analysis over time and space, as these organizations develop towards more sophisticated dynamics and rationales.

The structure and function of intermediaries widens during the last decades to adapt to new *"system innovation"* demands. Under previous assumptions, these organizations blossomed surrounding *"market failures"* that, as explained, originate as a consequence of the public intervention in the production of knowledge. The latter provoked certain mismatches or asymmetries between technological production and commercialization capabilities of innovation environments. In other words, new-born technologies needed to be *"transferred"* into markets, and intermediary organizations smoothed the transition phase in a number of ways that has been conveniently described and reviewed (Bessant and Rush, 1995 and 2000; Altenburg *et al.,* 1998; Howells, 2006; Parrilli *et al.,* 2010).

However, new technological, industrial and institutional schemes provoke intermediaries progressively evolve towards a much extensive

"catalytic" role[36] (Parrilli, 2013). Novel challenges require managing knowledge flows through research, education, industrial and government sectors, turning straightforward intermediation into a more and more multilateral and dynamic function (Altenburg *et al.,* 1998; Howells, 2006; Acworth, 2008; Nauwelaers, 2011). Intermediaries still tap into *"technological gaps[37]"* (Gap 3), but they also develop around some other system problems such as: *"human resource"* (Gap 1), *"openness and learning"* (Gap 2) and *"financial"* gaps (Gap 4) (Nauwelaers and Wintjes, 1999). Private firms realized about the need to foster crucial –managerial, strategic, financial, commercial- competences and networks. In a nutshell, novel non-technological, organizational and *"gradual[38]"* innovation services began to be provided (Nauwelaers, 2011: 476).

As a matter of fact, intermediary organizations turn systems –more-efficient -at least- in two complementary levels. A first interpretation of

36 The author claims that "catalysts may help create a systemic logic within the RIS and the regional innovation value chain that may help to close market and system failures and maximize coordination across regional innovation agents" (Parrilli, 2013). Thus, on the top of smoothing the connection between universities, research organizations, etc… and private firms, the author presents a wider outlook which implies that these organizations cover new essential roles, in the line of other reviews and developments (Howells, 2006; Nauwelaers, 2011).

37 Intermediaries still bridge "technological gaps" between both exploration and exploitation components. Nonetheless, these practices have evolved from linear "knowledge transference", towards more circular and collaborative dynamics of codependence and co evolution.

38 The author explains that intermediaries widen their portfolio including new services related to marketing, human resource management and finance areas.

efficiency revolves around the relative use of resources devoted to a particular activity in order to produce –innovative- outputs (i.e. patents) (Buesa *et al.,* 2002a, 2002b and 2007; Martínez- Pellitero, 2002, 2007 and 2008; Buesa and Heijs, 2007; Susiluoto, 2003; Zabala-Iturriagagoitia *et al.,* 2007; Zabala-Iturriagagoitia, 2008). A second interpretation of efficiency deals with the celerity that innovation systems require to adapt to change (Lundvall and Borrás, 1997; Nauwelaers, 2011). Intermediaries make a clear contribution with regards to both interpretations and their relation with the system problems we have introduced. In fact, the history of intermediaries evolves as these organizations adapt from a *"narrow/market"* towards a *"wider/system"* service-provision rationale. The latter was not an easygoing-straightforward process, bringing to the fore a number of tensions. First, intermediary organizations grew in a somewhat *"anarchic"* way, becoming too numerous and important to remain ignored (Nauwelaers, 2011). Second, and due to rapid changes in innovation environments, services provided by intermediary organizations were sometimes incoherent, other times invisible. Importantly, the functional rearrangement of intermediaries was properly observed and described (Howells, 2006; Nauwelaers, 2011).

First, Howells (2006) reviews and synthesizes the literature in the field of innovation intermediation, introduces an inclusive definition[39] and presents a typology and framework of the roles and functions developed

39 He proposed a working definition of Intermediaries as "organizations or bodies that act an agent or broker in any aspect of the innovation process between two or more parties" (Howells, 2006: 720).

by intermediary organizations. The author claims that the interest in the role of intermediaries has emerged from a number of complementary research fields over the last 20 years. These include: (a) literature on technology transfer and diffusion; (b) innovation management; (c) the systems of innovation literature; (d) research into service organizations or KIBS firms; while in practice there are overlaps between these main groups (Ibid: 717). The author acknowledges that the role of intermediaries has not generally been well-grounded theoretically. Instead, his review has revealed the highly eclectic nature of the literature (Ibid: 718). This seminal work constitutes a central reference in the field and brings forward a number of important contributions. First, by taking together all these studies on intermediaries, the author develops a much wider and holistic approach to the understanding of their functionality. Importantly, this approach contributes to the creation of a new field of research on its own. Second, his review facilitates cross-referencing across different and complementary research domains that tackle the issue.

Together with the former, there´s a second seminal work on *"intermediaries"* which also brings forward a number of important contributions. Nauwelaers (2011: 468) elucidates the role of intermediaries by taking the RIS as a generic framework of analysis, within an evolutionary perspective. Starting with a theoretical discussion, she proposes a conceptual framework providing a reference for their activities and expected impacts, while she discusses policy implications for regional authorities. Her work summarizes the contrasted features of innovation within traditional –linear- and systemic-evolutionary frameworks (Ibid: 471). As in the case of Howells, she also discusses a variety of points such as the role of intermediaries,

their targets, instruments, areas of action, etc (Ibid: 474). In her view, intermediaries care about the needs for innovation of the companies (particularly SMEs), but also have a broader mission which is to facilitate fluidity in the IS, rather than a narrow one defined as brokers between *"science"* and *"industry"* (Ibid: 474). In contrast with Howells´s purview, she claims that these organizations are established or –at least partially financially- supported by regional authorities (Ibid: 467). Thus, her typology includes a wide range of organizations such as technology transfer centers, university liaison offices, business advisory bodies, technology or science parks, territorial agencies involved in innovation promotion and cluster management organizations; but leaves no space to other –private- organizations such as consultancies or KIBS firms, which have also been included in other studies[40] (Hagardon and Sutton, 1997; Hagardon 1998; Howells, 2006; Bessant and Rush, 1995 and 2000; Dalziel, 2010). Another important contribution of the work is that it labels and treats *"intermediaries"* as a new *"set"* or *"system"* of organizations of their own; like a new class whose coherence, degree of fragmentation, visibility and efficiency could be evaluated.

Still, these approaches leave space for further contributions. Certain simplistic assumptions and *"umbrella definitions"* remain, which are not sufficient to explain real world variety and complexity (Nauwelaers, 2011). The lack of academic outlook and consensus on the issue still returns deficiencies in their identification, definition and assessment of

40 The dissertation supports this general strand and incorporates theoretical and empirical evidence of the presence of private intermediary categories tapping into a number of system problems.

their performance; not to mention their lack of clarity with respect to their targets (Ibid.). As explained, intermediaries have been arranged by their roles and functions (Howells, 2006:718) or by instruments and target groups (Nauwelaers, 2011: 473). Nevertheless, these authors support the need for development of better conceptual frameworks and methodological tools. In fact, including new functions to the purview of intermediary organizations might increase complexity. As Howells himself put it: *"there´s an issue of when is an Innovation intermediary not an Innovation intermediary?"* (Ibid: 725).

All in all, we believe this path reveals narrow development opportunities for the assessment of intermediaries in innovation environments. The fact that there´s no standardized model for intermediaries (Howells, 2006: 473) does call for categorization. Besides, to our best concern, the empirical assessment of their performance has not been called for yet, leaving significant space for scholar developments. The dissertation aims at making a contribution at this particular gap. We propose a more straightforward and comprehensive assortment. We observe different intermediary profiles that tap into each of the problems we have presented in a more specialized -or prevailing- fashion; creating pairs (i.e. "Gap 1" - "Cat 1"). Thus, by leveraging and relying on previous studies (Nauwelaers and Wintjes, 1999; Howells, 2006; Nauwelaers, 2011), our slightly different and complementary approach will bring forward an important novelty to the literature. Categorizing intermediary organizations will permit empirical assessments of their performance.

Instead of focusing on the roles and functions developed by innovation intermediaries, we pay special attention to their client organizations and their needs. This rationale relies on the fact that scholars need to observe those aspects that intermediaries share; on the contrary, they

could observe the differences among them. The classification leverages on a simple proposition: If a group of intermediary organizations share the client/service profile, they could be comparable and consequently, they could be arranged under a label. This focus on the supply-side of intermediary organizations permits the introduction of different *"categories".*

Categorizing intermediary organizations will permit (a) -a novel- empirical assessment on the performance of intermediaries over Spanish RISs, as it will be explicated in the methodological chapter of the dissertation; and (b) aggregating these –and other possible categories- in a new *"Associative Component"* which will be introduced in subchapter 2.5, and brings a number of benefits that are important for the development of this research domain. Finally, as in the case of Howells (2006), the dissertation also aims at (a) improving the low level of cross-referencing between studies; and (b) its theoretical grounding.

Our categories are composed of a number of different intermediary profiles which have been described by various literature strands. A first group of authors observe the field of intermediation through the study of its influence on the improvement of the human resources of private firms (Bessant and Rush 1995 and 2000; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999). The outlook is shared with a second strand (Burt, 1992, 1997 and 2004; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon 1998; Nauwelaers and Wintjes, 1999). In this occasion, these works focus on the study of the networking capabilities of the firms, and how these could be improved by the influence of a second category of intermediaries and their collaborative capabilities. Thirdly, a complementary strand of the literature observes how a third category of intermediary organizations

specialize in the provision of technological services to private firms (Fagerberg, 1987; Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Parrilli et al., 2010; Dalziel, 2010). Last but not least, a fourth category of intermediary organization could integrate VCs and BAs that facilitate firms overcome their financial difficulties (Nauwelaers and Wintjes, 1999; Beck and Demirguc-Kunt, 2006).

We aggregate these studies and present a novel *"categorization of intermediary organizations"* (Table 2.3). As the empirical evidence provided by the authors backs up, these categories specialize in overcoming dissimilar gaps that curtail the development potential of innovation environments, particularly in the case of firms. This background adds to functional and structural designs and assessments of intermediary organizations over time and space. Its clear-cut design nurtures simplicity and precision, and returns a number of key benefits. First, the table facilitates the location of intermediary categories together with a number of gaps that, as introduced, may originate at different layers of system innovation environments. Second, with regards to the definition of their activity, the table facilitates framing functional and structural interpretations regarding intermediary organizations in a logic and systematic manner. The latter would permit conducting longitudinal analyses of their activity in specific innovation environments. Third, in terms of analysis, the table assists the establishment of new indicators devoted to the study of different attributes of intermediary organizations (i.e. relational density levels).

Table 2.3 Categorization of Intermediary Organizations

Category.	Gap	Description of the gap	Subsystems involved	Predominating profile	Empirical evidence
Category 1	Gap 1 (Human resource)	Lack or poorly developed management capabilities of private firms (Bessant y Rush, 1995 y 2000; Nauwelaers and Wintjes, 1999).	Knowledge exploitation subsystem	Knowledge Intensive Business Service Organizations (KIBS)	Bessant and Rush 1995 and 2000; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999.
Category 2	Gap 2 (Openness and learning)	Lack of antennas to the outside (Nauwelaers and Wintjes, 1999)			Burt, 1992, 1997 and 2004; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999
Category 3	Gap 3 (Technological)	Lack of technological capabilities (Nauwelaers and Wintjes, 1999; Parrilli *et al.,* 2010; Dalziel, 2010).	Knowledge exploration and Knowledge exploitation subsystems	TTAs, technical advisory groups, business and trade associations.	Fagerberg, 1987; Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010.
Category 4	Gap 4 (Financial)	Lack of financial capabilities (Nauwelaers and Wintjes, 1999).	policy and Knowledge exploitation subsystems	Venture capitalists, Banks, BAs.	Nauwelaers and Wintjes, 1999; Beck and Demirguc-Kunt, 2006; European Commission, 2011.

An important subject matter is to clarify the reasons why we identify and match these intermediary profiles together with the gaps listed in Table 2.3. It is important to notice that the boundaries across intermediary organizations and gaps are often blurry. The lack of acknowledgment,

guidance and consensus in the scope and objectives regarding the activity carried out by these organizations frequently returns difficulties when justifying their overall performance. Precisely for this reason, instead of introducing a typology of intermediary organizations based on their –ever growing- functionalities (Howells, 2006), we propose a more straightforward approach. We list gaps and observe different organizational profiles that tap into each of them in a more specialized -or prevailing- fashion.

System problems constitute opportunities for the intermediary outlook. The latter permits the presentation of a brief but comprehensive categorization that shall also be enriched with new gaps and intermediary categories over time and experience. This –first- step to systematize intermediary organizations and functions leverages on previous empirical works and does nothing but put together under a common frame strong qualitative analyses performed through the years by the literature strand focused in the field (Burt, 1992, 1997 and 2004; Bessant and Rush 1995 and 2000; Hagardon and Sutton, 1997; Hagardon 1998; Nauwelaers and Wintjes, 1999; Howells, 2006; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010). In addition to Table 2.3, a necessary step to estimate the presence of intermediary organizations is to build on the previously presented theoretical framework (Figure 2.1) where system problems could now be adequately settled together with the components and intermediary organizational categories they relate to (Figure 2.2).

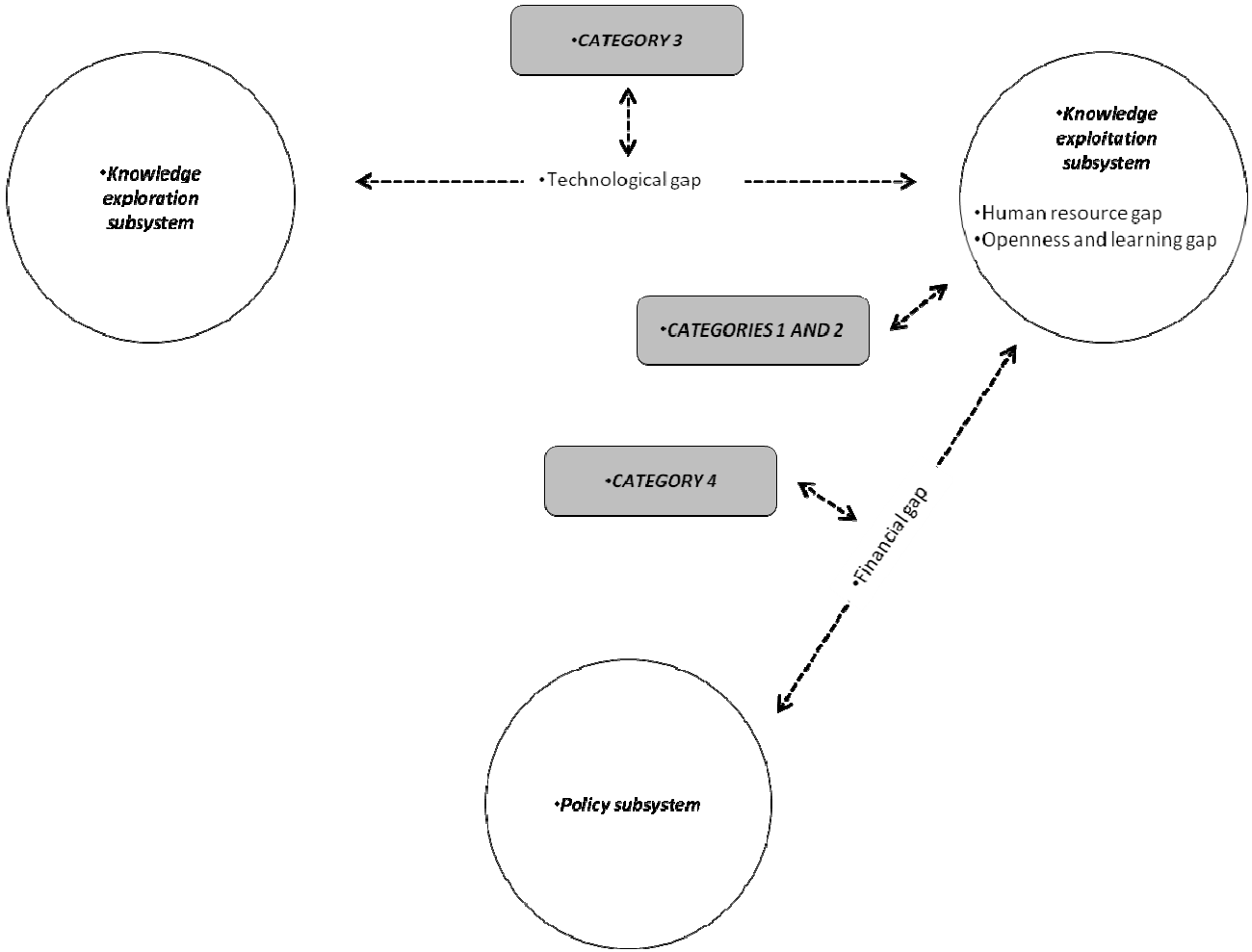


Figure 2.2 Intermediary categories, system problems and RIS components

We found very useful the framework presented by Nauwelaers and Wintjes (1999) (appendix 1), both as an input to the development of Table 2.3, as in the definition of the Figure 2.2. First, as stated, this framework helps us present together the gaps that the dissertation will analyze. Second, this contribution will also permit a joint and simplified outlook of these problems together with the empirical evidence related to the functions developed by intermediary organizations in RISs. This empirical evidence has been provided by the introduced literature strands (Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon 1998; Howells, 2006; Beck and Demirguc-Kunt, 2006; Parrilli *et al.,* 2010; Dalziel, 2010; Nauwelaers, 2011).

An important subject has to do with the rationale behind the election of a number of system problems ("Gaps 1" to "Gap 4") and intermediary categories ("Cat 1" to "Cat 4") for the analysis, overseeing the wider system problem typologies and frameworks introduced by system innovation and evolutionary theories (Lundvall and Borrás, 1997; Malerba, 1998 and 2009; Smith, 2000b; Isaksen, 2001; Tödtling and Trippl, 2005; Woolthuis *et al.,* 2005; Chaminade and Edquist, 2006; Chaminade *et al.,* 2012). In the development of the current dissertation we found few instances of either theoretical or empirical studies claiming intermediary organizations could tap into the introduced –wide-system problem typologies. On the contrary, to our best concern, Nauwelaers (2011) is the first author introducing a novel association between problems and intermediary organizations, following the typology presented by Smith (2000b). However, she does not explain how these problems are addressed by intermediaries. Instead, this relation is avoided being her interpretations yet preliminary and general.

The literature is currently underdeveloped. As it will be explicated in the limitations of the study, our preliminary approach frames in the ongoing and evolutionary process of decomposing a wide range of system problems (Lundvall and Borrás, 1997; Malerba, 1998 and 2009; Smith, 2000b; Isaksen, 2001; Tödtling and Trippl, 2005; Woolthuis *et al.,* 2005; Chaminade and Edquist, 2006; Chaminade *et al.,* 2012) into a number of specific variables that would induce scholars and policy makers have a deeper understanding of the interactions and innovation processes that explain the evolution of territories; and how the former connects with the performance of intermediary organizations. However, the current state-of-the-art prevents their employment. To our best concern, the literature simply provides no clue about the type of variables scholars might employ in order to assess the performance of intermediaries. Consequently, the dissertation adapts its scope to the assessment of those system problems and intermediary organizations that could be analyzed by the employment of available information. Thus, more research needs to be done in order to understand the association between intermediary organizations and –wider- system problem typologies.

For the time being, an important number of empirical studies provide that intermediary organizations are particularly joined to the second –more specific- group of problems (Nauwelaers and Wintjes, 1999; Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon 1998; Howells, 2006; Beck and Demirguc-Kunt, 2006; Parrilli *et al.,* 2010; Dalziel, 2010). As stated, intermediaries have developed a natural focus on regional innovation promotion targeting SMEs, based on the exploitation of the advantages of proximity (Nauwelaers, 2011: 474). Consequently, we

follow these studies in order to present the analysis of system problems and intermediaries developed in the current dissertation.

2.5. BEYOND INTERMEDIATION: THE "ASSOCIATIVE COMPONENT"

The existence of commonalities in the purpose and activity performed by intermediary categories suggests the possibility to arrange intermediary organizations around a common frame. We set them around a shared –new- system component. The new *"Associative Component"* (Figure 2.3) would be composed of all intermediary organizations which design, facilitate and catalyze systemic interaction within systemic frameworks. All in all, Figure 2.3 constitutes the third and last evolution of the theoretical framework that we employ in the dissertation.

The *"Associative Component"* would provide with a number of benefits both to academics and policy makers. First, the component returns a proper outline to build on the necessary assessment of the existence, spatial location, performance, structural and functional evolution of intermediaries. Second, the new component could also facilitate the coordination of intermediary organizations, so that there´s a supervision on the problems they operate. Third, it could conduct a central –piloting- role (Nauwelaers, 2011: 478), as their organizations spur and evaluate system´s networks over time. Managing intermediary organizations can facilitate the individual mission of each category could be adjusted. Constructing regional advantage (Cooke, 2006; Asheim *et al.,* 2006; Asheim and Parrilli, 2012) entails each RIS needs to –re- design and create its own networks; instead of reinforcing existing ones. Thus, a

well administered and tuned *"Associative Component"* could assist the accomplishment of the goals pursued by each RIS. Public-private alliances and/or specifically created organizations or agencies could lead the mission of this component to be designed and evaluated so that the lack of view on the results of the action of its organizations could be overcome (Nauwelaers, 2011). Fourth, a more aggregated and systemic outlook may ease improved designs of their functionality. Consequently, a mission could be assigned to the new component, as: **"shaping, piloting and ensuring systemic integration; by reducing complexity of transactions, enabling institutional change and promoting crucial learning interactions among system components, organizations and entrepreneurs; across political, economic and social innovation-relevant levels"**.

The mission of *"Associative Components"* could be directly linked to a basic concern underlined on Smart Specialization Strategies literature (Foray and Van Ark, 2007; Foray, 2009a; Foray, 2009b; Foray *et al.,* 2009; European Commission, 2011; Morgan, 2013; OECD, 2013). Smart Strategies are described as an entrepreneurial process of discovery that can reveal what a country or region does best in terms of science and technology (Foray *et al.,* 2009). The smart specialization approach suggests that countries or regions should identify and select a limited number of areas for knowledge-based investments, focusing on their strengths and comparative advantages, on the basis of: (a) *"More effective spending of public resources*"; (b) *"The creation of synergies between public support mechanisms for R&D and innovation, industrial promotion and training institutions";* (c) *"The elimination of fragmentation and duplication of policy interventions that may result in a waste of public resources"*; (d) *"The identification of the strongest or*

promising domains for entrepreneurship and growth through a careful analysis of the existing capabilities, assets, competences, competitive advantages in a region or country"; (d) *"Mechanisms to enable strategic development based on multi-faceted and multi-governance interactions";* (e) *"Mapping and benchmarking of cluster including analyses of the role and influence of key players"*, and (f) *"Evidence-based monitoring and evaluation systems to select the knowledge domains and innovation projects"* (OECD, 2013).

One of the basic assumptions describing these learning processes of innovation and experimentation entails the need for contribution of a broad set of stakeholders (Foray and Van Ark, 2007; Foray, 2009a; European Commission, 2011). Health, agriculture, climate or societal challenges require participation and decision making among disparate fields and differing interests (Acworth, 2008; Foray, 2009a; Cooke, 2011). Thus, definitions including *"individuals and organizations who have some entrepreneurial knowledge"* (Foray and Van Ark, 2007; Foray, 2009a; Foray, 2009b; Foray *et al.,* 2009; European Commission, 2011) can still be considered superficial, as more research and empirical evidence is developed by the authors. More information needs to be provided in order to facilitate and guarantee the success in the selection processes. A clear explanation on which actors, other than firms, are to be included in these strategies remains still an open question (Morgan, 2013: 105). In addition, these entrepreneurs – whether individuals or organizations- may not have sufficient external connections to marketing and financing sources and may find themselves in a weak position when negotiating with external parties (Foray *et al.,* 2009).

To our best concern, the literature has neither explained in a sufficient manner which organizations would foster and orchestrate these participatory processes. As a matter of fact, it could happen that essential organizations are kept outside the process as a consequence of the lack of understanding and oversights on the part of promoting agencies. All in all, we presume these processes would share some basic stages. First, stakeholder organizations would need to be networked and brought together, as projects need be socialized. Second, the objectives, scope, timetable and resource planning of the projects would need to be agreed. Third, differing interests among the parties would need to be balanced to facilitate consensus. We believe that *"Associative Components"* embed experts in the arena of competition and negotiation across public and private domains and institutions. Consequently, we state intermediaries may constitute a crucial agent in terms of helping shape the variable geometries of networks necessary to accomplish the objectives fixed in Smart Strategies across regions and countries. However, it is still an open question how the four categories of intermediary organizations coordinate to serve the cause.

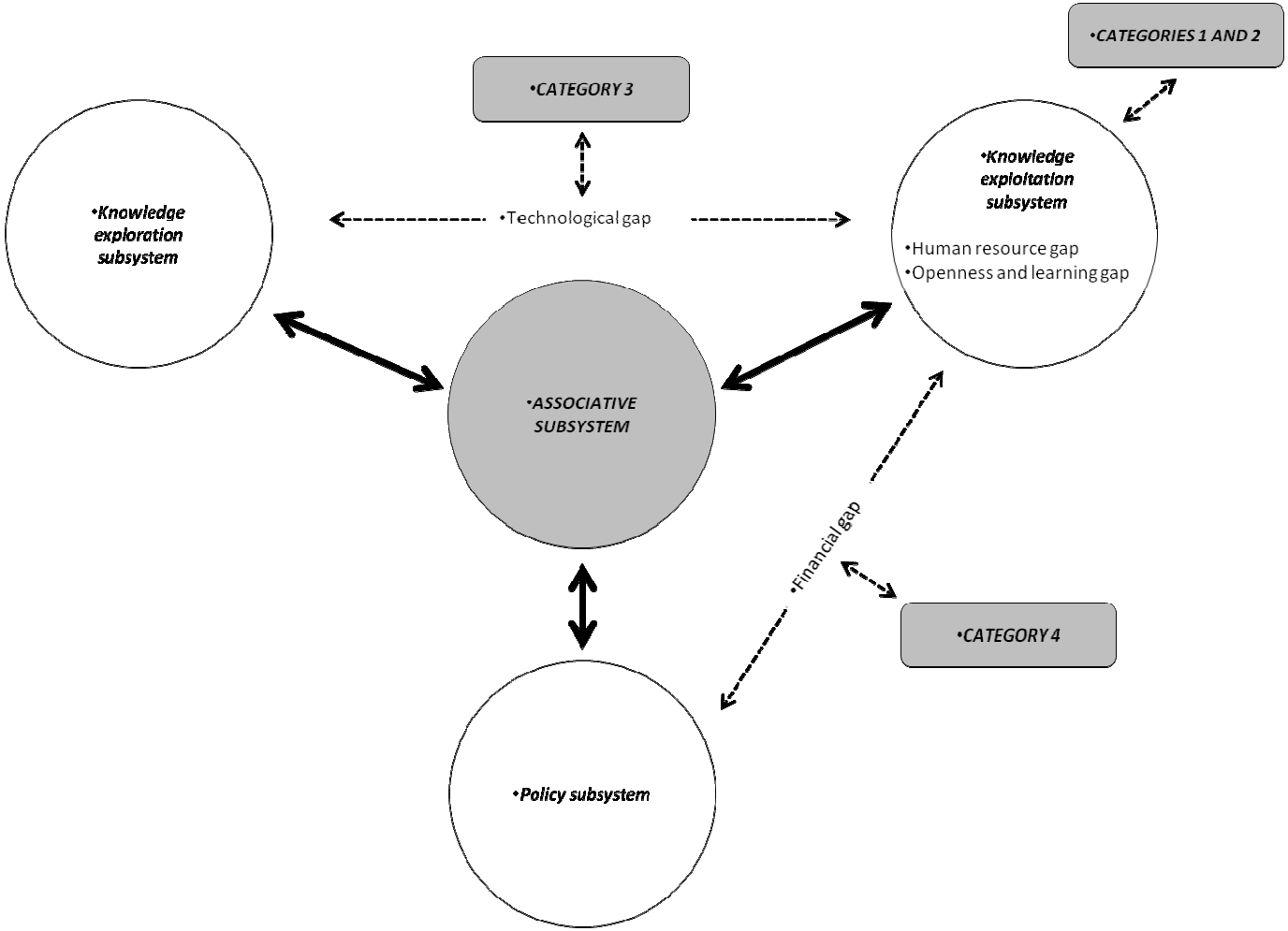


Figure 2.3 The "Associative Component

All in all, an important benefit of the *"Associative Component"* is that the latter may constitute a crucial tool to govern systemic integration by a number of rationales that call for specific policy intervention[41]. ISs shall not be considered static entities (Nelson, 1992; Freeman, 1995; Edquist, 1997; Asheim and Isaksen, 2002; Asheim and Gertler, 2005; Woolthuis *et al.,* 2005; Tödtling and Trippl, 2005; Uyarra, 2010; Chaminade *et al.,* 2012; Asheim and Parrilli, 2012; Tödtling and Trippl, 2012). On the contrary, these environments could be described as geographical areas where centrifugal and centripetal forces coexist. These forces entail diverging and coinciding interests, perceptions and knowledge bases among different layers of political, economic and societal organizations that shall compete and collaborate on a regular basis. While the former forces expand diversity, *"related variety"* (Frenken *et al.,* 2007) and provoke learning and system´s upgrading, the latter spur the contrary in favor of *status quo* or more precisely, in favor of certain –public and private- organizations that get benefited from the current state of systemic –interactive- evolution. The excessive power of such organizations could prevent systemic change and

41 According to Nauwelaers (2011: 470), under a System Innovation approach of policy intervention, the seven functions we have previously introduced (Edquist and Johnson, 1997; Johnson, 1998 and 2001; Jacobsson and Johnson, 2000; Alkemade et al., 2007; Hekkert et al., 2007; Jacobson and Berger, 2004; Edquist, 2011) open new avenues for policy intervention. Just to recall, these functions are: (a) "Entrepreneurial activities"; (b) "Knowledge development (learning)"; (c) "Knowledge diffusion through networks"; (d) "Guidance of the search"; (e) "Market formation"; (f) "Resource mobilization"; and (g) "Creation of legitimacy and counteracting resistance to change".

progress and consequently, innovation system policies shall observe these forces and play a role in managing these *"hidden"* interests. Otherwise, some innovative organizations and entrepreneurs would lose the game of competition without even have a chance to play. Some of these innovations shall often require policy drives that might provoke adaptation and institutional change in ISs, in favor of –crucial and creative- minorities[42]. Consequently, balancing between these forces comes to be a crucial systemic function that can be performed by the supervision of the *"Associative Component´s"* organizations.

In addition, the existence of certain system problems can help crystallize transactions of organizations that benefit from their current –prevailing- network position; and explicitly aim to put off other innovation-relevant organizations and entrepreneurs from commercial deals (i.e. monopolies and oligopolies). On the other hand, certain firms shall not necessarily acknowledge problems in the system; as it may exist in –but not cause or recognize- these imbalances. An organization might not even realize about the unexplored –financial, managerial, etc…- opportunities that remain hidden in these gaps[43] (Nauwelaers and Wintjes, 1999; Howells and Edler, 2011). Accordingly, these organizations might need external help to realize about their own barriers, or the limitations they inherit from the system itself. Even if an

42 Typically, the market will not be able to value a start-up firm (Nauwelaers and Wintjes, 1999).

43 The authors claim that "gaps" can be considered to be "opportunities" for organizations and systems, while at the same time comprise most clear evidence of the lack of relational density in ISs (Nauwelaers and Wintjes, 1999; Howells and Edler, 2011).

innovation-relevant organization acknowledged the existence of a problem, they might not dispose the necessary –managerial, technological, financial, relational- means to overcome it on their own. Put together, these difficulties might occur for a handful of reasons that may require *ad hoc* assessment and intervention, since each system will have its own problems and potentials (Nauwelaers and Wintjes, 1999; Lundvall and Borrás, 1997), and these reasons might entail complex interests that could help scholars disentangle why some ISs are more *"innovation friendly"* than others.

CHAPTER 3: METHODOLOGY OF THE DISSERTATION

3.1. SPANISH BACKGROUND: A REVIEW

The empirical chapter of the dissertation leverages on the assessment of the Spanish ACs. Consequently, we onwards introduce some basic and general background information concerning the country and its regions.

The kingdom of Spain is a sovereign and member state of the European Union. Spain is a democracy organized in the form of a parliamentary government under a constitutional monarchy which is located on the Iberian Peninsula in southwestern Europe. Madrid is the capital of the kingdom and its largest city, with 3,2 million inhabitants (INE). The official language is Spanish, which is known as Castellan. There are other recognized regional languages such as Catalan, Galician and Basque which are spoken in certain ACs. Parliamentary democracy was restored following the 1975 death of General Franco, who had ruled since the end of the civil war in 1939. The Spanish Constitution of 1978 was the termination of its transition to democracy. After 1979, Spain is composed of 17 ACs (Appendix 2, Table iv) and 2 autonomous cities (Ceuta and Melilla). Spain is a capitalist mixed developed country with the 13th largest economy (World Bank, 2013). Currently, its GDP per capita is 21,979.90 EUR, being 27th highest in the world (International Monetary Fund, 2013). The country is a member of the United Nations (UN), the North Atlantic Treaty Organization (NATO), the OECD, and the World Trade Organization (WTO). With an area of 505,992 km^2,

Spain is the second largest country in the European Union (INE). It has over 46 million inhabitants (Appendix 2, Table iv) which enjoy public healthcare services and free education from the age of six to sixteen. The country represents one of the most visited destinies in the world and is very well known for its music, architecture, cuisine, its lifestyle and beaches.

Spain´s accession to the European Community in January 1986 required to open its economy to trade and investment, improve infrastructure, modernize its industrial base and in general terms, revise its economy and legislation to adapt to EU guidelines. These measures helped the economy grow over two decades. Unemployment fell from 23% in 1986 to 8% in 2007 (INE). The adoption of euro in 2002 reduced interest rates, what partially induced a housing boom that fostered the growth of the country built on fragile foundations. The strong euro also facilitated international investments. During this period, several top banking, wind and solar power, biofuels (...) Spanish firms such as Banco Santander, Gas Natural Fenosa, Iberdrola or Repsol, to name a few, expanded their activities Latin America, China and India. The end of the boom in 2007, along with the international financial crisis led Spain to decline and recession. Housing sales and construction declined dramatically, and the unemployment rate augmented till 27,2% in 2013, being the highest in EU-27 (INE).

The current government (Popular Party) is headed by Mariano Rajoy since 2011. The government has implemented several labor market reforms in an effort to stimulate growth and create employment causing inconclusive outcomes. Under his government, banking sector has proven to be at the heart of the crisis, being the most noticeable cause and effect of the deteriorating economic situation. The state of affairs is

progressing since the euro-zone recapitalized Spanish banks and independent bodies conducted stress tests to verify their property assets. Partly as a consequence of the lack of trust and credit, business organizations live under a very difficult situation, confronted with a decrease in domestic sales and a context of falling European demand. Thus, exporting sectors are attempting to turn to alternative markets. International –non European- sales have increased in 13,7% during 2012 (INE). Still, weak points include a large underground economy and one of the poorest education systems among developed countries (OECD, 2006 and 2008), together with corruption and political crisis. Additionally, under this context of crisis and generalized recession, the Spanish expenditure in R&D and technological innovation is currently decreasing[44] (INE).

As matter of fact, Spain requires deep structural reforms to overcome its current situation. The country locates in a European context where competition demands intensive use of information and knowledge. Consequently, Spain cannot compete by decreasing wages, deregulating labor markets and disinvesting in R&D and technology; and needs to invert the tendency. For that to happen, one of the main priorities begins with the assessment of its -political, economic and social- systems. These analyses shall report general trends and new diagnoses, constituting essential inputs to design new policies. The

44 The Spanish expenditure in R&D has decreased till 14.184 million euros in 2011, being 2,8% lower than in 2010. On the other hand, the expenditure in technological innovation decreased 8,8% in 2011, till 14.756 million euros (INE).

current dissertation fits in this outlook, along with studies presented onwards.

In this line, the dissertation contributes to a literature strand that analyzes and produces innovation and efficiency patterns leveraging on the use of econometric techniques across Spanish RISs. This tradition gathers an important number of typologies that capture regional specificities while it also contributes to policy design and decision making. Scholars elaborate typologies based on the use of secondary sources. First, Coronado and Acosta (1999) present a pioneering work that elaborates on three main questions: (a) how to measure the technological and innovative capacity of regions; (b) which are the determinant factors of innovation and what is the influence of location; and (c) how to improve the technological capacity of less favored regions as a means to improve their competitiveness and growth. The study assesses the unbalances and potentialities that the Spanish regions present. It leads the authors to conclude that Spain is composed of different types of regions according to their capacity to produce innovations (patents). It also presents a typology of regions that distinguishes between two main groups: (a) technological regions, composed of Madrid (covering and outstanding position), Catalonia, the Basque County, Navarre and Valencia; and (b) peripheral regions, composed of the remaining Spanish ACs.

Second, the Spanish *"Institute of Industrial and Financial Analysis"* (IAIF) of the Complutense University of Madrid, congregates an important number of researchers which have developed a rich body of work related to the assessment of RISs, their efficient dynamics and the creation of typologies (Buesa *et al.,* 2002a, 2002b and 2007; Martínez-Pellitero, 2002, 2007 and 2008; Buesa and Heijs, 2007). Their

investigations employ the IAIF-index of regional innovation. This index is made of an elevated number of variables and statistical sources. The strand groups the variables following an analytical framework that includes four different subsystems: (a) firms and their relationship with the RIS; (b) support infrastructure for innovation; (c) public innovation-linked performance; and, (d) the regional and national environment for innovation (Heijs, 2001). The authors apply multivariate techniques in order to determine implicit factors in Spanish RISs and produce their typologies, as a consequence of the elevated number of variables employed in their studies. The technique reduces the variables into four main factors: (a) regional and productive environment for innovation; (b) universities; (c) civil service; and, (d) innovating firms. Their solution defines five heterogeneous system types, four of which comprise just one AC. Therefore, their typologies separate four Spanish regions: (a) Madrid; (b) Catalonia; (c) the Basque Country; (d) and Navarre; and a group composed of the remaining regions (Martinez-Pellitero, 2002; Buesa *et al.,* 2002a; Buesa *et al.,* 2002b; Buesa *et al.,* 2007; Buesa and Heijs, 2007).

These studies often depict RISs as a technically more or less efficient transformer of inputs into outputs (Zabala-Iturriagagoitia *et al.,* 2007: 663). The rationale behind considering efficiency measures as a relevant information lies in the fact that the existing methodologies are mostly based on the belief of *"the more the better",* and that it is the amount of resources employed (inputs), but not how they are used that matters (Zabala-Iturriagagoitia, 2008: 47). For this reason, apart from analyzing the structure of the RISs (input side), and the determinants of the innovative capacity (output side), some of these studies also analyze to what extent the regions make use of the resources in an

efficient way (maximum output with a minimum of input). Some results conclude that Madrid and Catalonia are the most efficient regions by minimizing the required inputs to obtain a certain level of output (patents) (Buesa and Heijs, 2007; Martinez-Pellitero, 2007 and 2008). By contrast, Madrid and Catalonia occupy less prominent positions in other analyses (Zabala-Iturriagagoitia *et al.,* 2007; Zabala-Iturriagagoitia, 2008). Importantly, Zabala-Iturriagagoitia claims that dynamic systems (i.e. Madrid) require high levels of coordination, which reduces their levels of efficiency. Other regions such as Navarre and the Basque country rendered more efficient and competitive to the author. Additionally, an interesting conclusion of the analysis is that some Spanish peripheral regions -such as Balear Islands and Castile La Mancha- proved highly efficient use of the resources. The author calls for a logic interpretation to justify its results*: "those regions with lower absorptive capacity and fewer resources adopt the embodied knowledge and the innovations of others, which involves lower levels of development, but at the same time is efficient since risk is avoided and the "new" knowledge is rapidly adopted"* (Zabala-Iturriagagoitia, 2008: 97, from: Fernández de Lucio *et al.,* 2003). Additionally, he claims that peripheral regions cannot afford to squander the scarce resources dedicated to innovation activities and consequently, their cautious behavior produces unexpected and unforeseen efficiencies (Zabala-Iturriagagoitia, 2008: 98).

However, innovation is, more and more, an outcome of the interaction across different organizations, institutions and knowledge domains, rather than the by-product of technical change (Nauwelaers, 2011: 468). Precisely for this reason, there are two –main- aspects that need to be considered. First, the ability of regions to change and evolve towards

the construction of their own advantages may have little to do with the capacity of their firms and universities to produce certain –specific- innovations (i.e. patents). As regions differ, so must systems and policy stances adapt their strategies in pursuit of their own objectives (Porter, 1990; Cooke, 1996, Navarro and Gibaja, 2009). The latter leads us presume that an important number of scholars and policy makers may rely on a wider rationale to assess their own innovative efforts and capabilities. Rather, regions could evaluate whether they were effective when it comes to achieve their own targets (Zabala-Iturriagagoitia, 2008: 108). Secondly, under evolutionary perspectives, technological innovations could only measure the innovative capacity of a portion of the organizations and institutions involved in the development and growth of regions. Thus, we claim these reasons might render these assessments remarkable when comparing leading regions and their ability to produce such innovations, as they might constitute an important component of regional benchmarks and policy making discussions[45] (Zabala-Iturriagagoitia *et al.,* 2007, Zabala-Iturriagagoitia, 2008; Buesa and Heijs, 2007; Martinez-Pellitero, 2007 and 2008). The bottom line, however, is that it may seem a little awkward to wonder about the capability of Spanish peripheral regions to produce certain specific innovations (i.e. patents); particularly under the current economic situation.

45 Zabala-Iturriagagoitia (2007: 85) claims that "it could be argued that the very concept of efficiency operationalized here is derived from neoclassic economics, incompatible with the heterodox underpinnings of the RIS concept, which its emphasis on non-optimality".

Finally, a complementary and essential body of work presents a number studies that enrich this strand with novel results (Navarro and Gibaja, 2009, Navarro *et al.,* 2009; Navarro and Gibaja, 2010 and 2012). The authors produce typologies of Spanish RISs leveraging on the use of different statistical sources; and compare their results to assess their quality and likelihood. Leveraging on the use of multivariate techniques, their typologies arrange regions in clear divisions composed of four and five groups of Spanish regions, as follows. Navarro and Gibaja (2009), distinguish among (a) agricultural peripheral regions (Extremadura and Castile La Mancha); (b) tourist peripheral regions (Canary Islands, Balear Islands and Andalusia); (c) Medium/low tech regions (Galicia, Cantabria, Asturias, Castile Leon, La Rioja, Aragon, Valencia and Murcia); (d) Medium/high tech industrial regions (Navarre, the Basque Country and Catalonia); and, (e) Capital region specialized in advanced services (Madrid). In other works, Navarro and Gibaja (2012) bring forward complementary typologies of regions: (a) agricultural or tourist (less developed) regions (Balear Islands, Canary Islands, Castile La Mancha, Andalusia, Extremadura[46] and Murcia); (b) Medium/low tech regions (Aragon, Asturias, Cantabria, Valencia, La Rioja, Galicia and Castile Leon); (c) Medium/high tech industrial regions (Basque Country, Catalonia and Navarre); and, (d) Capital region specialized in advanced services (Madrid).

All in all, the following Table 3.1 resumes the variables employed by this literature tradition. For instructive reasons only, we have also included the variables that the dissertation shares with former analyses.

46 This region is not included in the original typology due to a typographical error.

The complete list of variables of the current work will be developed in the following subchapters (Tables 3.2 & 3.4). As a matter of fact, this thesis learns and builds some of its rationales out of these studies. However, the approach varies significantly. The dissertation does not aim at developing innovation and/or efficiency patterns for the Spanish RISs. Instead, it assesses and maps (a) system problems; and (b) the presence or absence of intermediary organizations tapping into the former across the Spanish regions. Therefore, while the table presents a well defined distinction between input and output variables, the latter will have no significance in our study.

Table 3.1 Review of typologies of innovation for the Spanish regions (adapted from: Navarro and Gibaja 2009; Navarro *et al.,* 2009; and Navarro and Gibaja, 2012)

		Coronado and Acosta (1999)	Martínez-Pellitero (2002 and 2007)	Buesa and Heijs (2007)	Navarro *et al.,* (2009)	Navarro and Gibaja, (2009)	Zabala-Iturriagagoitia (2008)	Navarro and Gibaja (2012)	System problem assessment (current dissertation)	Intermediary organization assessment (current dissertation)
Economic output	GDP		X	X						
	GDP per capita				X	X	X	X		
	GDP per worker				X	X		X		
Scientific and technological output	Spanish´s patent office patents	X	X					X		
	European patent office patents		X		X	X	X			
	High tech European patent office patents				X	X		X		
	Sales of new-to-firm and new-to-market products							X		
Business R&D	Total R&D expenditure (% GDP)	X			X	X		X		
	R&D staff	X								

	Researchers	X								
	Expenditure per employee: R&D				X	X				
	Business R&D expenditure	X	X	X	X	X	X	X		
	Business R&D internal staff (FTE[47])	X	X	X					INDICATOR G35	
	Business R&D researchers (FTE)		X	X				X	INDICATOR G13	
	Firms technological capital stock in R&D		X	X						
	Expenditure of innovative firms in acquisition of machinery, equipment, software and other external knowledge (% GDP)							X		
Other innovative activity	Innovation expenditure			X						

47 Full-Time Employees.

Productive structure	High and medium technology industry (GVA[48])		X							
	Low technology industry (GVA)		X							
	Employment in agriculture				X	X		X	AGR	AGR
	Employment in industry				X	X		X	IND	IND
	Employment in high and medium technology industry		X	X	X	X	X	X		
	Employment in low technology industry		X	X						
	Employment in High-tech services						X	X		
	Employment in financial and business services				X	X	X	X		
	Export specialization index							X		

[48] *Gross Value Added.*

	Export-related variety index							X		
	Frims with 500 or more employees							X		
Scientific and technological infrastructure	Government expenditure on R&D		X	X	X	X	X	X		
	Higher education R&D							X		
	Civil service R&D staff (FTE)		X	X						
	Civil service R&D researchers (FTE)		X	X						
	Scientific capital stock in R&D per inhabitant		X							
	Scientific capital stock in R&D		X	X						
	Technological capital stock in R&D		X							
	Internal university R&D expenditure		X	X	X					
	Internal university staff in R&D (FTE)		X	X						
	Internal university researchers in R&D (FTE)		X	X						

	Research quality indicator of university		X	X						
Innovation Infrastructure	Venture capital investment		X	X						
	Regional distribution of technological centers		X	X						
	Annual income of technological centers		X	X						
Demography	Demographic density				X	X				
	Accessibility index				X	X				
Human resources	Population 25-64 with tertiary education				X	X	X			
	Students enrolled in first and/or second part of degree course		X		X	X				
	Students who have finished first and/or second part of degree course		X	X						
	Students registered in postgraduate courses		X	X						
	Students how have read their thesis		X							

	Science and technology human resources		X		X	X				
	Lifelong learning participation				X	X	X			
Job market	Employment rate				X	X				
Governance	National projects approved by the Centre for Industrial Technological Development (CDTI)		X	X						
internationalization	Export. High and medium-high tech industry		X							
	Export. Medium low-tech industry		X							
	Exports. Low-tech		X							
	Total exports			X						
Tourism index	Tourism index					X				

3.2. SYSTEM PROBLEMS: VARIABLES AND DATA

The integration of Spanish RIS´s could be explicated by means of the behavior each AC shows in the gaps listed in our study. Therefore, our interest is to perform a quantitative analysis of the gaps in order to estimate integration patterns. In order to do so, we aggregate a number of variables into four sets that would relate to each listed gaps (*"Gap 1"* to *"Gap 4"*). The explanatory indicators we choose and adapt stem from a classification formulated to describe RISs that outstand for their high integration. Our choice with regards to the variables employed in this study builds on several previous approaches that deal with the assessment of innovation and efficiency-related aspects in ISs. Particularly, we leverage on the work of several authors that employ indicators to assess and present typologies both of Spanish and international ISs (Susiluoto, 2003; Navarro and Gibaja, 2009, 2010 and 2012; Buesa et al. 2002a, 2002b and 2007; Martínez-Pellitero, 2002; Zabala-Iturriagagoitia *et al.,* 2007; Chaminade *et al.,* 2012). However, as developed in subchapter 3.1, our variables and employment rationales differ from these studies. Additionally, we introduce three supplementary variables (AGR, IND and SERV) which attest the quality of the analysis performed on the gaps. These variables provide an intuitive reference with regards to the quality of the results fed back; albeit they have no influence whatsoever over the core empirical findings (see Appendix 2: supplementary indicators).

As introduced, a first and necessary step to estimate the integration of Spanish RISs is to produce a theoretical framework where system problems could be adequately settled together with those components they relate to (Figure 2.1). Secondly, we need to operationalize a

number of quantitative variables that would permit the assessment of the problems: *"Gap1", "Gap2", "Gap3"* and *"Gap4"* over the Spanish regions. Table 3.2 resumes the sources of information we have scrutinized in search of adequate variables; and their time periods. We have selected a number of indicators that proxy the information we would like to gather to estimate the integration of Spanish RISs.

Though we find important limitations, a number of variables may constitute a first step to assess the introduced gaps, as presented in Table 3.2. Extended information on these variables is also provided in appendix 2.

Gap 1 analyzes to what extent firms *"use qualified resources in management".* A number of indicators (G11: G14) proxy certain characteristics of private companies that might be explained by sophisticated managing practices. We claim that *"Higher educational levels"* (G11), and the *"ability to employ foreign languages"* (G12), are descriptive of managers and businessmen which are better qualified to coordinate the internal and the international activity of the organization. On the other hand, a *"higher number of doctors performing research activity"* (G13) and a higher number of *"staff with a computer and internet access"* (G14), are descriptive of managers and businessmen who are sensitive to the importance of learning and firm´s *"absorptive capacity*[49]*"* of their firms (Cohen and Levinthal, 1990). Put together, these indicators are intended to grasp advanced managerial practices; but fail in the assessment of other important characteristics that remain

49 "Absorptive capacity" is described as a firm's ability to recognize the value of new information, assimilate it, and apply it to commercial ends.

veiled. Future approximations could complete the current view by adding variables such as: the *"number of markets in which the firm operates",* the *"DUI or STI styles of firm innovation"* (Jensen *et al.,* 2007), the *"organizational working environment"* or *"their investment in training".* This information would describe crucial characteristics of advanced managerial practices and would also feed back with more precise information regarding the managerial profile of the organizations under assessment.

Gap 2 analyzes to what extent firms *"learn from others and develop antennas in exploitation subsystems"* of RISs. In order to do that, we add two new indicators (G21: G22) that proxy the assessment of the *"density"* and the *"quality"* of beneficial interactions occurring among private companies of the *"knowledge exploitation component".* We claim that *"private companies joined or associated to a corporate group"* (G21), would be more prone to participate in group meetings, conferences and social acts were knowledge is shared and interchanged among participants. As a matter of fact, corporate groups usually function as a single economic entity which demands for communication and trust among group members. On the other hand, *"private firms that consider the Spanish market an important source of innovation"* (G22), would have better chance to update their knowledge as a consequence of the existence of certain crucial *"Knowledge spillovers"* in these networks that firms benefit from (Saxenian, 1996; Zucker *et al.,* 1998). Thus, if more firms engage in networks, the *"knowledge exploitation subsystem"* would turn a denser –more interactive- spatial dimension. Of course, very dense networks can bring about other key undesired externalities as lock-in problems (Nauwelaers and Wintjes; 1999, Isaksen, 1999; Tödtling and Trippl,

2005; Martin and Trippl, 2013). Thus, future approximations would aim to grasp the *"related variety"* of the networks firms belong to (Frenken *et al.,* 2007; Asheim *et al.,* 2011). New indicators could be added to assess the *"interaction"* levels among firms across different time periods. It would also be of interests to assess the *"level of trust"* existing in these networks.

Gap 3 is represented by a set of indicators (G31:G35) that aim at explaining to what extent firms *"screen for technological options and adapt state-of-the-art to their own situation"* (appendix 1). As stated, the *"technological outlook"* of the sources of innovation employed (INE) permits a closer approximation to the diagnosis of this gap. The *"purchase of R&D"* (G31 & G32), the *"number of external consultants performing R&D"* (G33), the *"percentage of private companies that consider the exploration subsystem an important source of innovation"* (G34), and the *"number of researchers developing R&D activity in private companies"* (G35), are good variables to assess the *"density"* of interactions between *"knowledge exploration" and "exploitation components"* which facilitate the analysis of firm´s technological adoption. Of course, new variables could improve future approximations by adding new indicators that, as in the case of Gap 1 regarded *"DUI or STI styles of firm innovation*[50]*"* (Jensen *et al.,* 2007). To this regard, the innovating style of the region should be considered a very important

50 It is crucial to underline that some RISs will be more prone to show intensive collaboration between the exploration and exploitation subsystems than others. This would have to do with the predominating type of innovation that prevails (Jensen et al., 2007) and the existing –analytic, synthetic, symbolic- knowledge bases of the region itself (Martin and Trippl, 2013).

input before creating typologies or inferring conclusions and policy recommendations. Importantly, researchers could find that different innovating profiles and consequently, comparisons among certain indicators (i.e. patents, scientific publications) would be less representative.

Gap 4 analyzes to what extent *"a regional policy component has developed tools to help firms overcome financial difficulties"* (when markets prefer secure investments with short term return, appendix 1) (Nauwelaers and Wintjes, 1999). We employ two complementary indicators to measure this (G41-G42). A higher *"venture capital portfolio"* (G41) would imply a higher commitment of the *"regional policy component"* to foster the creation of new firms and projects; helping firms to overcome this difficulty. A higher number of *"new technology-based firms born"* (G42) is an output indicator that actually shows the *"efficiency"* of the system; which also contributes to explain a good functioning of the *"regional policy component"* when it comes to nurturing the creation of new projects and firms. Of course we find important limitations. *"Venture capital"* is not only public capital. Consequently, new indicators could return a better approximation to the assessment of this gap. First, the amount of private loans demanded for firms (General Debt Ratio) in the private sector, could contribute to uncover firm´s financial difficulties and their access to loans, credit guarantees and equity. Second, the *"number of private firms that closed the business as a consequence of financial problems"* could also be a good indicator to measure the existence of policy tools adequately adapted to firm´s financial difficulties; as opposed to system´s capacity to foster new ones.

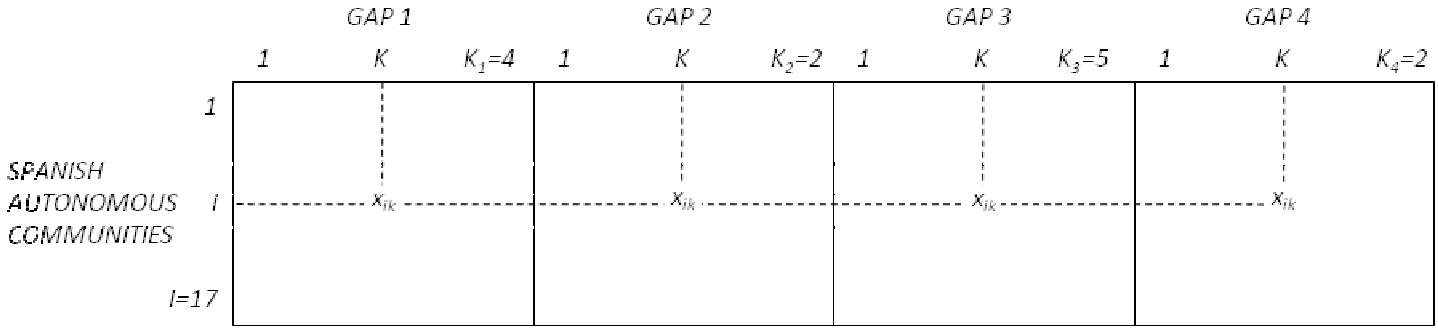
We claim this is still a very preliminary estimation. First, Figure 2.1 puts together system problems that mainly deal with firm´s purview (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998; Bessant and Rush, 1995 and 2000; Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010). This view could be completed with important interactions between and within other components and organizations that, as stated previously, could have been overviewed (i.e. intermediaries, public organizations, etc…). Secondly, the diagnosis of these problems is not intended to be complete and finalistic, as the current state-of-the-art prevents the employment of important variables that would improve the analysis.

The data we gathered for the empirical analysis is based on *ad hoc* exploitations sourced on various studies conducted by the INE. The special condition of an indicator employed in Gap 4 demanded new data sourced from the ASCRI. Though the employment of different sources could bias results, we decided to include it as it provides us with valuable and precious high quality information. Table 3.2 gathers all sources of information employed in the assessment of our units of analysis (Spanish ACs).

Our data is gathered in a matrix (Table 3.3) whose rows correspond to Spanish ACs, while its columns stand for four separated sets of continuous variables that have been grouped under the names of *"Gap1","Gap2","Gap3","Gap4",* and, as explained, relate to the system problems introduced. The data has been standardized. The process

returns dimensionless quantities (Kreyszig, 1979)[51]. The form of the matrix is displayed in the following Figure 3.1:

Figure 3.1 Gap´s matrix
For region i, x_{ik} corresponds to its value for continuous variable k



In terms of data analysis, the outputs regarding the assessment of system problems across spanish regions stem from the analysis carried out using R version 2.15.1 (R Development Core Team, 2011) and the FactoMineR package (Lê *et al.,* 2008; Husson *et al.,* 2011; R Development Core Team, 2011).

[51] *Standard scores are obtained by subtracting the population mean from an individual raw score and then dividing the difference by the population standard deviation. Technically, the process is done following this formula,* $z = \frac{x-\mu}{\sigma}$ *; where μ is the mean of the population and σ is the standard deviation of the population.*

Table 3.2 Variables employed in the study of system problems					
Component	Code	Indicator	UNIT	Source of information	PERIOD
GAP 1	G11	Businessmen, managing directors and executives that have completed third-level education; times employees who have also completed it.	Percentage	Survey on Adult Population Involvement in Learning Activities. Spanish Official Statistical Institute (INE)	2007
	G12	Businessmen, managing directors and executives capable of using languages other than their "mother-tongue"; times employees who are also capable of using them.			
	G13	Doctors performing research activity in private companies	Per hundred thousand people	Innovation in companies´ survey. Spanish Official Statistical Institute (INE)	2008-2009
	G14	Private company´s staff with a computer and an internet connection	Percentage	Survey on ICT. Usage and e-commerce in companies. Spanish Official Statistical Institute (INE)	2011-2012
GAP 2	G21	Private companies joined or associated to a corporate group		Innovation in companies´ survey. Spanish Official Statistical Institute (INE)	2008-2009
	G22	Private companies that consider the Spanish market52 an important source of innovation			
GAP 3	G31	Private companies that have purchased R&D services to joined, associated companies or other Spanish market sources			
	G32	Private companies that have purchased R&D services to joined, associated companies or other foreign market sources			
	G33	External consultants performing R&D activity within private companies	Per hundred thousand people		

52 In this table, the use of the word "market" refers to openly to: providers, clients or competitors belonging to the "knowledge exploitation subsystem" of the RIS.

	G34	Private companies that consider Spanish "exploration subsystems"53 an important source of innovation	Percentage		2008-2010
	G35	Researchers that develop R&D activity in private companies	Per hundred thousand people		
GAP 4	G41	Total venture capital portfolio	€ per thousand people	Spanish Venture Capital Association (ASCRI) Statistics about R&D activities 2010	2005-2011
	G42	New technology-based firms born	Per hundred thousand people	Innovation in companies´ survey. Spanish Official Statistical Institute (INE)	2008-2009
SUPLEMENTARY VARIABLES (SUP)	AGR	Employed population by branch of activity, sex and autonomous community: Agriculture	Thousands of employed population over thousands of working age population	Survey on Adult Population Involvement in Learning Activities. Spanish Official Statistical Institute (INE)	2012
	IND	Employed population by branch of activity, sex and autonomous community: Industry[54]			
	SERV	Employed population by branch of activity, sex and autonomous community: Services[55]			

53 Due to statistical constraints, the use of "knowledge exploration subsystem" in our study is referred to: universities, public organisms, technology centers and private non-profit organizations.

54 Corresponds to extractive industries; manufacturing industry; supply of electric power, gas, steam and air conditioning; water supply, sanitation activities, waste management and decontamination.

55 Corresponds to financial and insurance activities; professional, scientific and technical activities; administrative activities and ancillary services.

Table 3.3 Standardized data (system problems)

	GAP 1				GAP 2		GAP 3					GAP 4		SUP		
	G11	G12	G13	G14	G21	G22	G31	G32	G33	G34	G35	G41	C42	AGR	IND	SERV
Andalusia	-0.03	-0.03	-0.62	-0.17	-0.21	-0.87	-1.05	-0.76	-0.44	-0.81	-0.62	-0.7	0.15	0.08	0.09	0.11
Aragon	-2.47	-0.09	-0.3	-0.17	-1.19	0.43	0.46	0.16	0.42	0.16	-0.14	-0.7	-1	0.06	0.18	0.10
Asturias	0.35	0.94	-0.06	0.05	-1.01	-0.24	-0.29	-0.59	-0.41	-0.13	-0.18	0.73	0.21	0.04	0.15	0.11
Balear Islands	0.3	0.39	-0.81	0.72	0.47	-1.3	-1.22	-0.76	-0.54	-1.74	-0.83	-0.85	-1.51	0.01	0.07	0.12
Canary Islands	-0.44	-0.09	-0.8	-0.66	1.16	-1.41	-1	-1.26	-0.59	-1.04	-0.82	-0.89	-0.2	0.03	0.05	0.11
Cantabria	0.72	2.14	-0.67	-0.74	-0.79	0.17	-0.22	-0.3	-0.51	0.26	-0.44	-0.21	0	0.03	0.16	0.11
Castille Leon	-0.07	-0.03	-0.19	-0.73	-1.93	-0.37	-0.12	0.12	-0.57	-0.2	-0.3	0.62	0.27	0.07	0.16	0.09
Castille La Mancha	-0.9	-2.98	-0.58	-1.22	-0.7	-0.61	-0.39	-0.72	-0.38	-0.37	-0.69	-0.36	-0.8	0.07	0.17	0.09
Catalonia	-0.77	-0.03	0.79	1.44	1.54	0.19	0.06	1.21	0.22	-0.55	0.35	0.22	0.62	0.02	0.19	0.13
Valencia	0.06	-0.21	-0.27	0.82	0.65	-0.19	-0.29	-0.21	-0.43	0.47	-0.26	-0.77	-0.68	0.04	0.17	0.11
Extremadura	-0.07	-0.39	-0.74	-0.56	0.42	-0.69	0.17	-0.3	-0.63	-1	-0.79	1.8	-0.82	0.11	0.11	0.07
Galicia	0.88	-0.45	-0.45	0.35	-0.15	0.09	-0.34	-0.51	-0.34	0.58	-0.39	-0.39	0.18	0.08	0.16	0.10
Madrid	2.25	0.21	1.04	2.58	-0.64	-0.26	0.13	0.79	1.23	-0.6	1.41	0.5	0.95	0,00	0.10	0.19
Murcia	-0.44	-0.33	-0.46	-1.1	-0.64	-0.22	-1.29	-1.22	-0.5	0.12	-0.53	-0.66	0.39	0.14	0.13	0.11
Navarre	0.84	0.51	1.4	-0.11	1.42	1.11	1.96	2.3	3.36	0.89	1.57	2.61	2.04	0.04	0.25	0.10
Basque Country	0.51	-0.33	2.94	0.53	0.76	1.73	2.04	1.67	0.43	1.97	2.78	-0.01	1.69	0.01	0.21	0.14
La Rioja	-0.73	0.75	-0.21	-1.02	0.85	2.43	1.4	0.37	-0.32	2	-0.12	-0.94	-1.51	0.05	0.24	0.10

3.3. THE *"ASSOCIATIVE COMPONENT"*: VARIABLES AND DATA

Spanish RISs could also be sorted out with regards to the relational density levels of intermediary categories over the specific system problems they tap into (Table 2.3). In order to do so, we follow the general procedure introduced in chapter 3.2, when introducing the variables and data employed in the assessment of system problems. This time we need to estimate the presence of intermediaries over the gaps we have introduced. We also aggregate a number of variables into four sets. The variables relate to each listed intermediary category. The explanatory indicators we chose and adapt stem from a classification formulated to describe RISs that outstand for the active presence of intermediaries over the gaps. As in the case of system problems, our choice with regards to the variables employed in this study are influenced by several previous approaches that deal with the assessment of innovation and efficiency-related aspects of innovation systems (Susiluoto, 2003; Navarro and Gibaja, 2009, 2012; Buesa *et al.,* 2002; Martínez-Pellitero, 2002; Zabala-Iturriagagoitia *et al.,* 2007; Chaminade *et al.,* 2012). We also introduce the supplementary variables (AGR, IND and SERV).

We operationalize a number of quantitative variables that permit the assessment of the intermediary categories: *"Cat1", "Cat2", "Cat3"* and *"Cat4",* over the Spanish RISs. Table 3.4 resumes the sources of information we scrutinized in search of adequate variables. We have selected a number of indicators that proxy the information we would like to gather in order to estimate the relational densities of intermediary organizational categories.

As in the case of system problems, we also found difficulties when it comes to the identification of variables for the assessment of intermediary organizations. Nevertheless, a number of variables may also constitute a first approximation to analyze their categories. These variables are presented in Table 3.4. Extended information on these variables is also provided in appendix 2.

Category 1 analyzes the existence of KIBS organizations facilitating firms improve their *"managerial resources".* A number of indicators (C11:C13) proxy external help provided by KIBS. Indeed, current trends in management consulting developed in an industry can also solve problems emerging in other industries, in different periods of time. As the literature provides, KIBS such as IDEO in the product design consulting industry (Hagardon and Sutton, 1997; Hagardon, 1998; Howells, 2006) conduct this process of knowledge recombination that permits private firms learn and upgrade their managerial capacities. Consequently, we infer that *"private companies that have implemented non-technological innovation betterments, as marketing innovations"* (C11); or *"organizational innovations"* (C13), shall have demanded and contracted services from external and specialized –category 1- intermediaries. On the other hand, those *"private companies with an internet connection and a website"*, shall have also demanded and contracted external help to implement these innovations. Put together, these indicators are intended to proxy intensive collaborations between private firms and this category of intermediary organizations; but fail in the diagnosis of other important characteristics that remain veiled. Future approximations could complete the current view by adding variables which would help interpret not only the presence, but also the quality of the services provided by intermediaries over these gaps.

Category 2 analyzes the existence of KIBS companies facilitating firms *"learn from others and develop antennas in exploitation subsystems"* (Nauwelaers and Wintjes, 1999) of RISs (appendix 1). In order to do that, we add two new indicators (C21:C22) that proxy external help provided by KIBS. On the top of presented practices, IDEO consultants and engineers also identify unexplored opportunities among the managers of distant organizations. The latter´s central position can connect otherwise disconnected organizations. The strong ties of these organizations with their customers and suppliers sometimes prevent companies from experimenting with new ideas. Thus, KIBS organizations facilitate cooperation and cross-fertilization of ideas across organizations and industries (Hagardon and Sutton, 1997; Hagardon, 1998). Consequently, we deduce that *"private companies that have cooperated with joined or associated companies or other national market sources in some of their innovating activities"* (C21), or with *"international companies"* (C22), shall have demanded and contracted services of external and specialized intermediaries which, like IDEO, may recommend them to get engaged in different networks. Of course, these indicators fail to explain whether private firm´s participation in these networks originated as a consequence of collaborating with intermediaries, or for other reasons such as higher social capital levels in the AC, or even pure chance. Thus, future approximations would aim to grasp these insights by the incorporation of new complementary variables.

Category 3 is represented by a set of indicators (C31:C33) that proxy the existence of TTAs, technical advisory groups, business and trade associations (…) facilitating firms incorporate *"technological options and adapt state-of-the-art to their own situation"* (appendix 1). A high percentage of *"private companies located in science and technology*

parks" (C31), shall be explicated by their interest in locating close to –intermediary- organizations they collaborate with, which frequently locate their headquarters in these spaces, such as trade associations, R&D technology centers, university science parks and the like. On the other hand, a *"high percentage of private companies that contracted R&D services"* (C32), and a high *"percentage of private companies that have cooperated with sources belonging to Spanish knowledge exploration subsystems in some of their innovating activities"* (C33), provide a good approximation to ascertain the presence of intermediary organizations facilitating firms adapt technological options to their own possibilities. Of course, new variables could improve future approximations by adding new indicators that would help us add essential information as for example the profile of specific organization these companies are contracting and collaborating with, or the novelty of the results of these collaborations.

Category 4 analyzes the existence of venture capitalists, banks or BAs facilitating firms *"overcome financial difficulties"* in RISs (appendix 1). We employ three complementary indicators to measure this (C41:C43). The number of *"Public loans"* (C41), the amount of *"public subsidies"* (C42) and the *"total venture capital operations"* (C43), provide good insights to analyze the existence of these intermediary profiles. With regards to these intermediaries, during the last years we witness examples on how the importance of alternative finance sources grows in innovation finance across European countries (European Commission, 2011). These sources improve SME access to finance and reduce

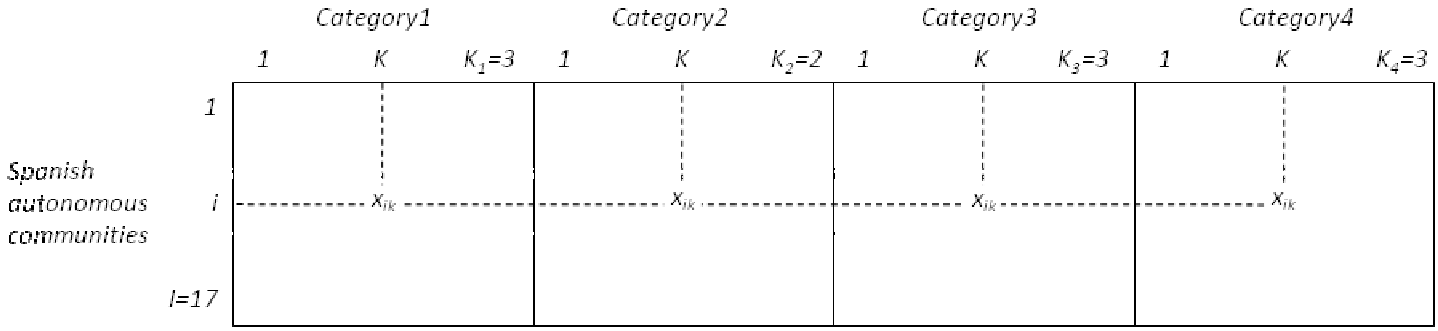
"financial gaps". For example, the competitiveness programme[56] (CIP) includes several financial instruments such as the European Investment Bank (EIB) and the European Investment Fund (EIF). The latter covers two main functions. First, it injects capital directly to venture capital funds, which supports investments in SMEs. In this case the EIF selects its financial intermediaries based on competence under public criteria, underscoring the importance of these organizations in spurring SMEs innovation management and support. Second, the EIF backs up guarantors and banks which also lend capital to SMEs. All in all, the Commission intends to continue using the EU budget to facilitate access to finance SMEs. In doing so, the EIF addresses information asymmetries and fragmentation of capital market that limits the growth of SMEs. However, while employed indicators provide with good information about this intermediary category, new indicators could facilitate sounder information. For example, it would be very interesting to separate public and private investment to get better information about the origin and destination of the funds. Additionally, it would also be very necessary to know the percentage of loans and grants these organizations concede, compared to the total number of demands.

To finish with, as previously presented, the data we gathered for the empirical analysis is based on *ad hoc* exploitations sourced on various studies conducted. Table 3.4 gathers all sources of information employed in the assessment of our unit of analysis (Spanish ACs). Our data is gathered in a matrix (Table 3.5) whose rows correspond to

[56] *The CIP is based on Decision No 1639/2006/EC of the European Parliament and of the Council of 24 October 2006 establishing a Competitiveness and Innovation Framework Programme (2007 to 2013).*

Spanish ACs, while its columns stand for four separated sets of continuous variables that have been grouped under the names of *"Cat1", "Cat2", "Cat3" and "Cat4",* and relate to the intermediary categories introduced. The form of the matrix is displayed in the following Figure 3.2:

Figure 3.2 Intermediaries matrix
For region i, x_{ik} corresponds to its value for continuous variable k



In terms of data standardization and analysis, the outputs regarding the assessment of intermediary organizations stem from the same procedures and sources as the ones corresponding to system problems (see chapter 3.2).

Table 3.4 Variables employed in the study of intermediary organizations

Component	Code	Indicator	Unit	Source of information	Period
CAT. 1	C11	Private companies that have implemented non-technological innovation betterments: marketing innovations.	Percentage	Innovation in companies´ survey. Spanish Official Statistical Institute (INE)	2008-2009
	C12	Private companies with a website and internet connection		Survey on ICT. Usage and e-commerce in companies. Spanish Official Statistical Institute (INE)	2011-2012
	C13	Private companies that have implemented non-technological innovation betterments: organizational innovations.		Innovation in companies´ survey. Spanish Official Statistical Institute (INE)	2008-200
CAT. 2	C21	Private companies that have cooperated with joined or associated Spanish companies or other Spanish market57 sources in some of their innovating activities			
	C22	Private companies that have cooperated with joined or associated international companies or other international market sources in some of their innovating activities			
CAT. 3	C31	Private companies located in science and technological parks			
	C32	Private companies that contracted R&D services to organizations and institutions belonging to Spanish *"exploration subsystems"*			2008-2010
	C33	Private companies that have cooperated with sources belonging to Spanish "*exploration subsystems"* in some of their innovating activities			
CAT. 4	C41	Public loans addressing private companies´ innovative activity	€ per thousand people		2010
	C42	Public subsidies addressing private companies´ innovative activity			
	C43	Total venture capital operations	Per hundred thousand people	Spanish Venture Capital Association (ASCRI) Statistics about R&D activities 2010	2005-2011
SUPLEMENTARY VARIABLES (SUP)	AGR	Employed population by branch of activity, sex and autonomous community: Agriculture	Thousands of employed population into thousands of working age population	Survey on Adult Population Involvement in Learning Activities. Spanish Official Statistical Institute (INE)	2012
	IND	Employed population by branch of activity, sex and autonomous community: Industry[58]			
	SERV	Employed population by branch of activity, sex and autonomous community: Services[59]			

[57] In this table, the use of the word "market" refers to openly to: providers, clients or competitors belonging to the "knowledge exploitation subsystem" of the RIS.

[58] Corresponds to extractive industries; manufacturing industry; supply of electric power, gas, steam and air conditioning; water supply, sanitation activities, waste management and decontamination.

[59] Corresponds to financial and insurance activities; professional, scientific and technical activities; administrative activities and ancillary services.

Table 3.5 Standardized data (intermediary categories)

	Category1			Category 2		Category 3			Category 4			SUP		
	C11	C12	C13	C21	C22	C31	C32	C33	C41	C42	C43	AGR	IND	SERV
Andalusia	-0.35	-1.11	-0.33	-1.06	-0.95	1.45	-0.88	-0.85	-0.26	-0.48	-0.08	0.08	0.09	0.11
Aragon	0.63	-0.33	0.98	0.09	0.08	-0.47	0.64	0.34	0.4	-0.38	-0.14	0.06	0.18	0.10
Asturias	-1.68	1.38	-1.24	0.59	0.12	1.56	0.48	0.45	-0.54	-0.04	0.37	0.04	0.15	0.11
Balear Islands	0.25	0.75	-0.9	-1.17	-0.91	0.65	-1.43	-1.37	-0.92	-0.83	-0.95	0.01	0.07	0.12
Canary Islands	-0.14	-0.76	-0.94	-1	-0.95	-1.31	-1.23	-1.32	-1	-0.84	-1.08	0.03	0.05	0.11
Cantabria	-1.3	0.38	-1.32	0.12	0.15	-0.55	0.14	0.2	-0.51	-0.33	-0.08	0.03	0.16	0.11
Castile Leon	0.03	0.08	-0.39	-0.18	-0.04	0	0.05	0.11	-0.46	-0.1	-0.39	0.07	0.16	0.09
Castile La Mancha	-0.02	-2.06	-0.3	-0.9	-0.87	-0.74	-0.71	-0.97	-0.75	-0.24	-0.64	0.07	0.17	0.09
Catalonia	1.83	1.15	2.08	0.13	0.45	-0.62	-0.25	-0.41	1.07	-0.05	0.71	0.02	0.19	0.13
Valencia	0.97	-0.33	-0.07	0	-0.06	0.15	0.95	0.11	-0.38	-0.1	-0.8	0.04	0.17	0.11
Extremadura	-2.08	-1.61	-1.35	-0.68	-1.16	-1.18	-0.63	-0.69	-0.84	-0.82	1.19	0.11	0.11	0.07
Galicia	-0.35	-0.19	0.11	0.22	-0.25	1.05	0.05	0.98	-0.76	-0.26	-0.34	0.08	0.16	0.10
Madrid	0.93	0.6	0.29	-0.13	0.54	-0.27	-0.54	-0.25	1	0.53	0.5	0.00	0.10	0.19
Murcia	-0.22	-0.37	0.27	-1.08	-1.05	0.44	-0.52	-0.6	-0.7	-0.56	-0.8	0.14	0.13	0.11
Navarre	0.84	1.03	1.34	1.27	1.94	-0.69	0.81	0.71	2.47	1.05	2.65	0.04	0.25	0.10
Basque Country	-0.05	1.25	1.01	2.53	2.33	1.76	2.8	2.63	1.22	3.4	1.08	0.01	0.21	0.14
La Rioja	0.72	0.09	0.76	1.25	0.63	-1.23	0.27	0.92	0.97	0.06	-1.2	0.05	0.24	0.10

3.4. LIMITATIONS OF THE STUDY

A fundamental problem that needs to be brought forward is the excessive –path dependent- neoclassic foci of both international (Ecotec, 2005; OECD, 1997/2006; UNU-MERIT, 2009) and national (Spanish) (INE) statistics on both *"firms"* and their *"R&D"* or *"technological capabilities"*. The latter coupling constitutes the main stress of questionnaires in most surveys focused on development and innovation. This implies that most employed indicators are based on a firm based *input-output* dichotomous perspective which limits systemic assessments –at least- in two ways. First, system innovation scholars are not able to carry out accurate diagnoses if the systemic perspective is not assimilated by statistical organizations. Old indicators would need to be adapted and new indicators need to be designed. Second, and as a consequence of the former, system innovation policy design and assessment will always be limited to data availability, and policy makers will continue in the position of taking crucial decisions at their expense (Edquist, 2011; Chaminade *et al.,* 2012), leveraging on a very narrow approximation on the real dynamics of the system.

System innovation and evolutionary paths need be broaden as scholars focus on the assessment of new subject organizations and changing institutions. However, as a consequence of the limited information returned by current indicators, we also claim that our typologies on *"integration"* and *"Associative Components"* are still very thin and preliminary estimations. First, Figure 2.2 puts together system problems and intermediary categories that mainly deal with firm´s purview (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998; Bessant and Rush, 1995 and 2000; Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010). This view

could be completed with important interactions *"between"* and *"in"* other components that, as stated, have been overviewed (Regional Innovation Agencies, TTAs, and the like). Secondly, the assessment we have introduced is not intended to be complete and finalistic, as data availability prevents scholars -to a great extent- from employing *"relational data"* (i.e. Social Network Analysis (SNA), Wasserman and Faust, 1994) which would induce systemic analyses. However, system assessments need to be conducted, even if limitations exist.

Back in 2010, the dissertation was at a preliminary stage. The student discussed these constraints with the supervisors of the dissertation. The chance to design novel indicators and questionnaires was on the table. New questionnaires would inherit the systemic outlook that surrounds the whole study. However, designing new indicators and conducting interviews was a resource consuming process. Consequently, we went through the main source of statistical information in Spain (i.e. INE and ASCRI) and scrutinized employable questionnaires and databases. We also commented the scope of the investigation with some INE´s technicians which raised no objections to the use of sampling while they advised about quality constraints and limitations. ASCRI´s statisticians were also consulted. The latter offered disposable information and helped through the process of the construction of the indicators. On the top of these, the Spanish sociological research center (CIS) and Eurostat (Community Innovation Survey) databases were also scrutinized. CIS data did not seem to satisfy the requirements. The limited size of the samples regarding the variables that called our attention prevented inferring strong conclusions and the source was finally dismissed. On the other hand, Eurostat data was incorporated in INE´s resources. Consequently, exploiting INE´s database was thought to be a more straightforward process.

At the same time, the student and his supervisors shared their thoughts in various meetings where the possibility to conduct the dissertation with the use of available sources was analyzed. As introduced, Table 3.1 summarizes a good number of studies and an elevated number of variables employed to assess Spanish RISs (Coronado and Acosta, 1999; Martinez-Pellitero, 2007 and 2007; Buesa and Heijs, 2007; Navarro *et al.,* 2009; Zabala-Iturriagagoitia, 2008; Navarro and Gibaja, 2012). The nature of the indicators employed in the current dissertation is still exploratory. It only constitutes a novel attempt to assess the dynamic behavior of Spanish RISs. During the development of the dissertation, we found no clue of the existence of other empirical studies making use of our variables (Tables 3.2 and 3.4). It is important to notice that the indicators we employ have been modified in a process that differentiates our investigation. However, as stated, we believe this body of work –now also including the current analysis- lacks from new indicators that would induce evolutionary and systemic assessments (i.e interactions among constituents, institutional changes, a focused assessment on the performance of new units of analysis such as intermediaries, a focused assessment on public organizations, etc…). The latter would exceed the current firm centered and technological focus that roots on neoclassic policy evaluation and intervention paradigms; and limits to a great extent the scope of analysis.

Consequently, and after some months of discussion, these meetings output in the creation of new variable sets, or *"blocks",* that bring forward novel meanings and interpretations to the data. These blocks lead us to conduct a first empirical approximation to the current matters of study. Instead of focusing our attention on the present limitations, we believe they also provide with important clues to demonstrate the existence of new potential research developments. Actually, these constraints present new avenues for the elaboration of novel variables

for future versions of analysis. For the time being they permit new understandings and interpretations that support developing the current dissertation.

When it comes to the evaluation of the robustness of the empirical results, it must also be underlined that the current dissertation frames in an exploratory assessment of system problems and intermediary organizations. For this reason, its current version includes a one-year analysis in most of the variables that have been employed (see Table 3.2 and Table 3.4). Most of these variables are contrasted with only 17 observations (one observation per AC). In the case of the variables provided by ASCRI we could employ data corresponding to 7 years (2005-2011). In this case, we obtained the mean for each region assessed to perform the analysis. All in all, we believe that longitudinal analyses could lead us improve the robustness of the results of the study.

Additionally, it is also important to notice here that the scope of the dissertation is limited to the analysis of four particular system problems and the presence or absence of intermediary organizations solving them. We disregard other options and approaches presenting complementary – and wider- system problems (Lundvall and Borrás, 1997; Malerba, 1998 and 2009; Smith, 2000b; Isaksen, 2001; Tödtling and Trippl, 2005; Woolthuis *et al.,* 2005; Chaminade and Edquist, 2006; Chaminade *et al.,* 2012). Of course, future developments of the dissertation could include a broader –all inclusive- analysis of system problems in ISs. The latter could develop by taking the current methodology as a starting point to research, design and develop new complementary indicators that might permit the assessment of some other crucial problems, as previously introduced (i.e. (a) organizational thinness, (b) lock-in, or (c) fragmentation problems). As stated, to our

best concern, Nauwelaers (2011) is the first author introducing a novel association between problems and intermediary organizations, following the typology presented by Smith (2000b). However, she does not explain how these problems are addressed by intermediaries. Instead, this relation is avoided being her interpretations yet preliminary. Consequently, this could ease a promising development path to present new hypotheses and research directions.

3.5. ASSESSMENT OF SYSTEM PROBLEMS AND "ASSOCIATIVE COMPONENTS"

MULTIPLE FACTOR ANALYSIS

Due to the number of variables of the datasets (Table 3.3 & Table 3.5), our first aim is to review and reduce their dimensionality. Multiple Factor Analysis (MFA) (Escofier and Pagès, 1990 and 1998; Pagès, 2004) allows integrating unlike groups of variables (each category under assessment) describing the same observations (Spanish ACs[60]) (Abdi

60 We mean to Spain´s seventeen ACs. Nomenclature of Territorial Units for Statistics (NUTS-2), by regional level. We chose this level of disaggregation because subsidies that Europe provides to ACs are based in NUTS-2 classification. For this reason, both design and implementation of corrective measures destined to overcome functioning problems within Regional Innovation Systems would need to be implemented under the coordination and supervision of autonomous governments. In order to get more information with regards to this issue:"NUTS-2 is employed as a basis for distributing cohesion funds, using eligible population, regional and national prosperity, and unemployment as variables for calculating the financial amounts corresponding to each country". (Pavía and Larraz, 2012, pp. 131).

and Valentin, 2007), which returns an integrated image of the observations and the relation among the groups of variables (Navarro and Gibaja, 2010). Each dataset needs to be *"normalized*[61]*".* After it, the second step is to merge the normalized data to form a unique matrix; then, a global Principal Component Analysis (PCA) is performed on that matrix. Finally, the individual datasets are projected onto the global picture to assess the existence of communalities and discrepancies (Abdi and Valentin, 2007). In this final projection, the final position of each Spanish AC in the global analysis would be the barycenter of its position for the four *"gaps"* or *"categories"* being considered.

HYPOTHESIS OF THE DISSERTATION

The main motivation of the dissertation comes down to the exploration of any existing potential relationship between the density level of *"Associative Components"* and the *"integration"* of innovation environments as multioperationalized in both variable sets. It would be of particular interest to assess to what extent the relational density level of *"Associative Components"* could be taken into consideration to predict the integration level of innovation environments such as (Spanish) RISs. This question opens a path to recall the hypothesis of the current study which claims that dense *"Associative Components"* predict well integrated (Spanish) RISs.

61 *Technically, it is done by dividing all its elements by the square root of the first eigenvalue obtained from its PCA (in other words, it is done by weighting each variable of the set j by* $1/\lambda_1^j$*, denoting* λ_1^j *the first eigenvalue of factor analysis applied to set j. (…) MFA weighting normalizes each of the clouds by making its highest axial inertia equal to 1, see Pagès (2004).*

The study will leverage on the variables and databases that we have introduced. First, the integration of RISs is assessed thanks to the observation of several system problems (*"Gap 1"* to *"Gap 4"*) across Spanish ACs. Second, the relational density level of the *"Associative Components"* is also analyzed by the observation of the activity carried out by their constituting intermediary categories (*"Cat 1"* to *"Cat 4"*) across the same ACs. In order to conduct these analyses, we create two sets of composite indexes, one for the *"gaps",* and the second for the *"categories".* Each index corresponds to the linear combination of a number of quantitative variables put together, as summarized in the following Table 3.6.

CANONICAL CORRELATION ANALYSIS

Canonical Correlation Analysis (CCA) (Hotelling, 1936; Thomson, 1984; Luthans *et al.,* 1988; Sherry and Henson, 2005; González *et al.,* 2008; Graham, 2008; Oslund, 2010) is a multivariate technique that describes the nature of the linear relationship between two sets of quantitative variables observed in the same experimental units. CCA feeds back with two sets of basis vectors, one for the first set of quantitative variables named X (*"Cat 1"* to *"Cat 4"*) and the other for the second one named Y (*"Gap 1"* to *"Gap 4"*); both observed across Spanish regions.

Figure 3.3 explains how CCA adapts to the needs of our assessment. The figure illustrates the variable relationships of the CCA of our study. We employ four predictor variables (X) and four criterion variables (Y). In order to assess the simultaneous relationship between these predictor and criterion variables, the observed variables in each set

must be combined together into one synthetic[62] (also called unobserved or latent) variable (Sherry and Henson, 2005; Graham 2008; Oslund, 2010). In order to do so, first, CCA creates two linear equations, one for the predictor variables and one for the criterion variables. Second, these equations yield the two synthetic variables illustrated in the figure. It is also important to note that these two equations are generated to accrue the largest possible correlation between the two synthetic variables. This is to say, the variance in the observed predictor variable set is combined to maximally correlate with the combined variance in the observed criterion variable set.

The most central statistic in a CCA is the canonical correlation[63] (R_c) between these two synthetic variables (see Figure 3.3). This index can be conceptualized as a simple bivariate correlation (Pearson r) between the former (Sherry and Henson, 2005). Additionally, the square canonical correlation[64] (R_c^2) will also provide information of the amount of variance shared by the variables that compose the canonical correlation.

62 The synthetic variables comprised in a canonical function are orthogonal (uncorrelated) to all other synthetic variables outside their own canonical function.

63 The canonical correlation coefficient (Rc) is the Pearson r relationship between the two synthetic variables on a given canonical function. Because of the scaling created by the standardized weights in the linear equations, this value cannot be negative and only ranges from 0 to 1 (Sherry and Henson, 2005).

64 The squared canonical correlation (Rc2) is the simple square of the canonical correlation (i.e. eigenvalues). This effect statistic can be interpreted as the proportion of variance (i.e. variance-accounted-for effect size) shared by the two synthetic variables across all functions (Sherry and Henson, 2005).

Table 3.6 Composite indexes, codes and definitions		
COMPOSITE INDEX	VARIABLES (CODE)	DEFINITION
Gap 1	G11- G14	Lack or poorly developed management capabilities of private firms (Nauwelaers and Wintjes, 1999; Bessant and Rush, 1995 and 2000)
Gap 2	G21- G22	Lack of new *"antennas"* or networks outside (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999).
Gap 3	G31- G35	Lack of technological capabilities of private firms (Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Parrilli et al., 2010; Dalziel, 2010).
Gap 4	G41- G42	Lack of financial capabilities (Nauwelaers and Wintjes, 1999).
Category 1	C11-C13	Knowledge Intensive Business Service organizations (Bessant and Rush 1995 and 2000; Hagardon and Sutton, 1997; Hagardon 1998; Nauwelaers and Wintjes, 1999).
Category 2	C21-C22	
Category 3	C31-C33	Technology Transfer Agencies (TTAs), technical advisory groups, technological centers, business and trade associations (Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Parrilli et al., 2010; Dalziel, 2010).
Category 4	C41-C43	Venture capitalists, Banks, BAs (Nauwelaers and Wintjes, 1999)

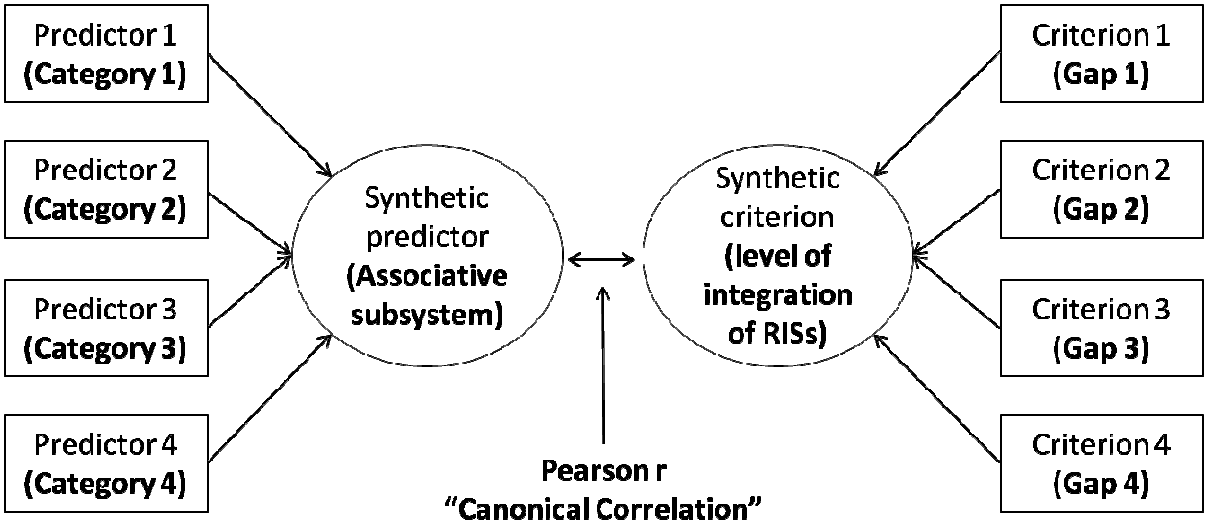
In a CCA there will be as many canonical functions[65] (i.e. variates) as there are variables in the smaller of the two variable sets (i.e. four

65 A canonical function is a set of standardized canonical function coefficients (from two linear equations) for the observed predictor and criterion variable sets (Sherry and Henson, 2005). CCA constructs two variates, X and Y (one for each set of variables) $CV_{X1} = a_1x_1 + a_2x_2 + a_3x_3 + \ldots + a_nx_n$ *and* $CV_{Y1} = b_1y_1 + b_2y_2 + b_3y_3 + \ldots + b_my_m$*. There will be as many canonical functions as there are variables in the smaller set. Thus, this study will consist of four canonical functions.*

functions in Figure 3.3). After the first canonical correlation is produced, there will remain some unexplained residual variance in the variable sets. All subsequent canonical functions are composed to analyze this residual variance left over by the former.

It is important to notice that when it comes to testing our hypothesis, its results would not permit –strong- causal conclusions. Correlation is a necessary but not sufficient condition for causality. Consequently, the results would induce the description of possible existing relationships between the *"density"* level of the former (X) and the *"integration"* of the latter (Y) synthetic variables. Nonetheless, the nature of CCA as a correlation method makes the declaration ultimately arbitrary and requires caution when making causal inferences (Sherry and Henson, 2005).

Figure 3.3 Synthetic predictor and criterion variables



The figure illustrates the first function of the canonical correlation analysis of the study (adapted from Sherry and Henson, 2005).

In terms of data analysis, the assessment of the relation between indexed predictor and criterion variables stems from an examination carried out using SPSS version 20 and R version 2.15.1 (R Development Core Team, 2011). When R was required, we employed some of its packages like CCA (Gonzalez *et al.,* 2008; González and Déjean, 2013), CCP (Menzel, 2009) and yacca (Butts, 2009; Carter, 2009).

MULTIVARIATE THINKING

It is important to unfold the reasons why we decided to employ multivariate techniques (i.e. MFA, CCA) for the assessment of patterns in the databases (Table 3.3 and Table 3.5). First, the employment of bivariate analyses (i.e. regression analysis) only permits the analysis of a single dependent variable of interest. This is to say that regression analyses help unfold how the typical value of a dependent variable would change after variations on any of the independent variables. On the contrary, multivariate techniques permit answering complex

questions that involve multiple plausible associations among variables or variable sets. The latter provides us with a much richer and more realistic picture. By contrast, multivariate analyses are more difficult to interpret and tend to be based on assumptions that, as in our dissertation, may be more difficult to assess.

On the top of the previous general explanation, and having already exposed the scope and objectives of our research, the employment of multivariate procedures such as MFA permits certain advantages compared to others such as PCA. Importantly, conducting more traditional methods such as the latter would prevent researchers from important information fed back by L_g and RV coefficients (Table 4.2 and Table 4.5), which can be found in the output of a MFA. These coefficients allow evaluating the stability of the empirical results, regarding their dimensionality and their internal structure (Escofier and Pagès, 1990, 1998; Abascal *et al.,* 2001).

Additionally, the employment of CCA brings about other crucial benefits to our study. CCA is a well-known procedure that would permit the analysis of simultaneous relationships between predictor and criterion variable sets. This procedure can be conceptualized as a simple measure of the linear correlation between two sets of variables. Therefore, instead of conducting simple bivariate correlations (Pearson r) between each pairs of variables, CCA permits much more interesting, complete and hypothesis-oriented assessments. We chose the procedure because it allows us to hypothesize on existing relations among different sets of predictor and criterion variable sets, while bivariate correlations could only have permitted analyses on the existing relations between each pair of *"gaps"* and peer *"categories"* (*"Gap 1"* and *"Category 1"*) across the regions.

CHAPTER 4: EMPIRICAL RESULTS

4.1. SYSTEM PROBLEMS

As it was previously introduced, our first aim is to reduce the dimensionality of the dataset in order to facilitate its understanding. In order to do so, we conduct a MFA whose first output is the presentation of the *inertia*[66] of the individuals in the two principal components from both separate and global analyses. Table 4.1 presents the results. The sequence of eigenvalues is similar among the separate analyses: the four groups of variables have significant first direction of inertia, albeit individual PCA number 1 also shows significant second direction of inertia of its variables. The likeness found between the four groups of variables justifies the simultaneous analysis performed, though we also find divergences among them that are important enough to vindicate the use of specific methods as the MFA, to highlight joint and detailed features presented.

Table 4.1 Eigenvalues from separate PCA and from MFA (gaps)

	PCA GAP 1 var.		PCA GAP 2 var.		PCA GAP 3 var.		PCA GAP 4 var.		MFA	
Axis	Eigenvalue	%	Eigenvalue	%	Eigenvalue	%	Eigenvalue	%	Eigenvalue	%
1	1.9551	48.87	1.2374	61.87	3.7504	75	1.5451	77.25	2,6698	42.45
2	1.0146	25.36	0.7625	38.12	0.7814	15.62	0.4548	22.74	1,0985	17.47

66 Inertia could be described as an overgeneralization of the concept of statistical variance that, instead of considering one of the variables, accounts for the whole set of variables employed in our study.

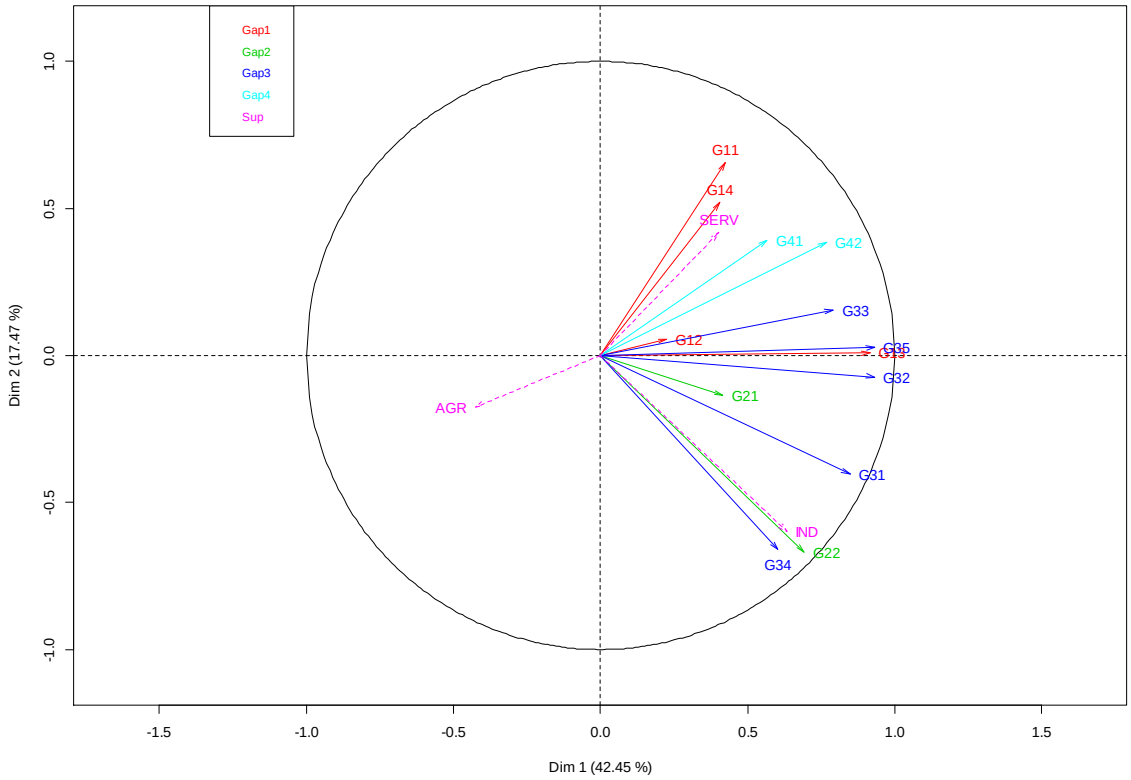
We accomplish a MFA with the four groups of variables and the Spanish ACs. As gathered in Table 4.1, the first factor represented along the horizontal axis, explicates 42.45% of the variance; while the second, represented along the vertical axis, explicates 17.47% of the variance[67]. Based on these results, now we focus on the narration of the visual outputs of the study.

The representation (of ACs and variables) can be rendered like those from a PCA: the co-ordinates of a region are its values for the common factors; the co-ordinates of a variable are its correlations with these factors (Pagès, 2004). The first axis is correlated to variables belonging to the four groups (See Figure 4.1). It opposes two clouds of regions. From right to left (See Figure 4.2), we first find a cloud that could be decomposed into two groups. We find a subgroup composed by Navarre and the Basque Country; then, a second one composed by Madrid, Catalonia and La Rioja. Then, the rest of Spanish ACs are found in a second cloud that could also be further decomposed into two subgroups. On the one hand, we find Extremadura, Castile Leon, Asturias, Valencia, Cantabria, Galicia and Aragon; then, a second subgroup formed by Balear Islands, Canary Islands, Andalusia, Castile La Mancha and Murcia. The first cloud shows high coordinates on the first axis, which is characterized by a positive association with variables related to *"system interactivity and integration"*. Thus, we can infer that Navarre and Basque Country show higher interactive levels when

67 Put together, these two dimensions gather around 60% of the variance, meaning we lose 40% of the information as a consequence of reducing the complexity contained in the database. Thirteen dimensions are reduced into two latent variables which are represented by the horizontal and vertical axes of the visual outputs of the study.

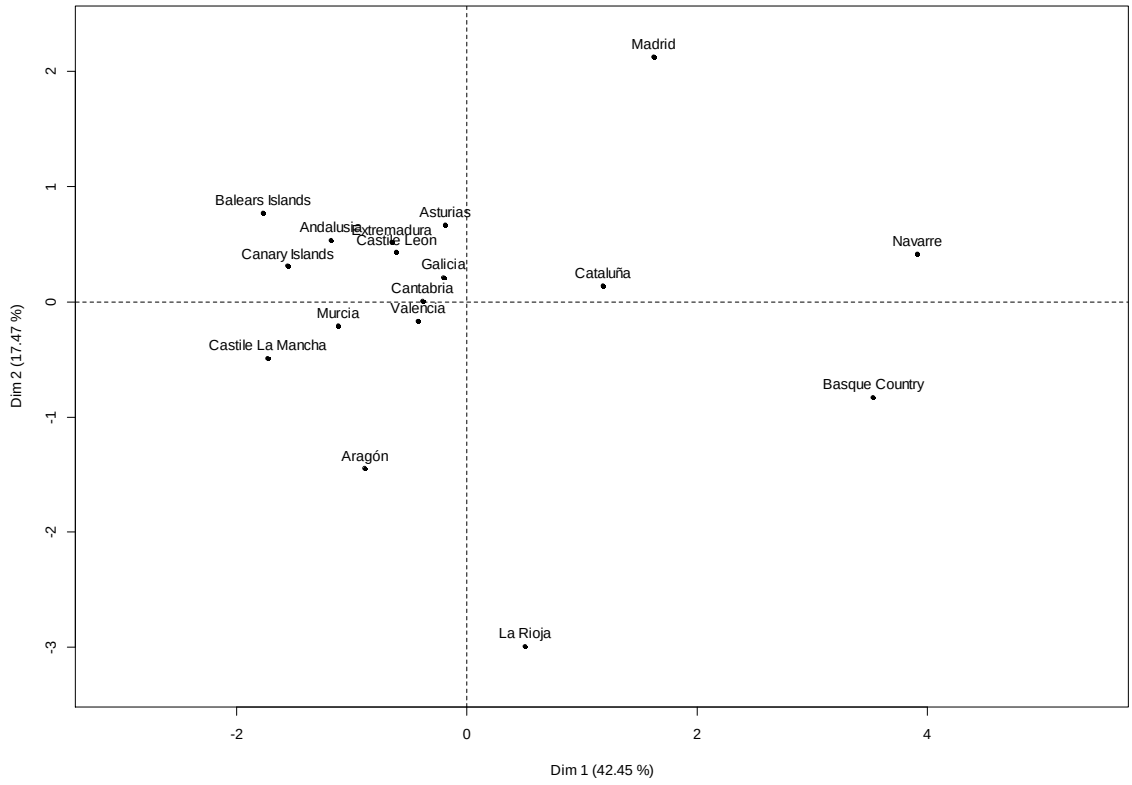
compared to other communities assessed. Symmetrically, the interactivity of the rest of communities fades away as they get closer to the left margin of the figure; which lead us intuit that, basing our thoughts on previous studies, interactivity could be correlated to the economic development and to the overall innovative capabilities of the regions under assessment[68] (Navarro and Gibaja, 2009; Navarro and Gibaja, 2012).

Figure 4.1 Correlation circle (Gaps)



[68] *This relation could be proven by the use of measurements such as the GDP per capita. The Basque Country (30.929 €) and Navarre (29.071 €) constitute the first and the third highest ranked ACs respectively. On the other hand, Murcia (18.520 €) and Castile La Mancha (17.698 €) are ranked among the lowest. Economic development could also be estimated by the use of other indicators such as the "employment" or "growth rates", feeding back very similar information. Source: INE (2012).*

Figure 4.2 Individual factor map (Gaps)

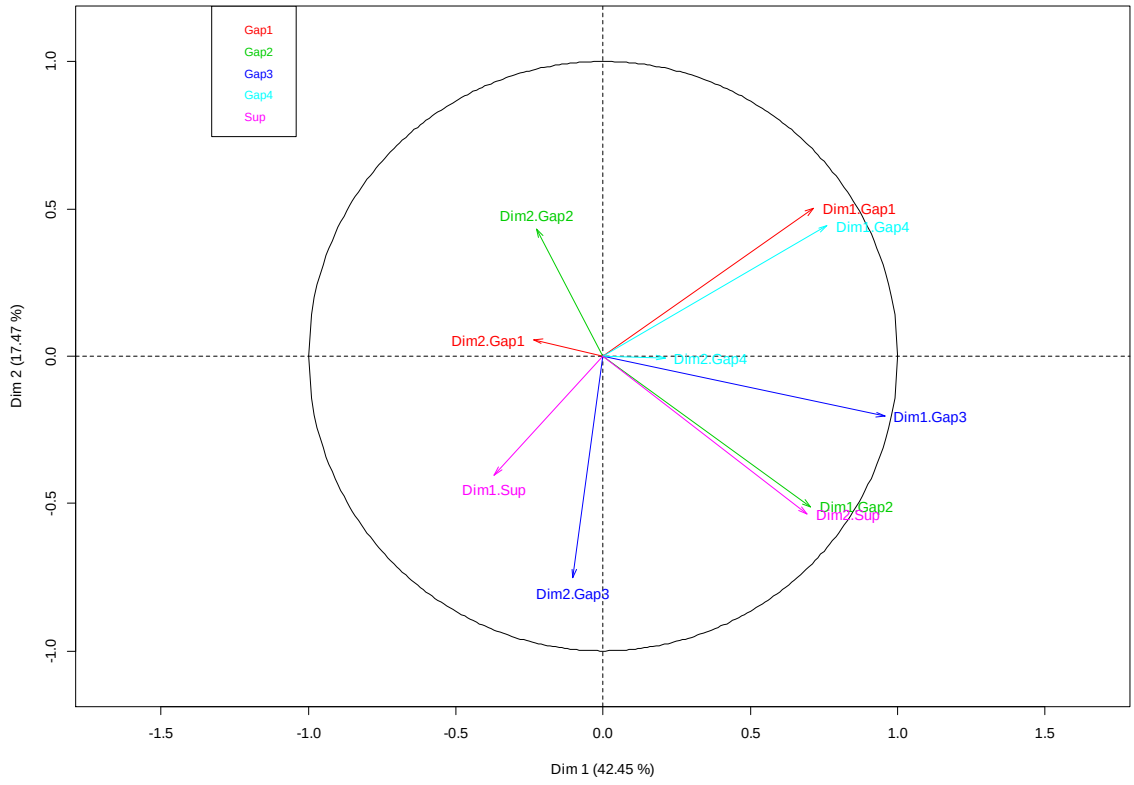


The second axis also provides distinct clouds of individuals. From the top to the bottom of the figure, we first find Madrid covering a lonely and outstanding position. Secondly, covering a central position, we find a group that congregates most of the ACs of the study. In fact this group gathers all the remaining communities but La Rioja, which stands alone at the bottom of the picture. The smaller variance of the second axis makes it more complex to find a pattern for these observations, as it gathers a smaller amount of information. In spite of it, we observe the dispersion of the four groups of variables, and we focus in those that reveal highest positive or negative correlations along this second dimension which are: G11, G14, G22, G31, G34, G41 and G42 (see Figure 4.1).

G11, G14, G41 and G42 attest clear positive correlation along the second dimension of the MFA. On the other hand, G22, G31 and G34 confirm clear negative correlation along the same axis. Though it is

intricate to infer strong conclusions, we could state that Madrid sets apart from the rest being the region with the highest measures along the former variables, employed here as indicators that stand for *"sophisticated managerial practices"* (G11 & G14), and for the *"regional-policy commitment to help firms overcome financial difficulties"* (G41 & G42), here best represented by the two first dimensions of gaps 1 and 4 in *"partial axes"* (Figure 4.3). On the other hand, we find La Rioja at the bottom of the picture, which is set apart for its negative correlation measures along the second dimension. This community shows high rates with regards to the *"number of private companies that consider the Spanish market an important source of innovation"* (G22) and the number of *"private companies that have purchased R&D services to associated companies or other Spanish market sources"* (G31). It also shows high rates regarding *"private companies that deem Spanish exploration subsystems important sources of innovation".* We return and go deeper in the special case of La Rioja when presenting the *"superimposed representations"* of the analysis.

Figure 4.3 Partial axes (Gaps)



All in all, Figure 4.2 shows that Navarre and Basque Country outstand for their *"inner technological integration"* (axis 1) which might imply that policy intervention could have been oriented to nurturing the interaction of firms and technology infrastructures. On the other hand, the second axis demands for more attention. The smaller variance of the axis makes more complicated to find an explanatory latent variable. Communities at the top of the picture (as Madrid) would outstand for their *"managerial and financial market integration"* levels. On the other hand, communities placed at the bottom of the picture (as La Rioja) would outstand for their *"market integration"* levels. Put together, we could sum up the second axis as the *"interior-market general integration".* This may imply policy intervention of the communities better represented in this axis could have been more oriented to nurture –different ways of- *"market interaction"* along their *"exploitation subsystems".* It is important to underline that Figure 4.1 also presents the supplementary variables named: *"AGR", "IND"* and *"SERV",* which

go hand in hand with the interpretations of the analysis. These variables are placed in the quadrant that one would intuitively find them; though the greater influence of the first axis (42.45%) provokes *"IND"* be placed in the first quadrant instead of the second, as expected. These variables help us explain that the second axis also distinguishes between *"service-oriented integrated markets"* (Madrid), and more *"industry-oriented systems"* (Basque Country, Navarre).

Principal components taken from separate analyses could also be depicted by means of their correlations with the principal components of MFA. Figure 4.3 reveals that the first factor of the MFA is highly correlated with the first principal component of separated analyses corresponding to the gaps considered (particularly when illustrating Gap 3). The second dimension is also significant when illustrating Gap 1, Gap 2 and Gap 4. This portray of the partial axes proves that the outcome of the MFA is consistent with the individual results achieved in separate analyses; all but in the case of the second dimensions of Gap 1 and Gap 4, which appear to be more correlated to the first axis. We later come back to this point on Figure 4.5.

Figure 4.4 Superimposed representation (Gaps)

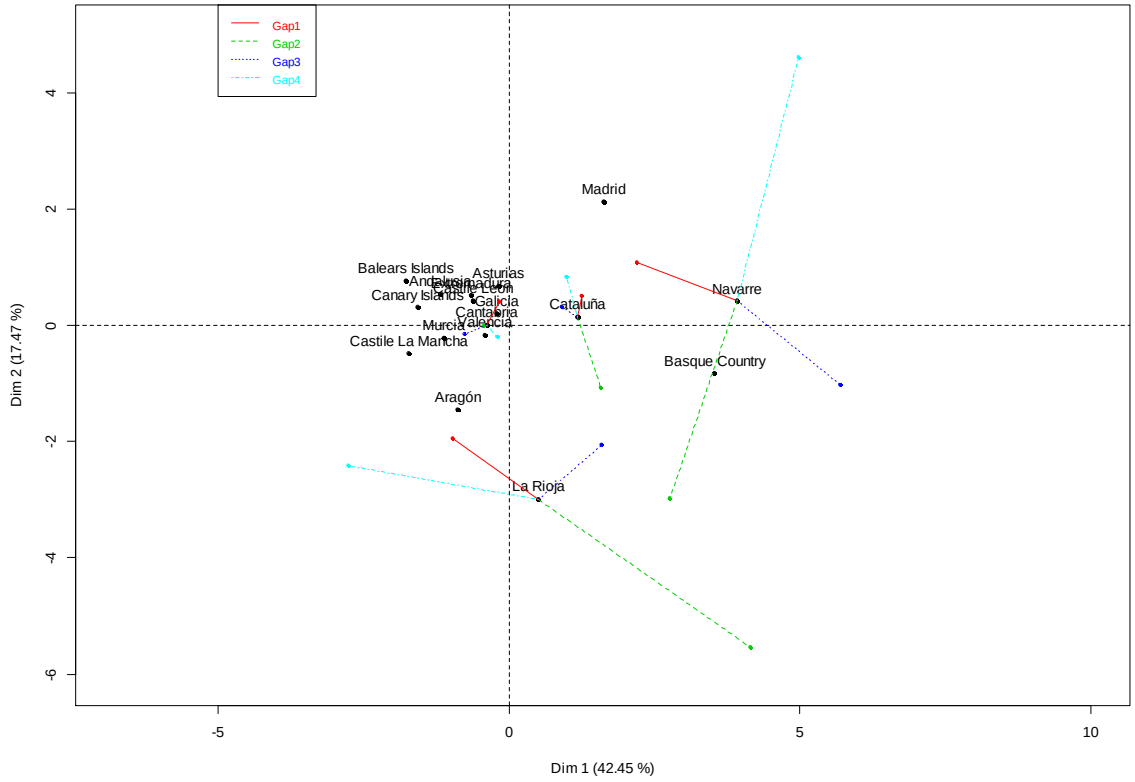


Figure 4.4 derives from Figure 4.2 by adding *"partial individuals"* which represent each region viewed in terms of each of the gaps assessed and its barycenter (Pagès, 2004; Abdi & Valentin, 2007). Focusing on the communities with the largest inner inertias, we find the special cases of Navarre and La Rioja. This means that their picture in figure 4.4 is less balanced than in the case of other communities; as in the case of Cantabria and Catalonia, which outstand because they represent the communities with smallest inner inertia. Navarre´s behavior outstands in Gap 2, 3 and 4, as it points the same directions as the first dimensions of those gaps. Its outcomes are less outstanding when it comes to Gap 1. This shows its well functioning RIS has found policy tools to help firms bridge *"financial gaps"* (Gap 4). This community also outstands in terms of collaboration levels between the *"exploitation and the exploration subsystems"* (Gap 3), and in the collaboration level within the *"knowledge exploitation subsystem"* (Gap

2). It does not have such a prominent position regarding indicators that explicate the capacity of its system to apply *"sophisticated managerial techniques"* in the firms (Gap 1). On the other hand, La Rioja clearly stands out for its level of collaboration along its *"knowledge exploitation subsystem"* (Gap 2), and also has a good position in terms of collaboration level between the *"knowledge exploitation and exploration subsystems"* (Gap 3). Its position is less prominent with regards to its *"inner technological integration"* (axis 1). It also is the worst positioned in terms of *"managerial and financial market integration"* regarding Gap 1 and 4; and the best placed in *"interior-market general integration"* of Gap 2. This fact could be linked to the particular profile of its economy which apparently does not stand out for the demand of high-profile managing directors (from G11 to G14). This could be explained because the specialization of the managers may not be explained by the variables we employ in our study. Instead, the particular profile of this community would require other capabilities more related to the specificities of wine-production-and-commercialization- related clusters.

Finally, in this database, where the first factors corresponding to the MFA are correlated to the ones from each separate analysis, the superimposed representation feeds back a better sense of the illustration from *"separate analyses"* corresponding to those communities with lowest inner inertias, as in the case of Cantabria and Catalonia. The rest of ACs are not fed back automatically and require computation in R.

GLOBAL DISPLAY OF GROUPS

The Pearson correlation coefficient, which takes values between -1 and +1, measures the degree of linear relationship between two quantitative variables for a set of individuals. However, our study presents an

assortment of ACs which are not defined by individual quantitative variables alone. Instead, they are illustrated by various sets of quantitative variables (from Gap 1 to Gap 4). Thus, we can take up the RV coefficient when we want to assess the existing degree of linear relationship among each pair of sets of variables employed. This coefficient represents a generalization of the squared Pearson correlation coefficient. With regards to the latter, it takes values that fluctuate between 0 and 1. When a RV coefficient´s value approximates to 1, it indicates the existence of a strong linear correlation between each pair of sets of variables (meaning that the sets of clouds are homothetic). When RV coefficients bring close to zero, we can state that each pair of sets do not show linear relationship.

Furthermore, the L_g index represents a complementary index which adds to the RV coefficient. It measures the common structure of two sets of variables represented by the same set of individuals. Thus, a high L_g coefficient indicates common structures between the two sets of variables studied. L_g coefficient can also be defined for a single set. In this case, this coefficient measures the dimensionality of the set of variables, which stands for the minimum number of common factors that the set can be reduced to without a substantial loss of information. Consequently, as we can see in the main diagonal of the L matrix, some gaps present lower dimensionality than the rest, as in the case of Gaps 3 and 4. This means we need more factors to explain them.

Consequently, MFA allows us to line out the similitude among the PCAs regarding the stability of its factors thanks to the study of these L_g and

RV coefficients[69] (Navarro and Gibaja, 2010). Table 4.2 provides us compelling information specifying which pair of sets of variables is much or little correlated (Abascal *et al.,* 2001).

Table 4.2 L_g and RV coefficients among groups of gaps

Lg	GAP 1	GAP 2	GAP 3	GAP 4	SUP	MFA	RV	GAP 1	GAP 2	GAP 3	GAP 4	SUP	MFA
GAP 1	1.4105						GAP 1	1					
GAP 2	0.2326	1.3797					GAP 2	0.1667	1				
GAP 3	0.5307	0.6546	1.0498				GAP 3	0.4361	0.5439	1			
GAP 4	0.4160	0.0570	0.4704	1.0866			GAP 4	0.3360	0.0466	0.4404	1		
SUP	0.7379	0.4663	0.5692	0.1550	1.4300		SUP	0.5195	0.3319	0.4645	0.1243	1	
MFA	0.9700	0.8704	1.0134	0.7604	0.7223	1.3537	MFA	0.7020	0.6369	0.8500	0.6269	0.5191	1

In our study, regarding the RV matrix, we find that Gap 3 shows comparative higher correlation with the rest of the gaps. Gap 3 is correlated to Gap 1 (0. 43), to Gap 4 (0. 44) and particularly correlated to Gap 2 (0. 54). Alternatively, the rest of the gaps show lower correlation degrees. Correlation degrees corresponding to Gap 4 are (0. 33) with Gap 1, and (0. 04) with Gap 2. The degrees corresponding to Gap 1 and Gap 2 are also low (0. 16). Additionally, when it comes to dimensionality (Matrix L_g), we also find this lower relation between Gap 4 and Gap 1 (0. 41), and Gap 2 (0. 05), and also between Gap 2 and Gap 1 (0. 23), compared to higher ranks found among the rest (ex. Gap 2 and Gap 3: 0. 65).

This data help us present Figure 4.5 which shows us the quality of representation of each group over this general picture (Escofier and

69 Consult the following authors for an accurate definition concerning RV and Lg coefficients (Escofier and Pagès, 2008).

Pagès, 1994). In this output, each group is represented by one point. Three interpretations can be made:

- ***Aid to the presentation of the global PCA (Figure 4.1). The coordinate of the group (i.e. Gap 1) with respect to axis (i.e. horizontal axis) is the inertia of the variables of that group along the same axis. According to this point of view, the display gives an illustration of Table 4.3. Thus the high coordinate of Gap 3 (0.91) with respect to the first factor "inner technological integration", shows that this factor corresponds to an important direction of this group (Escofier and Pagès, 1994). On the contrary, the second factor is mainly due to Gap 2 and Gap 1 which could be interpreted as "interior-market general integration". The position of Gap 2 (0.52), Gap 4 (0.59) and Gap 1 (0.63) on Axis 1 shows that these Gaps are not that strongly related to this factor as Gap 3 is.***
- ***Optimum display of groups. Figure 4.5 can also be interpreted as an orthogonal projection of the cloud of groups. In this cloud, two groups are close to one another if they induce the same structure upon individuals. Gap 3 is far from others, meaning "inner technological integration" is weakly related to overall system problem structure of the RISs. The closest groups are Gap 1 and Gap 2. Both take place in markets and consequently, they may involve the same profiles in bridging these gaps. As it could be interpreted, Gap 4 is not very much related to any of the axes. This finding would be explained by the fact that both "market oriented" and "technology oriented" RIS´s policy intervention aims at overcoming financial difficulties of firms and entrepreneurs.***
- ***Supplementary variables. As expected, supplementary variables are not very related to the first axis. We expected this***

because we were trying to find a variable (such as AGR) that could oppose the direction to the rest of the variables employed in the study. So, as the picture portrays, agriculture is opposed to "inner technological integration". On the contrary, the supplementary variables employed in the study are more related to the second axis.

Figure 4.5 Global display of groups (Gaps)

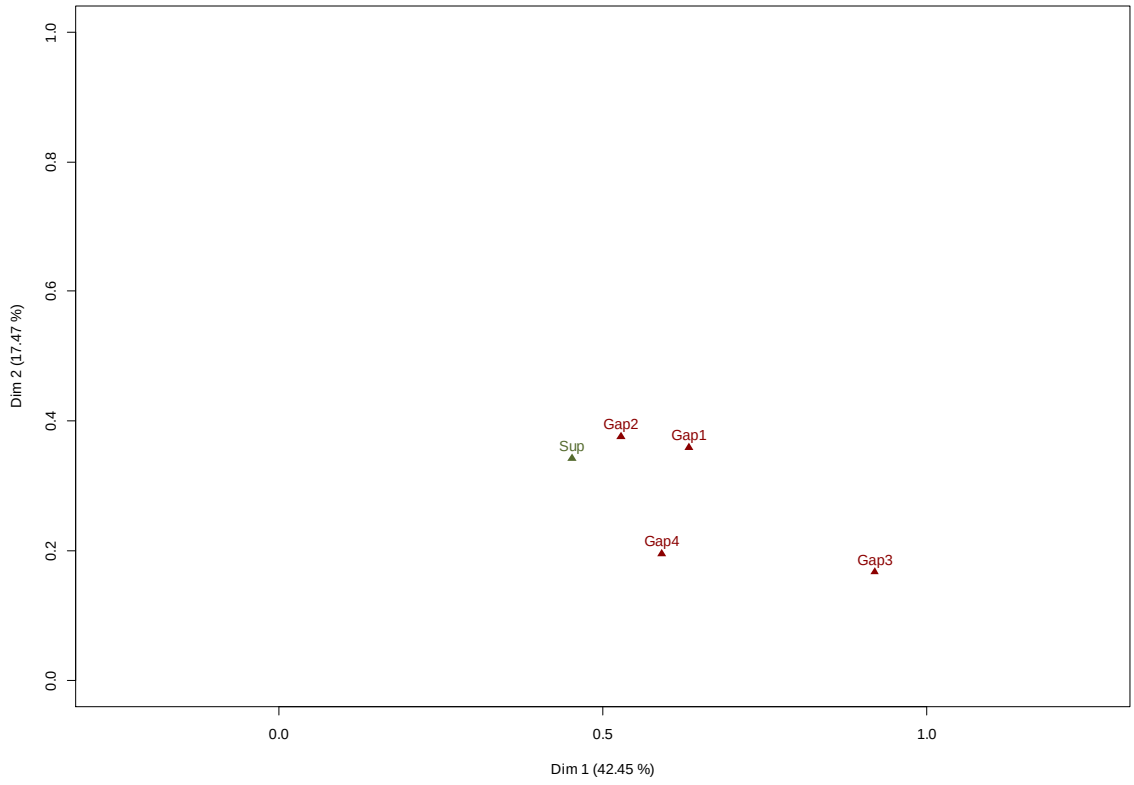


Table 4.3 Inertia of the variables (gaps)
Each group along the two first factors of MFA (maximum= 1)

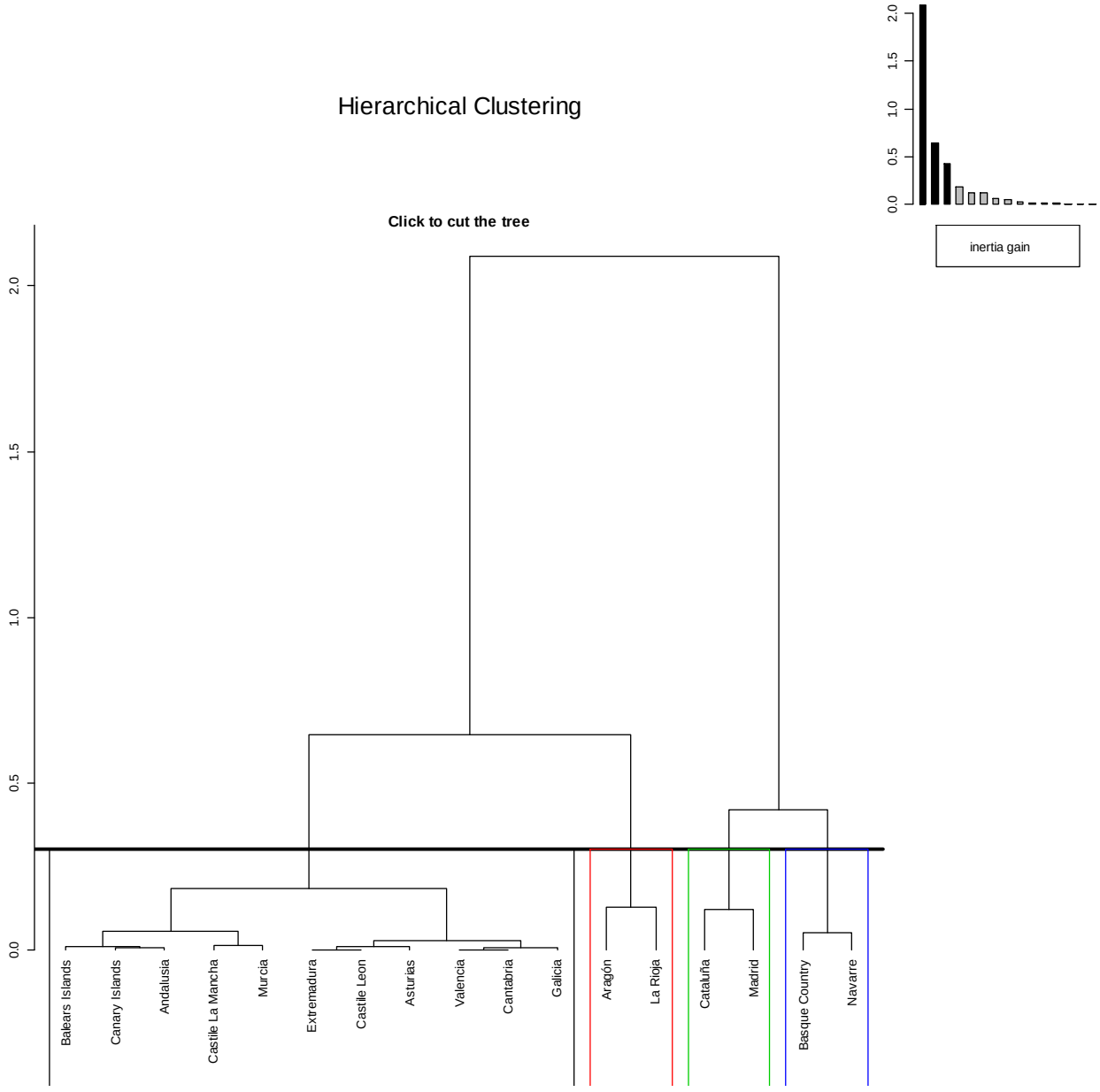
	Dim 1	Dim 2
Gap 1	0.63	0.35
Gap 2	0.52	0.37
Gap 3	0.91	0.16
Gap 4	0.59	0.19
S. Var	0.45	0.34

CLUSTER ANALYSIS

We finish our empirical study presenting the results of the Cluster Analysis (CA) performed over the findings of the MFA, which helps us classify communities in homogeneous groups. We conduct an algorithm for hierarchical classification by calculating incremental sum of squares (Ward´s method) and Euclidean distances among the observations of the study. The analysis outputs in the creation of 4 groups of ACs that reveal dissimilar integration levels along their RISs (Figure 4.6). We name these groups as follows:

- ***Group 1: Industry-oriented integrated RISs:***
  - ***Navarre and Basque Country.***
- ***Group 2: Service-oriented integrated RISs:***
  - ***Madrid and Catalonia.***
- ***Group 3: Moderately integrated RISs:***
  - ***La Rioja and Aragon.***
- ***Group 4: Disintegrated RISs:***
  - ***Balear Islands, Canary Islands, Andalusia, Castille La Mancha, Murcia, Extremadura, Castille Leon, Asturias, Valencia, Cantabria and Galicia.***

Figure 4.6 Cluster dendrogram (Gaps)



We finish with the presentation of a map of Spain that displays the geographical location of its regions and their cluster groups according to the level of integration of their ISs (Figure 4.7). The map reveals a strong north (center and east) –south pattern that represents the typology of regions fed back by the analysis.

Figure 4.7 Location of the regions and groups (system problems)

Colors in the map stand for the membership of the Spanish AC to the groups fed back from the empirical analysis performed.

4.2. "ASSOCIATIVE COMPONENTS"

In the following Table 4.4 we present the inertia of the two principal components from both separate and global analyses. The sequence of eigenvalues is similar among the separate analyses: the four groups of variables have significant first direction of inertia, albeit individual PCA number 1 and 2 also show significant second direction inertia of its variables. The likeness found between the four groups of variables justifies the simultaneous analyses performed, though we also find divergences among them that are important enough to vindicate the use of specific methods as the MFA, to highlight joint and detailed features presented.

Table 4.4 Eigenvalues from separate PCA and from MFA (Categories)

	PCA CAT 1. var.		PCA CAT 2. var.		PCA CAT 3. var.		PCA CAT 4. var.		MFA	
Axis	Eigenvalue	%	Eigenvalue	%	Eigenvalue	%	Eigenvalue	%	Eigenvalue	%
1	2,002831	66,76	1,931149	96,55	2,136506	71,21	2,225756	74,19	3,062587	57,94
2	0,801282	26,70	0,068850	3,44	0,790856	26,36	0,484073	16,13	0,925658	17,51

We accomplish a MFA with the four groups of variables and the Spanish ACs. As gathered in Table 4.4, the first factor represented along the horizontal axis, explicates 57, 94% percent of the variance[70]; while the second, represented along the vertical axis, explicates 17, 51 percent of

[70] *Put together, these two dimensions gather around 76% of the variance, meaning we lose 24% of the information as a consequence of reducing the complexity contained in the database. Thirteen dimensions are reduced into two latent variables which are represented by the horizontal and vertical axes of the visual outputs of the study.*

the variance. Based on these results, now we focus on the narration of the visual outputs of the study.

The first axis is correlates to the variables belonging to the four groups (see Figure 4.8). It opposes four clouds of regions. From right to left (see Figure 4.9), we first find an isolated AC: the Basque Country. After it, we find a small group constituted by Navarre, La Rioja, Catalonia, Madrid and Aragon. Thirdly, we find another group formed by Valencia, Castile Leon, Galicia, Cantabria and Asturias. Finally, we find a last group formed by Extremadura, Andalusia, Murcia, Balearic Islands, Canary Islands and Castile La Mancha. Both the Basque Country and the first small group of communities show high coordinates on the first axis, which is characterized by a positive association with variables related to *"high relational density levels of the intermediary categories"* under assessment. Thus, we can infer that intermediary categories belonging to the Basque Country and the first small group of communities, show higher relational density levels when compared to other communities. Symmetrically, the relational density levels of intermediary categories considered in the study fades away as they get closer to the left margin of the figure; which lead us intuit that, basing our thoughts on previous studies, it could be correlated to the economic development and to the overall innovative capabilities of the regions under assessment (as also happened in the case of the system problems previously analyzed) (Navarro and Gibaja, 2012).

Figure 4.8 Correlation circle (Categories)

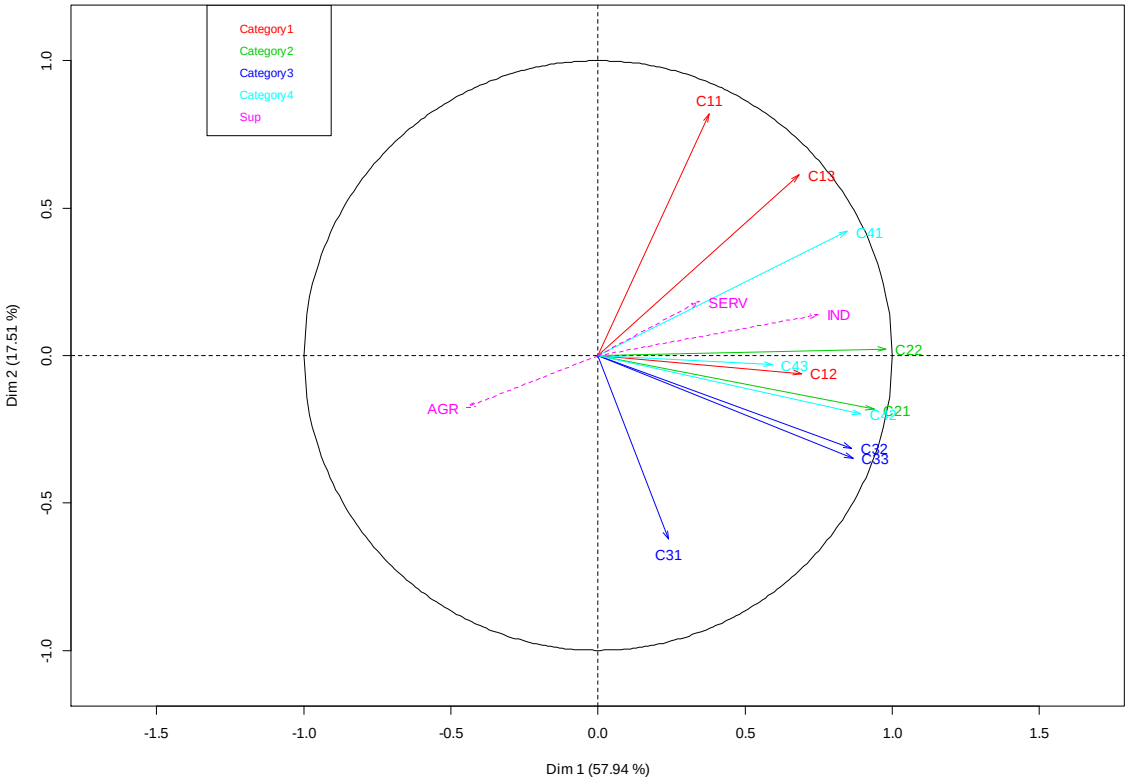
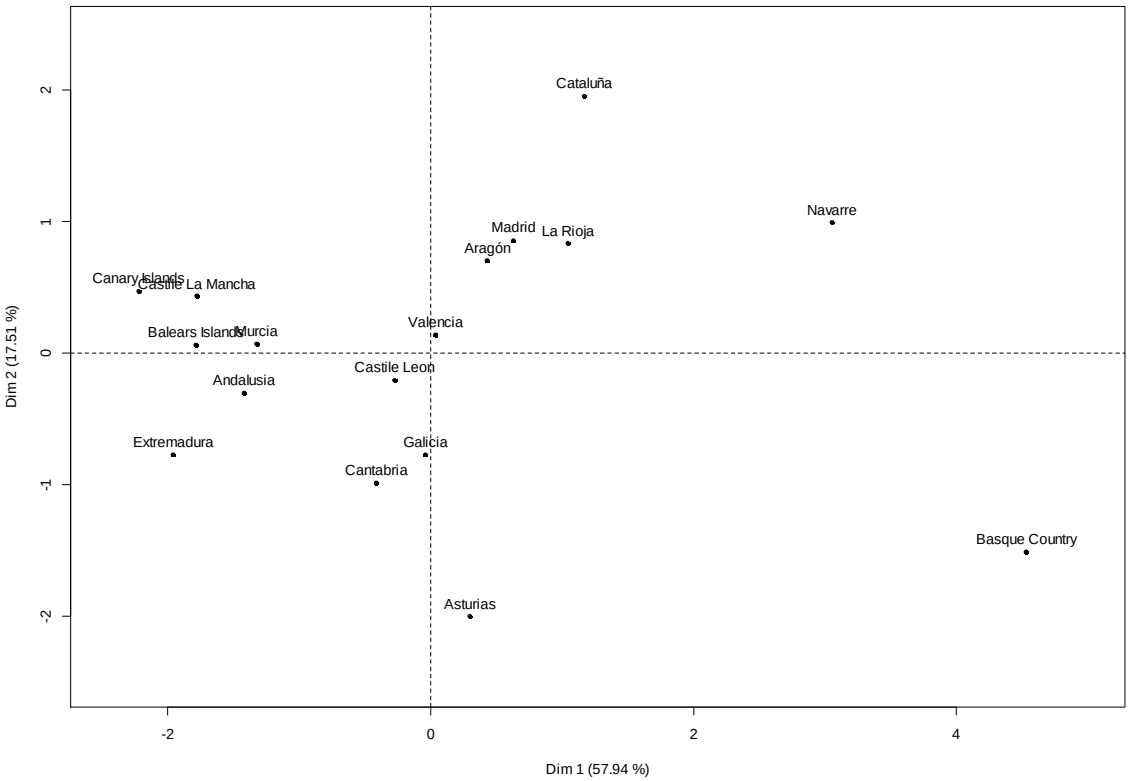


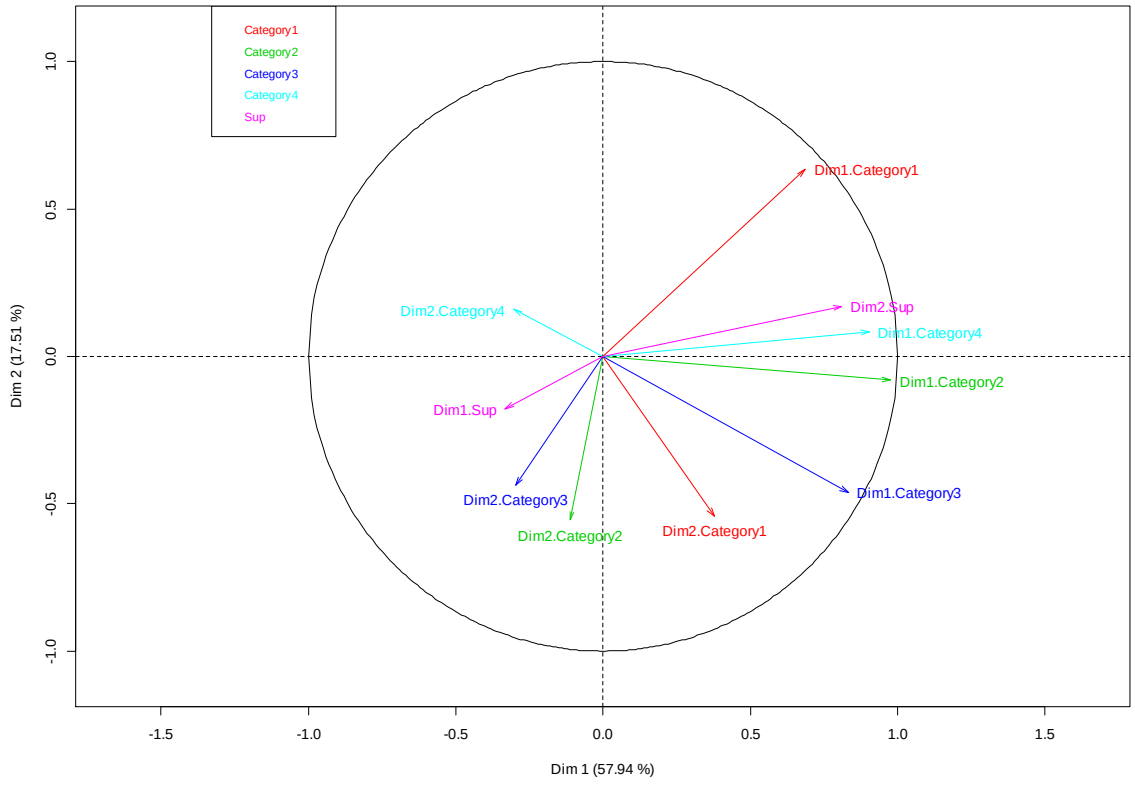
Figure 4.9 Individual factor map (Categories)



The second axis also provides distinct clouds of individuals. From the top to the bottom of the figure, we first find Catalonia covering a lonely and outstanding position. Secondly, we find a group that congregates Navarre, Madrid, La Rioja and Aragon. Onwards, we find a second group that gathers together most of the communities of the study. In fact this group gathers all the remaining communities but the Basque Country and Asturias, which stand at the bottom of the picture. The smaller variance of the axis makes more complicated to find an explanatory latent variable. In spite of it, we observe the dispersion of the four groups of variables, and we focus in those that reveal highest positive or negative correlations along this second dimension which are: C11, C13 and C31 (see Figure 4.8).

C11 and C13 attest clear positive correlation along the second dimension of the MFA. On the other hand, C31 confirms clear negative correlation along the same axis. Though it is intricate to infer strong conclusions, we could state that Catalonia, Navarre, Madrid, La Rioja and Aragon, set apart from the rest being the communities with the highest measures along the former variables, employed here as indicators that stand for *"non-technological innovation betterments"* (C11 & C13). On the other hand, in the case of Basque Country and Asturias we would find a better observation of the variables that contribute negatively to the second factor, particularly in the case of *"private organizations located in science and technology parks"* (C31); here best represented by the first dimension of Category 3 (Figure 4.10). We return and go deeper in the special case of the Basque Country when representing the *"superimposed representations"* of the analysis.

Figure 4.10 Partial axes (Categories)



All in all, Figure 4.9 shows that the Basque Country and Navarre outstand for *"high relational density level of their intermediary categories"* (axis 1). On the other hand, the second axis demands for more attention. This axis opposes the presence of category 1 and category 3 intermediary organizations. Communities at the top of the picture (such as Catalonia) would be best represented by the high density of Category 1 intermediaries; whereas communities placed at the bottom (such as Asturias or the Basque Country) would be represented by higher densities of Category 3 intermediaries. It is important to underline that Figure 4.8 also presents three supplementary variables named: *"AGR"*, *"IND"* and *"SERV"*, which go hand in hand with the interpretation of the analysis. These variables are placed in the quadrant that one would intuitively find them; though the greater influence of the first axis (57.94%) provokes *"IND"* be placed in the first quadrant instead of the second, as expected. These variables

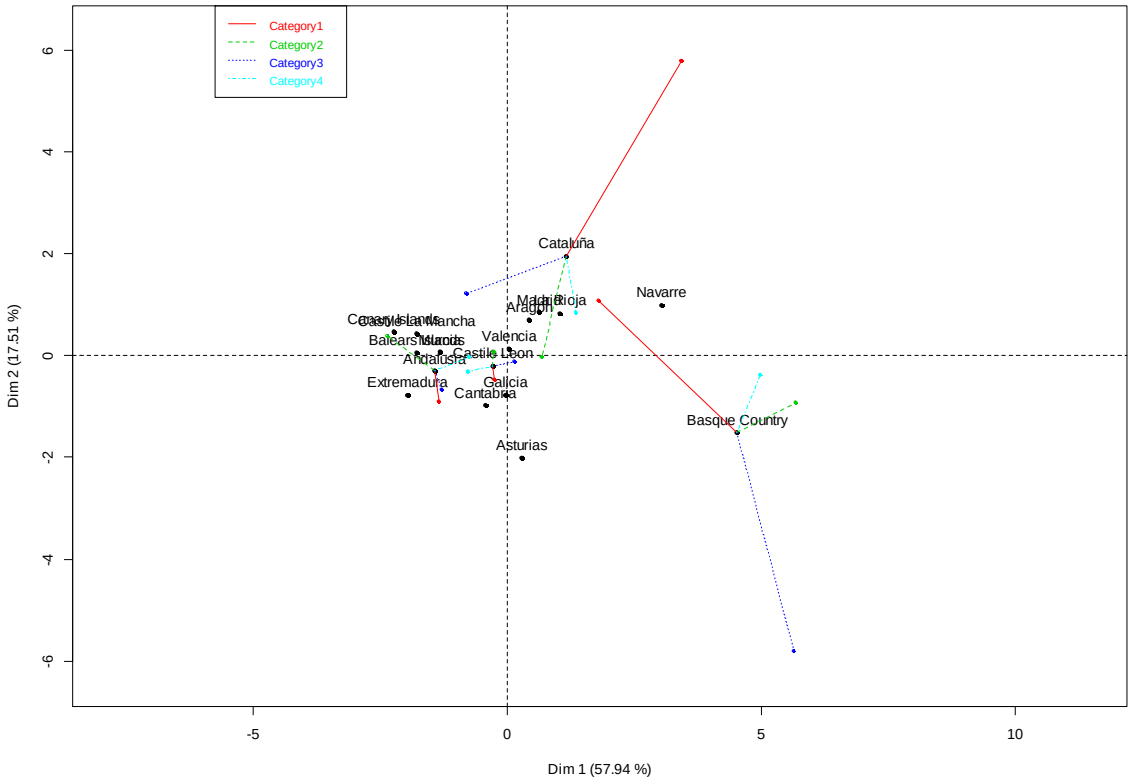
help us explain that the second axis also distinguishes between *"service-oriented"* (Catalonia), and more *"industry-oriented"* (Asturias, Basque Country) RISs.

Principal components taken form separate analyses could be depicted by means of their correlations with the principal components of MFA. Figure 4.10 reveals that the first factor of the MFA is highly correlated with the first principal component of separated analyses corresponding to the categories considered (particularly when illustrating categories 2 and 4). The second dimension is also significant when illustrating categories 1 and 3. This portray of the partial axes proves the outcome of the MFA is consistent with the individual results achieved in separated analyses; all but in the second dimensions of categories 1, 2 and 4. We later come back to this point on figure number 4.12.

Figure 4.11 derives from Figure 4.9 by adding *"partial individuals"* which represent each region viewed in terms of each of the categories assessed and its barycenter (Pagès, 2004; Abdi and Valentin, 2007). Focusing on the communities with the largest inner inertias, we find the special cases of the Basque Country and Navarre. This means that their picture in Figure 4.11 is less balanced than in the case of other communities. Catalonia´s behavior outstands in Category 1, as it points in the same direction this category does. Its outcomes are less outstanding when it comes to the rest of the categories. This shows its RIS particularly outstand for the high density of Category 1 intermediaries. On the other hand, the Basque Country clearly stands out for the high densities of Category 3 intermediaries, which specialize in enhancing interaction between private firms and research. Its position is less prominent with regards to categories 2 and 4. Figure 4.11 shows a *"lag"* in the first category of intermediaries of the Basque Country. The density of the latter category is lower when compared to others of the

same community. This fact could be linked to the particular profile of the Basque economy where policy intervention has fostered Category 3 intermediaries taping into *"technological gaps"*; but clearly shows room for improvement with regards to the density of Category 1 intermediaries, which facilitate non-technological innovation such as marketing or organizational betterments in private firms.

Figure 4.11 Superimposed representations (Categories)



Finally, in this database, where the first factors corresponding to the MFA are correlated to the ones from each separate analysis, the superimposed representation feeds back a better sense of the illustration from *"separate analyses"* corresponding to those communities with highest inner inertias, as in the case of Catalonia and the Basque Country.

GLOBAL DISPLAY OF GROUPS

As in the case of the gaps previously analyzed, we can take up the RV coefficient when we want to assess the existing degree of linear relationship among each pair of sets of variables employed. This coefficient represents a generalization of the squared Pearson correlation coefficient. With regards to the latter, it takes values that fluctuate between 0 and 1. When a RV coefficient´s value approximates to 1, it indicates the existence of a strong linear correlation between each pair of sets of variables (meaning that the sets of clouds are homothetic). When RV coefficients bring close to zero, we can state that each pair of sets do not show linear relationship.

Furthermore, the L_g index represents a complementary index which adds to the RV coefficient. It measures the common structure of two sets of variables represented by the same set of individuals. Thus, a high L_g coefficient indicates common structures between the two sets of variables studied. It can also be defined for a single set. In this case, this coefficient measures the dimensionality of the set of variables, which stands for the minimum number of common factors that the set can be reduced to without a substantial loss of information. Consequently, as we can see in the main diagonal of the L matrix, some of the categories present lower dimensionality than the rest, as in the case of categories 2 and 4. This means we need more factors to explain them.

Consequently, MFA allows us to line out the similitude among the PCAs regarding the stability of its factors thanks to the study of these L_g and

RV coefficients[71] (Navarro and Gibaja, 2010). Table 4.5 provides us compelling information specifying which pair of sets of variables is much or little correlated (Abascal *et al.,* 2001).

Table 4.5 L_g and RV coefficients among groups of categories

L_g	CAT. 1	CAT. 2	CAT. 3	CAT. 4	(SUP)	MFA	RV	CAT. 1	CAT. 2	CAT. 3	CAT. 4	(SUP)	MFA
CAT. 1	1,1696						CAT. 1	1,000					
CAT. 2	0,4282	1,0012					CAT. 2	0,3957	1,000				
CAT. 3	0,2363	0,7492	1,1381				CAT. 3	0,2048	0,7018	1,000			
CAT. 4	0,4578	0,7731	0,5010	1,0642			CAT. 4	0,4103	0,7489	0,4552	1,000		
(SUP)	0,5286	0,5470	0,3428	0,4346	1,4300		(SUP)	0,4087	0,4571	0,2687	0,3522	1,000	
MFA	0,7483	0,9638	0,8570	0,9130	0,6051	1,1370	MFA	0,6489	0,9033	0,7533	0,8299	0,4745	1,000

In our study, regarding the RV matrix, we find that Category 2 shows a high correlation with Category 4 (0.74). On the other hand, Category 4 shows low correlation with Category 3 (0.45). Nonetheless, lowest correlations correspond to Category 1 with the rest of the categories considered. Additionally, when it comes to dimensionality (L_g matrix), we also find this lower relation between Category 1 and the rest of the categories, being (0.42) in the case of Category 2, (0.23) in the case of Category 3, and (0.45) in the case of Category 4. This is more obvious when we compare this correlation degree to higher ranks found among other categories (ex. Categories 2 and 4: 0.77).

This data and interpretations help us present Figure 4.12 which shows us the quality of representation of each group over this general picture (Escofier and Pagès, 1994). In this output, each group is represented by one point. Three interpretations can be made:

71 *Consult the following authors for an accurate definition concerning RV and Lg coefficients (Escofier and Pagès, 2008).*

- ***Aid to the presentation of the global PCA (Figure 4.8). The coordinate of the group (i.e. Category 1) with respect to the axis (i.e. horizontal axis) is the inertia of the variables of that group along the same axis. According to this point of view, the display gives an illustration of Table 4.6. Thus the high coordinate of Categories 2 (0.95) and 4 (0.83) with respect to the first factor "high relational density levels of the intermediary categories", shows that this factor corresponds to an important direction of these groups (Escofier and Pagès, 1994). On the contrary, the second factor is mainly due to Categories 1 and 3. The position of the latter on axis 1 shows these categories are not as strongly correlated to this factor as Categories 2 and 4.***
- ***Optimum display of groups. Figure 4.12 can also be interpreted as an orthogonal projection of the cloud of groups. In this cloud, two groups are close to one another if they induce the same structure upon individuals. Category 1 is far from others, meaning the relational density levels of the intermediaries represented under this label is weakly related to the overall density levels of the rest of the categories. The closest groups are Categories 2 and 4, meaning these sets are almost homothetic.***
- ***Supplementary variables. As expected, supplementary variables are not very related to the first axis. We expected this because we were trying to find a variable (such as AGR) that could oppose the direction to the rest of the variables employed in the study. So, as the picture portrays, agriculture is opposed to "high relational density levels of the intermediary categories". The rest of supplementary variables employed in the study are also related to the first axis, but set off towards the expected direction.***

Figure 4.12 Global display of groups (Categories)

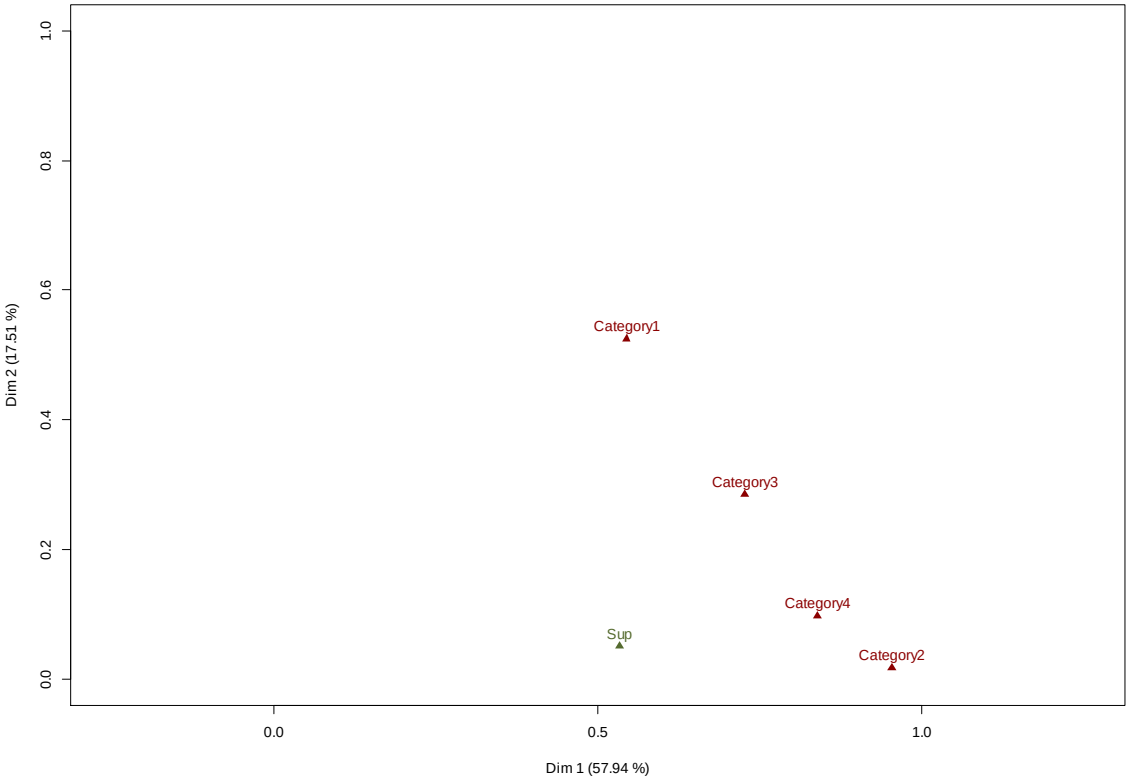


Table 4.6 Inertia of the variables (Categories) of each group along the two first factors of MFA (maximum= 1)

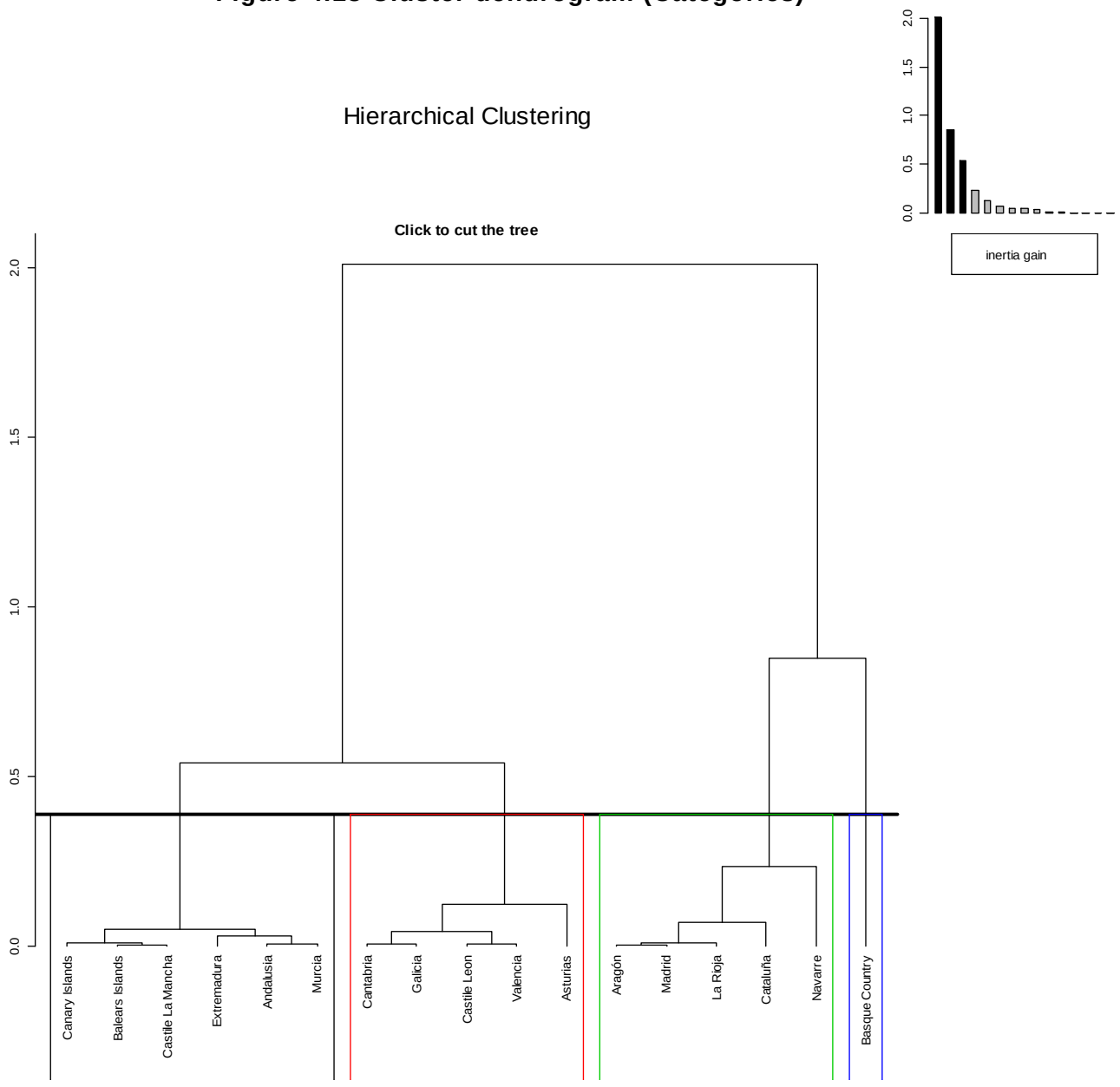
	Dim 1	Dim 2
Category 1	0.54	0.52
Category 2	0.95	0.01
Category 3	0.72	0.28
Category 4	0.83	0.09
S. Var	0.53	0.05

CLUSTER ANALYSIS

We finish our empirical study presenting the results of the CA performed over the findings of the MFA, which helps us classify communities in homogeneous groups. We conduct and algorithm for hierarchical classification by calculating incremental sum of squares (Ward´s method) and Euclidean distances among the observations of the study. The analysis outputs in the creation of four groups of ACs that reveal dissimilar relational density levels of their intermediary categories over their RISs (Figure 4.13). We name these groups as follows:

- ***Group 1: Active industry-oriented "Associative Components":***
  - ***Basque Country.***
- ***Group 2: Active service-oriented "Associative Components":***
  - ***Aragon, Madrid, La Rioja, Catalonia and Navarre.***
- ***Group 3: Moderately active "Associative Components":***
  - ***Cantabria, Galicia, Castile Leon, Valencia and Asturias.***
- ***Group 4: Inactive (or inexistent) "Associative Components":***
  - ***Canary Islands, Balearic Islands, Castile La Mancha, Extremadura, Andalusia and Murcia.***

Figure 4.13 Cluster dendrogram (Categories)



We finish with the presentation of a map of Spain that displays the geographical location of its regions and their cluster groups according to the relational density of their *"Associative Components"* (Figure 4.14). The map reveals a strong north (center and east) –south pattern that represents the typology of regions fed back by the analysis.

Figure 4.14 Location of the regions and groups *("Associative Components")*

Colors in the map stand for the membership of the Spanish AC to the groups fed back from the empirical analysis performed.

4.3. HYPOTHESIS VERIFICATION

Just to recall, the main motivation of the dissertation comes down to the exploration of any existing potential relationship between the density level of *"Associative Components"* and the *"integration"* of innovation environments. As stated, the hypothesis of the current dissertation is:

Dense *"Associative Components"* predict well integrated (Spanish) RISs.

Table 4.7 presents the most common method to test the statistical significance of the full canonical model (see subchapter 3.5) (Sherry and Henson, 2005). Wilks´s lambda (λ) analyzes the shared variance between the predictor and the criterion variables across all of the canonical functions. Our full model was statistically significant with a Wilks's λ of .009, F (16, 28.13) = 6.30, p<.001[72]. Conveniently, Wilk´s λ represents an inverse effect size of the amount of variance unshared between the variable sets. Thus, by taking 1 – λ, we found an overall effect of 1-.009 = .99 = R_c^2 for the full model.

After this general assessment has been conducted, we need to study its canonical functions separately. We chose to interpret the first function alone, as it explains 97.81 % of the variance (squared correlation) [73] (Table 4.8). Next important consideration is the reduction analysis in which these hierarchal statistical significance tests are presented (Table 4.9). Here we confirm that the full model is statistically significant, as well as the cumulative effects of functions 2 to 4, 3 to 4 and 4 to 4. The latter were not statistically significant in isolation (.394; .878 and .703

72 Because the p value is rounded to three decimal places, we can only note that p < .001 in this case.

73 Each canonical function must be evaluated because they may not explain enough of the relationship between the variable sets to warrant interpretation, much like a weak or poorly defined factor would be discarded. The first function will be created to maximize the Pearson r (Rc) between the two synthetic variables. Then, using the remaining variance in the observed variables, the next function will be created to maximize another Pearson r (the second Rc) between two other synthetic variables under the condition that these new synthetic variables are perfectly uncorrelated (orthogonal) with all others preceding them.

respectively). In addition, we have decided not to interpret these functions since they only explain 51.62%, 8.7% and 0.12 %, respectively, of the variance left over (see R_c^2 for each function), which stands for less than 3% of the total variance of the canonical model. Additionally, it is important to notice that by looking at the first function we can underline an outstanding relationship between our variable sets by evidence of statistical significance and effect sizes.

Standardized canonical function coefficients [74] (i.e. weights) and structure coefficients[75], need also be interpreted to confirm the validity of the results. These coefficients are critical for deciding which variables are most useful for the model. Table 4.10 resumes the first function and facilitates the interpretation of the patterns among the variables. The latter introduces the weights and structure coefficients for the criterion (called *"Dependent"*) and predictor (called *"Covariates"*) variables for the first function. Looking at the Function 1 structure coefficients, we see that Cat 2 and Cat 4 outstand in the construction of the synthetic predictor variable. This conclusion was supported mainly by the

74 The standardized canonical function coefficients are the standardized coefficients used in the linear equations discussed to combine the observed predictor and criterion variables into two respective synthetic variables (Sherry and Henson, 2005).

75 The structure coefficient (rs) is the bivariate correlation between an observed variable and a synthetic variable. In CCA, it is the Pearson r between an observed variable (i.e. a predictor variable) and the canonical function scores for the variable´s set (i.e. the synthetic variable created from all the predictor variables via the linear equation).

squared structure coefficients[76]. The standardized canonical function coefficients were also consulted, and these categories tended to have the largest ones. Notice as well that with the exception of Cat 3, all of these coefficients had the same sign, indicating that they were all positively related. Cat 3 was –slightly- inversely related to the rest. The other side of the equation on Function 1 involves the criterion set. Accordingly, the results inform us that the Gap 3 was the primary contributor to the criterion synthetic variable. The standardized canonical function coefficients were also consulted. Gap 3 also proved a larger coefficient. All in all, the first Function demonstrated theoretically consistent relationships among all of the variables that contributed to its construction. These results were generally supportive of the theoretically expected relationship between gaps (Gap 1 to Gap 4) and categories (Cat 1 to Cat 4).

We would also like to expand our current knowledge by researching possible -transversal- patterns of relation of the gaps and the categories with our common experimental units of analysis (Spanish ACs). In order to do so, we study two kind of graphical representations that can be displayed to visualize and interpret the result of our CCA: scatter plots for the initial variables (categories and gaps), and scatter plots for the units (González *et al.,* 2008). First, the variables plot (Figure 4.15) allows discerning the structure of correlation between the two sets of variables X and Y. On this graphic, two circumferences are plotted corresponding to the radius 0.5 and 1. The latter reveal the most salient patterns in the ring defined between these two circumferences. Second,

76 The squared canonical structure coefficients (rs2) represent the percentage of shared variance between the observed variable and the synthetic variable created from the observed variable´s set (Sherry and Henson, 2005).

the representation of the units (Figure 4.16) clarifies the interpretation of the correlation between the variables.

In Figure 4.15, variables with a strong relation are projected in the same direction from the origin. The greater the distance from the origin is, the stronger its relation becomes. Accordingly, we confirm a very strong relation among the two variable sets (R_c). Both predictor and criterion variables are projected in the left part of the figure, and consequently, revealing most salient patterns. As the first function demonstrated theoretically, the first dimension of the figure clearly shows high correlations between *"relational density levels"* of intermediate categories (Cat1 to Cat 4) and RIS *"integration"* (Gap 1 to Gap 4).

On the other hand, Figure 4.16 reveals the position of the Spanish ACs along the axes. Our interest now is to find relationships between both plots (variables and units) drawn on the matching axes; as this can reveal associations between variables and experimental units. As introduced, the first function gathers 97.81 % (Rc^2) of the variance within its function. The latter is projected in the first axis and consequently, it will be the only dimension of interest for the current research. This first axis opposes regions characterized by dense *"Associative Components"* and well integrated RISs; and inactive or inexistent RISs. In the left margin of the figure, we find regions such as Navarre, the Basque Country, Catalonia or Madrid; which also showed highest comparative performance measures on previous chapters. Density and integration vanish as we get closer to the right margin of the figure. As shown in previous chapters, Canary Islands, Balear Islands, Murcia or Castille La Mancha rank lower comparative measurements.

In our example, we would also like to know (in terms of degree and directionality) what categories (predictor variables) could be related to

what gaps (criterion variables). In order to do so, we now turn our attention to the visualization of the correlation matrices. Figure 4.17 highlights some significant correlations not only within each set of variables (squared matrices 4x4 at the top) but more importantly, between both sets (the 4x4 matrix at the bottom). We find that the images obtained show positive cross-correlations between predictor (X) and criterion (Y) variables (as it can be verified in Table 4.11). The coupling shows the following main cross-correlations: Gap 1 and Cat 1, 0.42; Gap 2 and Cat 2, 0.71; Gap 3 and Cat 3, 0.67; Gap 4 and Cat 4, 0.77. This means the correlation matrix generally proves that X variables predict Y ones, all but in the case of the first gaps and categories whose cross-correlations are below the expected level. We expected each of the gaps to be particularly correlated to its *"peer"* category forming correlated *"pairs"* across the regions. On the contrary, we discover some unusual findings. As it can also be observed in Table 4.15, categories number 2 and number 4 show very high cross-correlations with gap number 3 (0.92 and 0.95 respectively). This means that these categories are cross-correlated to an unexpected gap. The same situation occurs when we observe the correlation of the category number 2 with categories 3 and 4. Apparently these categories induce very similar projections on the individuals, meaning –unexpectedly- high correspondence in their behavior. This is to say that we could wait for the density of the categories 2, 3 and 4 to come together across the regions. This information can be –easily- verified in the X correlation matrix of the Figure number 4. The lower comparative cross-correlation between Gap 4 and Category 1 (0.23) could also be considered, which can also be verified in Figure 4.14 (yellow box). Table 4.12 shows the values of the observations across these individuals, which would explain quite a different final projection.

In the light of the results, and after verifying the significance of the CCA, we accept the hypothesis of the study. **Dense *"Associative Components"* predict well integrated (Spanish) RISs.**

Table 4.7 Statistical Significance Test for the Full CCA Model (S=4, M=-1/2, N=3 1/2)					
Test Name	Value	Approximate F	Hypothesis DF	Error DF	Significance of F
Wilks´s	.00953	6.30696	16.00	28.13	.000
Table 4.8 Canonical Correlations for Each Function. Eigenvalues and Canonical Correlations					
Function Number	Eigenvalue	%	Cumulative %	Canonical Correlation	Squared Correlation
1	44.72110	97.43695	97.43695	.98900	.97813
2	1.06719	2.32515	99.76210	.71851	.51625
3	.9648	.21020	99.97230	.29663	.8799
4	.01271	.02770	100.000	.11205	.01255
Table 4.9 Hierarchical Statistical Significance Test.					
Functions	Wilks λ	F	Hypothesis DF	Error DF	Significance of F
1 to 4	.00953	6.30696	16.00	28.13	.000
2 to 4	.43565	1.10724	9.00	24.49	.394
3 to 4	.90056	.29570	4.00	22.00	.878
4 to 4	.98745	.15257	1.00	12.00	.703

Table 4.10 Canonical Solution. For gaps (Gap 1 to Gap 4) predicting categories (Cat 1 to Cat 4) for Function 1			
	Function 1		
Variable	Coef	r_s	r_s^2 (%)
Gap 1	.08750	.62882	39.54
Gap 2	.08250	.71700	51.40
Gap 3	.80856	.99269	98.54
Gap 4	.11783	.70592	49.83
R_c^2		97.81	
Cat 1	.04298	.64522	41.63
Cat 2	.49828	.93235	86.92
Cat 3	-.15403	.66688	44.47
Cat 4	.62242	.98072	96.18

Note: Structure coefficients (r_s) greater than |.90| are underlined. Coef= standardized canonical function coefficient; r_s^2 = squared structure coefficient.

Table 4.11 Cross-correlation matrix (XYcor)								
Cat 1	1							
Cat 2	0.5780	1						
Cat 3	0.3281	0.8319	1					
Cat 4	0.5860	0.8633	0.6302	1				
Gap 1	0.4299	0.5591	0.4235	0.6266	1			
Gap 2	0.5936	0.7139	0.4327	0.6337	0.2912	1		
Gap 3	0.6485	0.9313	0.6752	0.9541	0.5579	0.7205	1	
Gap 4	0.2300	0.5198	0.3462	0.7753	0.5611	0.2240	0.6437	1

Table 4.12 Cross-correlation (Gap 4 and Category 1)					
	Gap 4	Category 1		Gap 4	Category 1
Andalusia	-0.4000	-0.9221	Valencia	-1.0559	0.4478
Aragon	-1.2381	0.9335	Extremadura	0.7151	-2.9538
Asturias	0.6859	-1.3477	Galicia	-0.1522	-0.2345
Balear Islands	-1.7191	-0.1239	Madrid	1.0576	1.0595
Canary Islands	-0.7935	-1.0475	Murcia	-0.1959	-0.1181
Cantabria	-0.1522	-1.5780	Navarre	3.3899	1.8914
Castille Leon	0.6495	-0.2085	Basque Country	1.2252	1.1803
Castille La Mancha	-0.8445	-1.0897	La Rioja	-1.7847	1.0225
Catalonia	0.6130	3.0889			

Figure 4.15 Representation of the variables

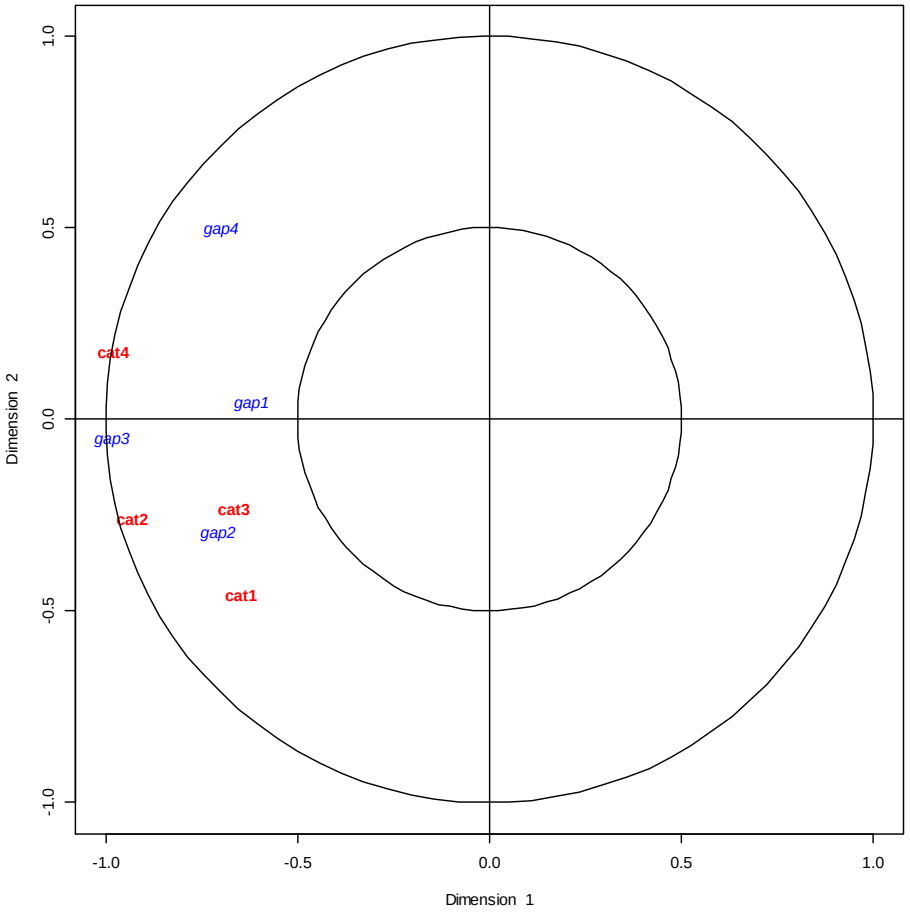


Figure 4.16 Representation of units

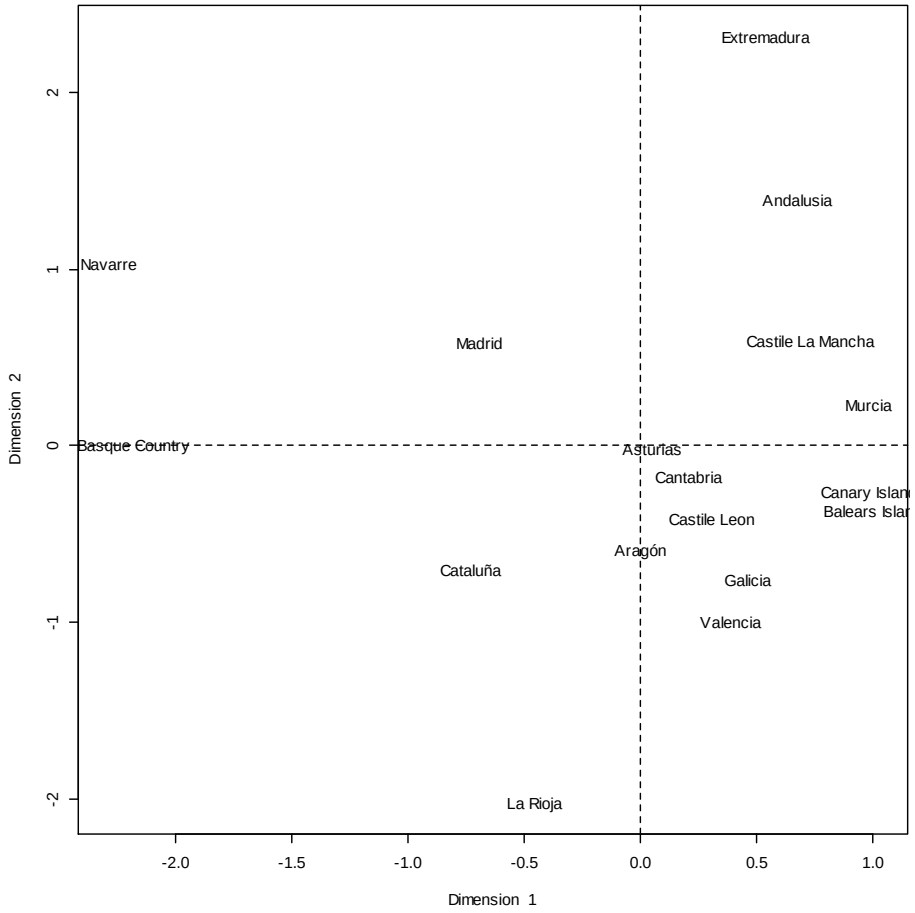
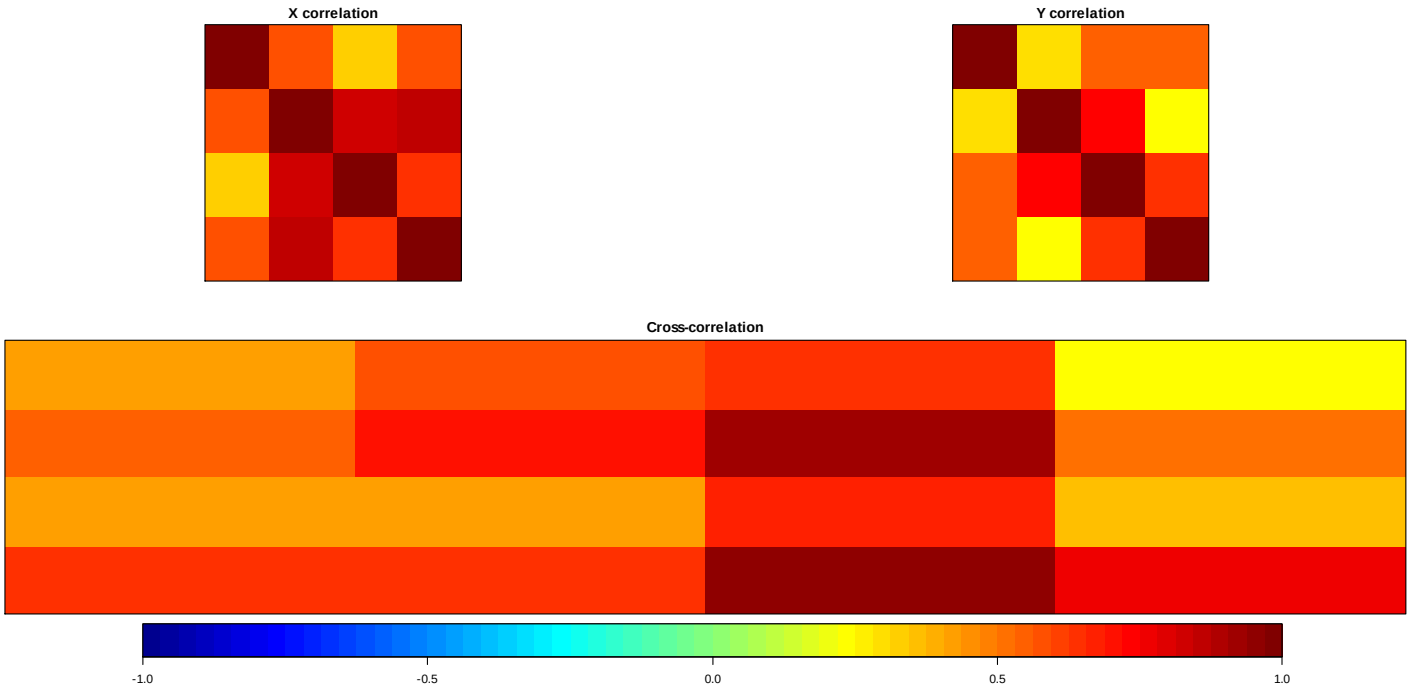


Figure 4.17 Correlation matrices



For: X variables (upper-left), Y variables (upper-right), cross-correlation X x Y (bottom).
Increasing values are translated into colors from blue (negative correlation) to red (positive correlation). (Adapted from González *et al.*, 2008).

CHAPTER 5: CONCLUSIONS

5.1. THEORETICAL SYNTHESIS AND IMPLICATIONS

The dissertation presents a number of theoretical implications which are synthesized onwards. These implications can be summarized in three main blocks. The first block introduces several novelties intended to overcome some specific limitations incurred by various schools of thought engaged in the study of system problems. These novelties permit a simpler and more straightforward classification and assessment of the problems. The second block presents several theoretical implications that smooth the process of categorizing and assessing intermediary organizations across systemic environments. Third, a final theoretical implication of the dissertation brings forward a crucial distinction among the strand of studies that produce empirical assessments on the performance of innovation environments.

With regards to the first block, we found three main approaches concerning the study of the system problems which have been analyzed in the dissertation. Innovation management studies described the lack of capabilities of managers and executives to operate private organizations and external networks (Burt, 1992, 1997 and 2004; Bessant and Rush, 1995 and 2000; Saxenian, 1996; Hagardon and Sutton, 1997; Hagardon, 1998). A second collection of studies illustrated their lack of technological capabilities and the complex relation between the former and technological infrastructures (Fagerberg, 1987; Martin and Scott, 2000; Parrilli *et al.,* 2010; Dalziel, 2010). Additionally, the financial literature presented how VCs and BAs

facilitate private organizations overcome their lack of financial capabilities (Beck and Demirguc-Kunt, 2006; European Commission, 2011).

These schools observed the problems separately and consequently, there was little space for cross-reference and communication. In addition, the managerial orientation of these schools prevented the observation and specification of the institutional dynamics and their influence on the behavior of organizations (Lundvall and Borrás, 1997; Asheim and Coenen, 2006; Edquist, 2001 and 2011; Moodysson and Zukauskaite, 2014). Together with the latter, managerial orientations also prevented scholars from the development of an aggregated –economic- outlook that would induce the assessment of other important multiadic interactions across new units of analysis (other than business and markets) such as regions or nations. As a matter of fact, most of these studies evidenced interactions between two firms, or between a firm and a technological infrastructures; preventing scholars from the observation of other crucial components (i.e. regional policy subsystem) and -public and private- organizations (i.e. intermediaries) which are usually eliminated from analysis.

The thesis overcomes these limitations thanks to the presentation of some theoretical achievements. First, our interpretative framework (Figure 2.1: System problems and RIS components) is intended to facilitate the communication among the schools of thought that engage in the study of system problems. The framework displays and locates these gaps together, which may facilitate -more- collaborative development paths among the schools. Second, the framework exceeds previous managerial orientations and brings forward the chance to settle these studies in line with the specific institutional dynamics influencing the behavior of the organizations across locations. Third, the

framework eases the operationalization of quantitative variables. The latter helps overcome another important limitation that dealt with the unit of analysis of previous studies. This framework permits the assessment of system problems from an aggregated and systemic regional or national outlook; while it also permits the operationalization of new variables designed to analyze –public- organizations and their influence in the innovation system as a whole (i.e. possible existing system problems between the *"regional policy subsystem"* and the *"exploration subsystem";* or the existence of *"Gaps 1"* and "*Gaps 2"* within the *"exploration"* and *"policy subsystems"*).

With regards to the second block, the thesis introduces a number of implications regarding intermediaries. As evidenced by the literature, different and complementary classifications could be possible. These organizations have been arranged by their roles and functions (Howells, 2006: 718), or by their instruments and target groups (Nauwelaers, 2011: 473). We explicate that this path revealed narrow development opportunities for their empirical assessment. The dissertation makes a contribution at this particular gap by proposing a more straightforward and comprehensive alternative approach. As stated, we list a number of system problems and observe different intermediary profiles that tap into each of them in a more specialized -or prevailing- fashion; creating pairs. Thus, by leveraging and relying on previous developments (Howells, 2006; Nauwelaers, 2011), our approach brings forward important theoretical implications. First, it permits -a novel- classification of intermediary organizations and their empirical assessment over RISs. Categorizing intermediary organizations also permits aggregating these –and other possible categories- in a new *"Associative Component"* which constitutes another important theoretical contribution of the dissertation.

The presentation of these achievements leverages on new stage of development of the conceptual framework of the dissertation (Figure 2.2: Intermediary categories, system problems and RIS components & Figure 2.3: The *"Associative Component"*). First, the new framework includes a number of intermediary categories that tap into the system problems. In this case, the framework also helps in the operationalization of a number of variables that facilitate the production of our –novel- empirical assessment of intermediary organizations. Second, intermediaries are also aggregated in a new *"Associative Component"*.

A final theoretical implication of the dissertation brings forward a crucial distinction among the strand of studies that assess the performance of innovation environments. First, an important number of studies analyze the relative use of resources that RISs devote to the production of some specific innovative outputs (i.e. patents) (Buesa *et al.,* 2002a, 2002b and 2007; Martínez- Pellitero, 2002, 2007 and 2008; Susiluoto, 2003; Buesa and Heijs, 2007; Zabala-Iturriagagoitia *et al.,* 2007; Zabala-Iturriagagoitia, 2008; Navarro and Gibaja, 2009, Navarro et al., 2009; Navarro and Gibaja, 2010 and 2012). A second –evolutionary- strand focuses on the behavior of the systems, and how –quickly- these can adapt to internal and external changes and/or overcome system problems; putting a special stress on interactive dynamics (Lundvall and Borrás, 1997; Nauwelaers, 2011; Chaminade *et al.,* 2012). The current dissertation supports the second tradition while it also provides a bridge with the former, blending most significant aspects of both approaches in order to deepen their scope. All in all, the thesis establishes a theoretical and empirical bridge between neoclassic and systemic assessments, facilitating the identification of mismatches between innovation policies, intermediaries and the existence of system problems in RISs.

5.2. RESULTS AND COMPARABILITY

The IS outlook underlines learning mechanisms as crucial drives of dynamic systems where multiple forms of institutional, organizational, social and political innovations go beyond the former technology and firm centered tradition. This literature strand responds to the growing need for a better understanding of innovation processes as well as the production and distribution of knowledge in economies (Nelson, 1992, 1993 and 1995; Freeman, 1995; Lundvall and Borrás, 1997; Edquist, 1997 and 2001; Asheim and Isaksen, 2002; Asheim and Gertler, 2005; Woolthuis *et al.,* 2005; Tödtling and Trippl, 2005; Chaminade and Edquist, 2006; Uyarra, 2010; Chaminade *et al.,* 2012; Asheim and Parrilli, 2012; Parrilli, 2013). In fact, the underlying rationale faces the growing complexity and the interplay among economic, societal and political issues founded on technological, information and communication revolutions, which constitute widespread effects of the ongoing trend of globalization. Nevertheless, it is not a contradiction to claim that while certain dynamics are going global (i.e. trade and financial flows), others like knowledge creation and innovation, appear to be more and more embedded in specific locations and networks. As a matter of fact, we witness an analogous and continuous process of regionalization whereby specific organizations and institutions compete and collaborate to construct advantages (Asheim *et al.,* 2006; Nauwelaers, 2011; Asheim and Parrilli, 2012). The interplay between these inexorable convergence and divergence strengths has given rise to a number of system problems that were previously unobserved or overlooked. The productivity and *"low-road"* advantages of developing

countries (i.e. BRIC[77] and MINT[78]) in fact elevate world competition standards, and demand that developed ones nurture renewed strategies to maintain and reinforce their competitive edge.

In this context, IS scholars recognize a wide variety of system problems (Lundvall and Borrás, 1997; Malerba, 1998 and 2009; Smith, 2000b; Isaksen, 2001; Tödtling and Trippl, 2005; Woolthuis *et al.,* 2005; Chaminade and Edquist, 2006; Chaminade *et al.,* 2012) that prevent modern economies from a more effective use of their knowledge and its conduction towards development and growth. Importantly, some of these problems have been aggregated under the category of *"learning processes and accumulation of capabilities"* (Marzucchi, 2010), which take shape in various *"gaps"* such as: *"Human resource"* gaps, *"Openness and learning"* gaps, *"Technological"* gaps, and *"Financial"* gaps. As explained, the first two gaps take place in markets. Firms often lack knowledge, capabilities and networks to take right managerial decisions as a consequence of their lack of size, or their location and/or resource limitations. Additionally, *"technological"* gaps take place when firms and universities or other research organizations do not collaborate as a means to raise the technological level of the former to the current state-of-the-art. Finally, *"financial"* gaps originate when territories lack policy instruments to support the investment of firms in innovation-related projects.

This growing complexity also demands *"intermediaries"* adapt and rearrange (Nauwelaers and Wintjes, 1999; Bessant and Rush, 2000; Howells, 2006; Acworth, 2008; Parrilli *et al.,* 2010; Cooke, 2011;

77 Brazil, Russia, India and China

78 Mexico, Indonesia, Nigeria and Turkey

Nauwelaers, 2011; Tödtling and Trippl, 2012). Rooted in a neoclassic tradition whereby these organizations helped firms overcome *"market failures"* (Nelson, 1959; Arrow, 1962), intermediaries widen and specialize to adapt to the new systemic outlook. New technological, industrial and institutional schemes provoked intermediaries progressively evolved towards a much extensive *"catalytic"* role which entails managing knowledge flows through research, education, industrial and government sectors; turning straightforward intermediation into a more and more multilateral and dynamic function (Altenburg *et al.,* 1998; Howells, 2006; Acworth, 2008; Nauwelaers, 2011; Parrilli, 2013).

The dissertation completes previous seminal works where intermediary profiles were reviewed and assessed (Howells, 2006; Nauwelaers, 2011). We wondered whether a RIS that lacks system problems would also be a system where intermediary categories behave effectively, and vice versa. In other words, the underlying research question of the dissertation was:

- ***Does a dense intermediary network predict well integrated RISs across regions?***

In order to answer the question, we categorized a number of intermediary categories and linked them to several system problems (i.e. gaps) creating pairs (Table 2.3). Besides, the existence of commonalities in the purpose and the activity performed by the introduced intermediary categories suggested arranging them around a common subsystem. Consequently, the *"Associative component"* was also set up. The new component (Figure 2.3) was set to assemble all organizations which design, facilitate and catalyze systemic interaction within systemic frameworks (i.e. intermediaries).

This classification permits the assessment of gaps and categories, and the relation between the former across RISs. The analysis built on the operationalization of sets of indicators based on *ad hoc* data exploitations that stem from form various surveys (i.e. INE, ASCRI). Our data was gathered in two data sets. The rows of both matrices correspond to Spanish ACs, while their columns stand for four separated sets of continuous variables grouped under the names of *"Gap1", "Gap2", "Gap3", "Gap4"* (Table 3.3); and *"Cat1", "Cat2", "Cat3", "Cat4"* (Table 3.5).

Due to the size of both data sets, our first aim was to reduce their dimensionality. MFA allowed us integrating unlike groups of variables (each gap/category under assessment) describing the same observations (Spanish ACs) (Abdi and Valentin, 2007). We completed the study performing CAs to categorize and summarize their results and create typologies of regions. First, Spanish ACs were grouped together in accordance to their integration levels. Second, the regions were arranged in terms of the density levels of their *"Associative Components".* Third, we also present a new background to assess the relation among these typologies, aiming at finding a potential relationship between them. CCA permits stressing correlations between data sets. The procedure aggregates the variables employed in the assessment of the *"gaps"* and *"categories"* to create two sets of composite indexes. Each index corresponds to the linear combination of its quantitative variables put together, as summarized in Figure 3.3, and they facilitated verifying the hypothesis of the dissertation.

The empirical analyses present two complementary typologies for Spanish ACs (Figure 4.6 and Figure 4.13). The first one distinguishes among groups of regions according to the integration of their RISs. Group 1 gathers *"industry-oriented integrated systems"* such as Navarre

and the Basque country. Group 2 collects *"service-oriented integrated systems"* such as Madrid and Catalonia. Group 3 is represented by *"moderately integrated systems"* such as La Rioja or Aragon. Finally, Group 4 puts together the remaining regions under the label of *"disintegrated systems"*. The second typology differentiates among four groups according to the level of density of their *"Associative Components".* Group 1 gathers *"active, industry-oriented Associative Components"* such as the Basque Country. Group 2 collects *"active, service-oriented Associative Components"* such as Aragon, Madrid, La Rioja, Catalonia and Navarre. Group 3 is represented by *"moderately active Associative Components"* such as Cantabria, Galicia, Castile Leon, Valencia and Asturias. Group 4 puts together the remaining regions under the label of *"inactive (or inexistent) Associative Components".*

Both analyses exhibit the behavior of the *"gaps"* and the *"categories"* to be asymmetric not only within a given RIS, but also when comparing them with its pairs in other Spanish ACs. Not only gaps present dissimilar sizes and shapes when we compare them within a particular system. Additionally, each of the gaps behaves dissimilarly when we compare them across the regions. As a consequence of this asymmetric behavior, neither the *"integration"* of RISs, nor the density level of the *"Associative Components"* should be considered a homogenous characteristic across ACs, as it may vary depending on historic and cultural idiosyncrasies, institutional thickness and private´s sector proactive behavior, among others.

These findings were completed with a second –main- result of the dissertation. After these analyses were completed, what remained unfold was the exploration of any existing relationship among their outputs. This called into question a potential relationship between the

density level of *"Associative Components"* and the *"integration"* of RISs as multioperationalized in both data sets. In doing so, we presented the hypothesis of the dissertation which claimed that: dense *"Associative Components"* predict well integrated (Spanish) RISs. The statistical output of the study has proved the validity of the hypothesis.

These results were completed by the investigation of possible patterns of relation between specific *"gaps"* and peer intermediary *"categories"* across our common experimental units of analysis (Spanish ACs). As specified in Table 4.7, we found positive cross-correlations between predictor (*"categories"*) and criterion (*"gaps"*) variables. This means the correlation matrix supports the hypothesis. However, we expected each of the *"gaps"* to be specifically correlated to its *"peer category"* forming correlated *"pairs"* across subsystems and regions. On the contrary, we discovered some unusual findings[79]. These findings brought about some inconclusive results that could guide further investigations.

When it comes to the comparability of the results of the dissertation, we found that our typologies could be compared to others that also leveraged in the use of quantitative indicators. Our typologies reveal patterns that resemble some previous studies (Figure 4.7 and Figure 4.14) (Coronado and Acosta, 1999; Martínez- Pellitero, 2002; Buesa *et al.,* 2002; Buesa and Heijs, 2007; Navarro and Gibaja, 2009, 2010 and 2012). This is an outstanding aspect of our investigation, as it correlates RIS integration and the density level of *"Associative*

79 *As presented in subchapter 4.3:"Categories number 2 and number 4 show very high cross-correlations with gap number 3. The same situation occurs when we observe the correlation of the category number 2 with categories 3 and 4. Apparently these categories induce very similar projections on the individuals, meaning –unexpectedly- high correspondence in their behavior".*

Components" with other aspects measured by previous studies, as their efficiency or, more broadly, their overall innovative capabilities (Coronado and Acosta, 1999; Susiluoto, 2003; Martínez-Pellitero, 2007 and 2007; Buesa and Heijs, 2007; Zabala-Iturriagagoitia *et al.,* 2007; Zabala-Iturriagagoitia, 2008; Navarro *et al.,* 2009; Navarro and Gibaja, 2012). Still, while the pattern is common to most typologies, there are aspects that characterize the results. The fact that the final projections of these analyses could be similar, in fact brings about quite different – and complementary- information inputs for innovation policy recommendations that will be formulated.

Though empirical assessments often leverage on the use of commonly available data (i.e. INE), they build on dissimilar rationales. Former studies often measured *input-output* additionalitity (i.e. R&D investment and its results) to assess systemic environments (i.e. system´s efficiency and innovative capabilities). We acknowledge that data limitation constitutes an insurmountable obstacle to perform systemic analyses. Unfortunately, most available indicators are still designed under neoclassic rationales and do not permit systemic assessments on important organizational and institutional aspects. Nevertheless, we deem that our approach completes the scope of former assessments in a number of ways. First, it focuses on the *"behavioral additionalitity"* of a number of organizations (i.e. firms & intermediaries). Second, our approach links the presence of a number of intermediary categories with the level of integration of RISs. Besides, the use of new tools (i.e. CCA) permits the formulation and resolution of new relevant questions and hypotheses related to the association of the existence of systemic problems and intermediary categories across innovation environments. In this line, the dissertation establishes a bridge between neoclassic and systemic assessments, facilitating the identification of mismatches between innovation policies, intermediaries and the existence of system

problems. It also facilitates framing a new generation of systemic indicators that could return crucial organizational and institutional data to academics and policy makers (Figure 2.1, 2.2 & 2.3).

All in all, the dissertation has produced new typologies for the Spanish ACs. Even so, an important question remains unfold. Though we employ the general framework of RISs to conduct our research, the empirical output lead us wonder about the existence of RISs in Spain. Our first typology evidences severe system problems in an important number of Spanish regions (Balear Islands, Canary Islands, Andalusia, Castille La Mancha, Murcia, Extremadura, Castille Leon, Asturias, Valencia, Cantabria and Galicia). Moreover, our second typology evidences an important number of regions that may lack active *"Associative Components"* (Canary Islands, Balearic Islands, Castile La Mancha, Extremadura, Andalusia and Murcia).

A number of authors have stated that Spanish regions cannot be considered as perfect or comprehensive RIS because of their limited interactivity and the fact that the learning processes related to innovation in policy making are at a very early stage (Riba Vilanova and Leydesdorff, 2001; Zabala-Iturriagagoitia, 2008). As a matter of fact, some authors believe that RISs exist when (a) there´s a concentration of interdependent firms within the same or adjacent industrial sectors in a small geographic area; (b) increasingly organized co-operation (agreements) between firms, stimulated by trust, norms and conventions; and (c) co-operation between the former and different organizations for knowledge development and diffusion (Isaksen, 2001: Navarro and Gibaja, 2009).

Following these arguments, and building on our own results, it is reasonable to emphasize there are only a few Spanish regions where there is enough evidence of the existence of a well-functioning RIS. For

this reason, we claim that RISs are only present in a reduced number of Spanish ACs, such as Navarre, Basque Country, Madrid, Catalonia, Aragon and La Rioja (Group 1 and Group 2 regions in our typologies). However, the RIS approach offers a conceptual framework that enables comparison of the relative position of ACs in terms of innovation, efficiency or, as in the current dissertation, their dynamic behavior (Buesa *et al.,* 2002; Zabala-Iturriagagoitia, 2008; Navarro *et al.,* 2009). For this reason, we maintain that the employment of the RIS as a conceptual approach brings important benefits for academy and policy making. All in all, this framework *"allows regional authorities to orient their innovation policies according to a systemic view which may account for identified needs and weaknesses as well as promoting key strengths"* (Zabala-Iturriagagoitia, 2008: 51).

5.3. POLICY IMPLICATIONS

As stated, a system innovation policy approach needs to be experimental and adaptative (Metcalfe, 1995; Chaminade *et al.,* 2012). Rather than starting from scratch or copying from best practice, policy makers might want to follow a guideline based on certain crucial aspects we have put together. In a nutshell, we claimed that policy formulation and its implementation shall be the result of intensive communication, close interaction and consensus building between all stakeholders in policy networks. Consequently, the key role governments play shifts from direct intervention towards stimulation, intermediation, brokering, promoting dialogue and building up social capital, across different levels of policy, including non-state actors such as firms, non-governmental organizations, professions and other actors, engaged in a collective process of negotiation and compromise (Tödtling and Trippl, 2005; Uyarra, 2010).

In this line, the dissertation brings forward important policy implications. These implications add to the novelty of the conceptualization and its related empirical evidence *vis-à-vis* previously developed complementary studies (Zabala-Iturriagagoitia *et al.,* 2007; Navarro *et al.,* 2012; Trippl and Martin, 2013; Parrilli, 2013). The presented conceptual and empirical foundations constitute a step forward towards the improvement of the diagnostic capabilities that might empower innovation policy intervention. Second, the dissertation presents a move forward to empirically assess and guide the functions developed by intermediary categories. The individual nature and behavior of the latter might demand for the design of specific objectives and strategies across regions, bringing to the fore important implications and challenges.

All in all, the outputs of the dissertation compile significant inputs for policy making. However, the rationale behind the current dissertation is more closely related to the methodological foundations guiding the analysis of *"system problems", "intermediary organizations"* and their potential relation; rather than being related to detail descriptive aspects –like policy implications- guided by the empirical results. Importantly, the observation of the specific spatial location of the *"partial analyses*[80]*"* returned by the visual outputs of R could also facilitate the design of -more specific- measures for each region being considered. These outputs could constitute an adequate input for further research geared

80 "Partial analyses" -or "superimposed representations"- represent each region viewed in terms of each of the gaps and intermediary categories assessed and its barycenter (Pagès, 2004; Abdi & Valentin, 2007). As in the case of Figures 4.4 and 4.11, R can represent each region in terms of its gaps and categories, leading to appropriate and very specific system innovation policy designs.

to the specification of -more detailed- opportunities for the Spanish regions. However, we onwards develop a general guidance for the groups of regions output by the analysis.

GROUP 1. INDUSTRY-ORIENTED INTEGRATED RISs

Navarre and the Basque Country constitute the first group of regions output by the analysis. In general terms, these regions outstand for their performance and their economic development. They would comprise the most integrated regions according to the indicators we employed in the analysis. The comparative development of the managerial capabilities of their firms and their intensive participation in networks represent important strengths of their economies. The latter is also supported by higher R&D expenditures and the presence of financial support to spur innovation projects, which translate into habitual collaborative practices between universities, research centers and their medium and high-tech firms and industries.

However, the fact that these regions rest in comfortable positions when we compare them to the rest of Spanish ACs does not necessarily mean there is no room for improvement. In fact, the regions occupy modest positions which appear to be close to EU-25 average values (Navarro *et al.,* 2008). Therefore, when it comes to integration, these regions could focus on the improvement not so much of the quantity, but particularly on the quality of the relationships among their agents, so that the R&D investment could reflect in greater levels of technological results. For that to happen, we need to go beyond superficial policy statements like *"universities need to collaborate with firms"*, and actually develop new tools that empower scholars and policy makers to design and spur *"smart networks"* depending on the clusters that shall be fostered and the underlying expectations and visions.

While their *"Associative Components"* reveal good practices and high network densities, intermediary organizations still face great challenges. Many innovations are hidden opportunities, and innovation policies could be oriented to the assessment of the current networks. Importantly, the existence of interactions could only be considered a departing point to assess which –other- networks shall be activated to drive smart strategies. Otherwise, the lack of analysis on the latter, or even the reinforcement of existing ones could also lead these regions to dangerous lock-in situations, particularly in the case of their oldest industries and clusters.

GROUP 2. SERVICE-ORIENTED INTEGRATED RISs

Madrid and Catalonia constitute the second group of regions output by the analysis. As in the case of Navarre and the Basque Country, these regions also outstand for their performance and economic development. However, though the regions show high levels of integration, they represent less prominent positions compared to Navarre or the Basque Country. These regions have great importance culturally, politically and economically and act as attractors of young qualified professionals from the rest of the country. The latter takes place as a consequence of the concentration of national public research facilities, headquarters and R&D activities of big companies (Navarro *et al.,* 2008).

These regions specialize in service industries and concentrate important levels of high tech, consultancy and financial KIBS organizations. Perhaps due to their service specialization, the regions show less outstanding positions with regards to collaborative projects between universities, research centers and their private organizations.

Their *"Associative Components"* also reveal good practices and high network densities. However, as in the case of Navarre and the Basque

Country, intermediary organizations still face great challenges. The gaps under assessment constitute opportunities for their outlook. Consequently, current networks could be also taken into consideration as a means to design and foster new interactions and smart strategies among appropriate stakeholders to face and take advantage of -international and regional- challenges. Intermediary organizations could also depart from fostering new collaborations between universities, research centers and service organizations.

GROUP 3. MODERATELY INTEGRATED RISs

La Rioja and Aragon comprise the third group of regions fed back by the analysis. These regions represent average performance and economic development measurements and need to improve their position with regards to all the system problems that have been assessed. Paradoxically, according to the indicators employed in our assessment, these region´s *"Associative Components"* perform well and reveal good practices and high network densities. This particular case reveals that the density of the *"Associative Components"* is not the only factor affecting highly integrated RISs. As stated, correlation is a necessary but not sufficient condition for causality. If this was the case, we would expect these regions pertained to better positioned groups. Consequently, even if intermediary organizations are present, perhaps a strategy to improve the efficiency of the system itself could be still missing, proving the validity of previous analyses that specialize in the issue (Zabala-Iturriagagoitia *et al.,* 2007)

GROUP 4. DISINTEGRATED RISs

The last group is comprised of the rest of Spanish ACs: Balear Islands, Canary Islands, Andalusia, Castille La Mancha, Murcia, Extremadura,

Castille Leon, Valencia, Cantabria and Galicia. These regions show low levels of economic and technological development. Additionally, these regions specialize in tourism and agriculture, showing lower levels of industrial presence and development. Valencia constitutes an exception to the rule. This AC could, at least intuitively, belong to *"moderately integrated RISs"* (Group 3).

Due to their lack of integration, we claim that the RISs of these territories are at a very early stage or just do not exist (Navarro *et al.,* 2008). Consequently, the challenge faced by *"Associative Components"* is even greater when compared to the rest of regions. To this regard, we observe two different scenarios. First, communities like Cantabria, Galicia, Castile Leon, Valencia and Asturias comprise a first subgroup with moderately active *"Associative Components".* Second, the remaining regions could lack the presence of intermediary organizations. Consequently, policy implications are dissimilar. The first subgroup demands a strategy that could drive *"Associative Components"* to activate networks with special attention to the individual visions and strategies of their RISs. On the contrary, the second subgroup could demand that policy intervention fostered the creation of a well integrated network of intermediary organizations. This strategy would require extra levels of leadership and good coordinating capabilities among the multiple layers of governance on the part of policy making representatives.

5.4. FURTHER RESEARCH

The dissertation suggests three main directions for further research. A first path could be practical and straightforward. The *"partial analyses"* of the dissertation leave space to elaborate on more specific and focalized policy recommendations regarding individual needs and

development possibilities of regions. The second path would leverage on the results of the current dissertation to elaborate on –evolutionary-system innovation indicators that could facilitate further steps towards wider and more enlightened assessments over a wider range of system problems (i.e. (a) organizational thinness, (b) lock-in, or (c) fragmentation problems (Isaksen, 2001; Tödtling and Trippl, 2005). This path would require intensive investment on the design of novel variables dedicated to new focal organizations (i.e. TTAs, university liaison offices, business advisory bodies, technology or science parks, territorial agencies of cluster management organizations, to name a few; and also the employment of complementary techniques such as SNA (Wasserman and Faust, 1994) which could return improved observations of the interactions that take place in RISs. The third path demands further elaboration. In a context where general guidance has already been provided, the academic discourse needs to go beyond. Imagination and creativity spur when appropriate individuals are connected. However, the drive for connectivity requires eliminating redundant relations and spurring the right ones in a process that varies across longitudinal and latitudinal dimensions. A higher level of integration is not necessarily good as it may bring regions to undesirable lock-in effects (Tödtling and Trippl, 2005; Woolthuis *et al.,* 2005; Chaminade and Edquist, 2006; Chaminade *et al.,* 2012). For this reason, we need to understand whether integration occurs among the right organizations and at the right time to produce the construction of regional advantage under unique value propositions (Cooke, 2006; Asheim *et al.,* 2006; Asheim and Parrilli, 2012). Thus, this dissertation could only be the start point leading to open questions and new possibilities. We conclude the dissertation posing two open questions for further analysis:

- ***What are the specific system problems caused by the selection of individual strategic paths towards the construction of regional advantage?***
- ***How can we identify and measure possible additional gaps? (i.e. between "regional policy" and "knowledge exploration" components)***

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APPENDIX 1: SYSTEM PROBLEMS AND POLICY TOOLS

Own modification adapted from SMEPOL project: Nauwelaers and Wintjes, 1999- Table 8.2.				
	Human resources gap81	Openness and learning gap	Technological gap	Financial gap
Proposed definition	-Using qualified resources in firms; investing in training.	-Learning from others; developing antennas to the outside.	-Screening for technological options. Adapting state-of-the-art to own situation.	-Getting capital when markets prefer secure investments with short term return.
Policy tools	-Foster exchange of codified and tacit knowledge. -Foster intra-firms nodes for co-operation.	-Foster a more collaborative spirit and more strategic orientation in the regions.	-Provide bridge between firms and technological resources. -Provide "accessible technology". -Finance firms to access technology centers.	-Coach firms in linking to finance sources. -Foster specialization by combining technological support and finance. -Support the formation of sector-specific venture capital funds.

[81] *We include "strategy & organization" barriers into the category "human resources". We consider that the formalization of innovation strategies and the recognition of difficulties in commercial orientation of technological projects are intimately bounded to the qualification of resources in firms. This is why we believe simpler and clearer to label these categories under a single category named: "human resource gap".*

APPENDIX 2: HANDBOOK ON COMPOSITE INDICATORS

SYSTEM PROBLEMS

This appendix provides definitions and presents the calculation procedure of the indicators employed in the assessment of systemic problems and *"Associative Components"* across Spanish RISs. The data we employed in the creation of the current handbook corresponds to various questionnaires and sources that are specified in each of the cases. We always make use of the latest available year.

"HUMAN RESOURCE": GAP 1

Original definition: Lack or poorly developed management capabilities of private firms, especially present in smaller and less experienced ones, when setting innovation processes (Nauwelaers and Wintjes, 1999; Bessant and Rush, 1995 and 2000).

Proposed definition: Lack or poorly developed management capabilities of private firms belonging to knowledge exploitation subsystems.

Aim of the study: To assess the lack of management capabilities of private firms across Spanish regions.

INDICATOR G11: Percentage of businessmen, managing directors and executives that have completed third-level education; times the percentage of not businessmen who have also completed it.

Source of information: INE (Survey on Adult Population Involvement in Learning Activities –EADA-C.7+13+15)

Period: 2007

Definition: Percentage of businessmen, managing directors and executives that have completed third-level education [82], times the percentage of not businessmen who have also completed it; in both cases belonging to private firms with employees.

Aim: To assess whether businessmen, managing directors and executives of private firms belonging to the knowledge exploitation subsystem outstand (competencies and/or skills) with respect to the employees.

Required data: Percentage of businessmen, managing directors and executives that have completed third-level education; and percentage of non businessmen, non managing directors or executives that have completed third-level education.

Calculation procedure: We divide the percentage of businessmen, managing directors and executives that have completed third-level education; into the percentage of non businessmen, non managing directors or executives that have completed third-level education.

Interpretation: The existence of a higher percentage of businessmen, managing directors and/or executives with tertiary education is used as a proxy to explain firm´s adequate use of existing competencies and skills in knowledge exploitation subsystems.

[82] - *Third level education includes advance vocational training and college education (INE).*

INDICATOR G12: Percentage of businessmen, managing directors and executives capable of using languages other than their mother-tongue; times the percentage of employees who are also capable of using them.

Source of information: INE (Survey on Adult Population Involvement in Learning Activities –EADA-C.56)

Period: 2007

Definition: Percentage of businessmen, managing directors and executives capable of using languages other than their mother-tongue, times the percentage of employees who are also capable of using them; in both cases belonging to private firms with employees.

Aim: To assess whether businessmen, managing directors and executives of private firms belonging to the knowledge exploitation subsystem outstand (language abilities) with respect to the employees.

Required data: Percentage of businessmen, managing directors and executives capable of using languages other than their mother-tongue; and percentage of employees who are also capable of using them.

Calculation procedure: We divide the percentage of businessmen, managing directors and executives capable of using languages other than their mother-tongue, into the percentage of employees who are also capable of using them.

Interpretation: The existence of a higher percentage of businessmen, managing directors and/or executives capable of using languages other than their mother-tongue is used as a proxy to explain firm´s adequate use of existing language abilities in knowledge exploitation subsystems.

INDICATOR G13: Doctors performing research activity in private companies.

Source of information: INE (Innovation in companies´ survey – EI-10-B.4)

Period: 2008-2009

Definition: Total number of doctors performing researching activity in private companies; expressed in hundreds of thousands of regional inhabitants.

Aim: To assess the degree of penetration of doctoral researchers in knowledge exploitation subsystems across region.

Required data: Total number of doctors performing researching activity in private companies; and the population of the regions (Table ii).

Calculation procedure: We divide the total number of doctors performing researching activity in private firms, into the population of the region under assessment. We multiply the result by 100.000. We obtain the total number of doctors performing research activity in private firms per one hundred thousand inhabitants of the region.

Interpretation: The degree of penetration of doctoral researchers researching in private firms is used as a proxy to assess the managerial commitment in the employment of specialized staff.

INDICATOR G14: Private company´s staff with a computer and an internet connection.

Source of information: INE (Survey on ICT. Usage and e-commerce in companies– ETTICE- C.1.2)

Period: 2011-2012

Definition: Private company´s staff that uses a computer and an internet connection at least once a week; expressed as a percentage of total private firms.

Aim: To assess the percentage of private companies whose staff uses a computer and an internet connection at least once a week.

Required data: Total number of private companies whose staff uses a computer and an internet connection at least once a week; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies whose staff uses a computer and an internet connection at least once a week into the total number of private firms in the region (Table i).

Interpretation: A higher number of private companies using computers and an internet connection help us to assess the managerial commitment with the use of new information and communication Technologies; which is here interpreted to proxy advanced managerial practices.

"OPENNESS AND LEARNING GAPS": GAP 2

Original definition: Lack of new *"antennas"* or networks from the outside (Burt, 1992, 1997 and 2004; Hagardon and Sutton, 1997; Hagardon, 1998; Nauwelaers and Wintjes, 1999).

Proposed definition: Lack of networks across knowledge exploitation subsystems.

Aim of the study: To assess the lack of relational density of private firms belonging to the exploitation subsystems.

INDICATOR G21: Private companies joined or associated to a corporate group.

Source of information: INE (Innovation in companies´ survey – EI-10-A.4.)

Period: 2008-2009

Definition: Private companies joined or associated to a corporate group; expressed as a percentage of total private firms.

Aim: To assess the relational densities (or networks) of businessmen, managing directors and/or executives of private firms belonging to the *"knowledge exploitation subsystems"* across the regions.

Required data: Total number private companies joined or associated to a corporate group; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number private companies joined or associated to a corporate group, into the total number of private firms in the region (Table i).

Interpretation: The existence of a higher percentage of private companies joined or associated to a corporate group is used as a proxy to explain higher relational densities on the part of businessmen, managing directors and executives belonging to private firms across regions.

Limitations: The existence of a higher percentage of private companies joined or associated to a corporate group does not necessarily imply a more efficient employment of the resources across *"knowledge exploitation subsystems".*

INDICATOR G22: Private companies that consider the Spanish market an important source of innovation.

Source of information: INE (Innovation in companies´ survey – EI-10-E.4.)

Period: 2008-2009

Definition: Number of firms that consider moderate or high the degree of importance of external information sources (such as: suppliers of equipment and materials, of software components, customers, competitors, or other companies in the same branch of activity, consultants, commercial labs or private R&D institutes) on their innovating capacities.

Aim: To assess the number of businessmen, managing directors and executives that consider moderate or high the degree of importance that external sources of information have on their innovating capacities.

Required data: Number of firms that considered moderate or high the degree of importance of external information sources belonging to Spanish *"knowledge exploitation subsystems"* on their innovating activities; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of firms that considered moderate or high the degree of importance of external information sources belonging to Spanish *"knowledge exploitation subsystems"* on their innovating activities, into the total number of private firms in the region.

Interpretation: The existence of a higher number of firms that consider the market an important source of innovation is employed as a proxy to explain the existence of good quality relations among businessmen,

managing directors and executives belonging to private firms across exploitation subsystems.

Limitations: This indicator does not provide information about the location of these market sources, which can be found at different regional or national levels.

"TECHNOLOGICAL GAP": GAP 3

Original definition: Lack of technological capabilities of private firms (Fagerberg, 1987; Nauwelaers and Wintjes, 1999; Martin and Scott, 2000; Olazaran *et al.,* 2009; Parrilli *et al.,* 2010; Dalziel, 2010).

Proposed definition: Lack of networks between firms belonging to knowledge exploitation subsystems and organizations belonging to *"knowledge exploration subsystems*[83]*"*.

Aim of the study: To assess the networking activity between firms that belong to *"knowledge exploitation subsystems"* and the organizations belonging to *"knowledge exploitation subsystems"*.

INDICATOR G31: Private companies that have purchased R&D services to joined, associated companies or other Spanish market sources

Source of information: INE (Innovation in companies´ survey – EI-10-C.)

Period: 2008-2009

[83] *We elaborate on the taxonomy employed by INE: Universities, PAB, research organizations and technology centers, and /or private nonprofit organizations.*

Definition: Number of private firms that have purchased R&D services to joined, associated companies or other Spanish market sources; expressed as a percentage of total private companies.

Aim: To assess the percentage of private firms that have purchased R&D services to joined, associated companies or other Spanish market sources.

Required data: Total number of private firms that have purchased R&D services to joined, associated companies or other Spanish market sources; and total number of private enterprises in the region (Table i).

Calculation procedure: We divide the total number of private firms that have purchased R&D services to joined, associated companies or other Spanish market sources into the total number of private enterprises in the region.

Interpretation: We employ the percentage of private firms that have purchased R&D services to joined, associated companies or other Spanish market sources as a proxy to assess the intensity of knowledge purchase by the *"knowledge exploitation subsystem"* of the regions under assessment.

Limitations: The current indicator does not provide information on the quality of the interactions and transactions between the organizations. The latter could only represent their mutual interest to access, for example, public grants that demand collaboration agreements. The indicator does neither provide information about the location of these –knowledge exploration- sources, which can be found at different regional or national levels.

INDICATOR G32: Private companies that have purchased R&D services to joined, associated companies or other foreign market sources.

Source of information: INE (Innovation in companies´ survey – EI-10-C.)

Period: 2008-2009

Definition: Number of private firms that have purchased R&D services to joined, associated companies or other international market sources; expressed as a percentage of total private companies.

Aim: To assess the percentage of private firms that have purchased R&D services to joined, associated companies or other international market sources.

Required data: Total number of private firms that have purchased R&D services to joined, associated companies or other international market sources; and total number of private enterprises in the region (Table i).

Calculation procedure: We divide the total number of private firms that have purchased R&D services to joined, associated companies or other international market sources into the total number of private enterprises in the region.

Interpretation: We employ the percentage of private firms that have purchased R&D services to joined, associated companies or other international market sources as a proxy to assess the intensity of knowledge purchase by the *"knowledge exploitation subsystem"* of the regions under assessment.

Limitations: The current indicator does not provide information on the quality of the interactions and transactions between the organizations. The latter could only represent their mutual interest to access, for example, public grants that demand collaboration agreements. On the other hand, the indicator provides information about international purchasing activity, which has no influence whatsoever on the intraregional interactions.

INDICATOR G33: External consultants performing R&D activity within private companies.

Source of information: INE (Innovation in companies´ survey– EI-10-B.3.)

Period: 2008-2009

Definition: Total number of external consultants (FTE) performing R&D activity within private companies; expressed in hundreds of thousands of inhabitants.

Aim: To assess the existence of collaborations between private firms and R&D supplying firms.

Required data: Number of external consultants that perform research activity in private firms; and the population of the regions (Table ii).

Calculation procedure: We divide the number of external consultants that perform research activity in private firms into the population of the regions. We multiply the result by 100.000. We get the number of external consultants that perform research activity in private firms per hundreds of thousands of regional inhabitants.

Interpretation: We employ the number of external consultants that perform research activity in private firms as a proxy to assess collaborations between consultants that provide and firms that require research activity.

Quality standards: The data was disaggregated applying the criterion of regionalization with regards to the location of the headquarters of the firm. The latter implies that the resources of the firm are assigned to regions according to the location of its headquarters.

Limitations: The current indicator does not provide information on the quality of the interactions and transactions between the firms. The latter could only represent their mutual interest to access, for example, public grants that demand collaboration agreements. The indicator does neither provide information about the location of these –knowledge exploration subsystem- sources, which can be found at different regional or national levels.

INDICATOR G34: Private companies that consider Spanish *"knowledge exploration subsystems"* an important source of innovation.

Source of information: INE (Innovation in companies´ survey – EI-10-E.4)

Period: 2008-2010

Definition: Percentage of firms for whom the universities, Public Administrative Bodies (PABs), research organizations and technology centers, and /or private nonprofit organizations, had a moderate or high importance on their innovating activities.

Aim: To assess the percentage of firms considering moderate or high the importance of universities, PAB, research organizations and technology centers, and /or private nonprofit organizations on their innovating activities.

Required data: Total number of firms that consider moderate or high the importance of universities, PAB, research organizations and technology centers, and /or private nonprofit organizations on their innovating activities; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of firms that consider moderate or high the importance of universities, PAB, research organizations and technology centers, and /or private nonprofit

organizations on their innovating activities, into the total number of private firms in the region (Table i). We multiply the results by 100.

Interpretation: The total number of firms that consider moderate or high the importance of universities, PAB, research organizations and technology centers, and /or private nonprofit organizations on their innovating activities is employed as a proxy to assess to what extent private firms value the contribution of the services provided by organizations belonging to knowledge exploration subsystems.

Limitations: The aggregation procedure of the EI-10 questionnaire does not permit to collect individual information on organizations that –following our literature strand- are included in the *"knowledge exploration subsystem"*. Besides, the current indicator does not provide information on the quality of the interactions and transactions between these organizations and the firms. The latter could only represent their mutual interest to access, for example, public grants that demand collaboration agreements. The indicator does neither provide information about the location of these *–knowledge exploration subsystem-* sources, which can be found at different regional or national levels.

INDICATOR G35: Researchers that develop R&D activity in private companies.

Source of information: INE (Innovation in companies´ survey – EI-10-B.3)

Period: 2010

Definition: Total number of researchers (FTE) that develop R&D activity in private companies belonging to *"knowledge exploitation subsystems"*; expressed in hundreds of thousands of regional inhabitants.

Aim: To assess the total number of researchers that devote their time to research and develop new products and services in Spanish firms.

Required data: Total number of researchers that develop R&D activity in private firms belonging to *"knowledge exploitation subsystems"*; and the population of the regions (Table ii).

Calculation procedure: We divide the total number of researchers that develop R&D activity in private firms belonging to *"knowledge exploitation subsystems"*, into the population of the regions. We multiply the results by 100.000. We get the total number of employees performing research activity in private firms per one hundred thousand inhabitants of the region.

Interpretation: The total number of researchers that develop R&D activity in private firms belonging to knowledge exploitation subsystems is employed as a proxy to explain to what extent private firms value the contribution of the services provided by researchers which bring in new knowledge rooted in *"knowledge exploration subsystems"*.

Quality standards: The resources of the firm are assigned to regions according to the location of its headquarters.

"FINANCIAL GAP": GAP 4

Original definition: Lack of regional policy tools to help firms overcome financial difficulties (Nauwelaers and Wintjes, 1999; Beck and Demirguc-Kunt, 2006).

Proposed definition: Lack of financial tools between the *"regional policy subsystem"* and the *"knowledge exploitation subsystem"* helping firms overcome their lack of resources destined to innovation.

Aim of the study: To assess whether RISs have developed mechanism to support private firms. This support should be oriented to counterbalance the lack of commitment of the traditional financial system to support private innovation projects.

INDICADOR G41: Total venture capital portfolio

Source of information: Spanish Venture Capital Association (ASCRI)

Period: 2005-2011

Definition: Total venture capital portfolio in the region; expressed in € per thousand of regional inhabitants.

Aim: To assess the total portfolio of venture capitalists in Spanish start-ups across regions.

Required data: Total portfolio of venture capitalists in Spanish start-ups; and the population of the regions (Table ii).

Calculation procedure: We divide the millions euros invested in each region into its population and multiply the result by one thousand. We get the number of euros invested per each inhabitant of the region.

Interpretation: The existence of a larger portfolio is employed as a proxy to explicate the existence of financial support mechanisms destined to the capitalization of new firms.

INDICATOR G42: New technology-based firms born

Source of information: INE (Innovation in companies´ survey – EI-10)

Period: 2008-2009

Definition: Birth of new technology-based firms in medium and high manufacturing sectors and high technology services; expressed in hundreds of thousands of regional inhabitants.

Aim: To assess the number of new technology-based firms in medium and high manufacturing sectors and high technology services that were established during the studied period.

Required data: Total number of new technology-based firms. The latter firms belong to medium and high manufacturing sectors and high technology services (Table iii). The population of the regions is also required (Table ii).

Calculation procedure: We divide the total number of new technology-based firms in medium and high manufacturing sectors and high technology services that were established during the studied period into the regional population. We multiply the result by 100.000. We get the number of new technology-based firms that have been established per one hundred thousand inhabitants of the region.

Interpretation: The total number of new technology-based firms in medium and high manufacturing sectors and high technology services is employed to proxy the effectiveness of RISs in fostering new technology-based ventures.

Quality standards: The data was disaggregated applying the criterion of regionalization with regards to the location of the headquarters of the firm. The latter implies that the resources of the firm are assigned to regions according to the location of its headquarters.

INTERMEDIARY ORGANIZATIONS

INTERMEDIARY ORGANIZATIONS: CATEGORY 1

Definition: *"Category 1"* analyzes the presence of KIBS companies facilitating firms improve their *"managerial resources"* across knowledge exploitation subsystems.

Aim of the study: To assess the presence of *"Category 1"* intermediary organizations taping into *"Gaps 1"* system problems across *"knowledge exploitation subsystems"* of Spanish RISs.

INDICATOR C11: Private companies that have implemented non-technological innovation betterments: marketing innovations.

Source of information: INE (Innovation in companies´ survey – EI-10-J.1)

Period: 2008-2009

Definition: Private firms that have implemented non-technological betterments such as marketing or merchandizing related innovations. These innovations can be particularly related to the introduction of significant changes in products and services like new product designs or packaging, new techniques and promotion and sales channels, new methods for positioning, or new methods for setting prices; expressed as a percentage of all private companies.

Aim: To assess the percentage of private firms who have collaborated with Category 1 intermediary organizations in order to introduce non-technological betterments.

Required data: Total number of private firms who have implemented non-technological betterments such as marketing or merchandizing

related innovations; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private firms who have implemented non-technological betterments such as marketing or merchandizing related innovations, into the total number of private firms in the region.

Interpretation: A higher percentage of private firms who have implemented non-technological betterments such as marketing or merchandizing related innovations, leads us assess the managerial commitment with the implementation of these betterments, which often demand for external collaboration with *"Category 1"* intermediary organizations.

Limitations: The indicator does not specify whether private firms that have implemented non-technological betterments have, either developed internal resources to produce new knowledge, or found it externally by collaborating with *"Category 1"* intermediary organizations.

INDICATOR C12: Private companies with a website and internet connection.

Source of information: INE (Survey on Information and Communication Technologies. Usage and e-commerce in companies– ETTICE- C.1.-C.6)

Period: 2011-2012

Definition: Private companies with a website and internet connection; expressed as a percentage of all private companies.

Aim: To assess the percentage of private firms who have collaborated with Category 1 intermediary organizations in order to develop a website and internet connection.

Required data: Total number of private companies with a website and internet connection; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies with a website and internet connection into the total number of private firms in the region.

Interpretation: A higher percentage of private firms with a website and internet connection, leads us assess the managerial commitment with the implementation of these betterments, which often demand for external collaboration with *"Category 1"* intermediary organizations.

Limitations: The indicator does not specify whether private firms with a website and internet connection developed internal resources to produce the website, or found them externally by collaborating with *"Category 1"* intermediary organizations.

INDICATOR C13: Private companies that have implemented non-technological innovation betterments: organizational innovations.

Source of information: INE (Innovation in companies´ survey – EI-10-I.1)

Period: 2008-2009

Definition: Private firms that have implemented non-technological betterments such as organizational innovations. These innovations can be particularly related to the introduction of significant improvements in work organization or company procedures, new methods of organizing

the workplace, or new methods of managing external relations, expressed as a percentage of total private companies.

Aim: To assess the percentage of private firms who have collaborated with Category 1 intermediary organizations in order to introduce non-technological betterments.

Required data: Total number of private firms who have implemented non-technological betterments such as organizational innovations; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private firms who have implemented non-technological betterments such as organizational innovations, into the total number of private firms in the region.

Interpretation: A higher percentage of private firms who have implemented non-technological betterments such as organizational innovations, leads us assess the managerial commitment with the implementation of these betterments, which often demand for external collaboration with *"Category 1"* intermediary organizations.

Limitations: The indicator does not specify whether private firms that have implemented non-technological betterments have, either developed internal resources to produce new knowledge, or found it externally by collaborating with *"Category 1"* intermediary organizations.

INTERMEDIARY ORGANIZATIONS: CATEGORY 2

Definition: *"Category 2"* assesses the presence of KIBS companies facilitating firms learn from others and develop antennas across exploitation subsystems.

Aim of the study: To assess the presence of *"Category 2"* intermediary organizations taping into *"Gaps 2"* system problems across knowledge exploitation subsystems of Spanish RISs.

INDICATOR C21: Private companies that have cooperated with joined or associated Spanish companies or other Spanish market sources in some of their innovating activities

Source of information: INE (Innovation in companies´ survey– EI-10-E.5.1.)

Period: 2008-2009

Definition: Private companies that have cooperated in some of their innovating activities with joined or associated Spanish companies or other Spanish market sources such as suppliers of equipment and materials, software and components, customers, competitors or other companies in the same branch of activity belonging to the *"knowledge exploitation subsystem"* of the Spanish regions; expressed as a percentage of total private companies.

Aim: To assess the percentage of private firms who have collaborated with Category 2 intermediary organizations in some of their innovating activities.

Required data: Total number of private companies that have cooperated with joined or associated Spanish companies or other Spanish market sources in some of their innovating activities; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies that have cooperated with joined or associated Spanish companies or other Spanish market sources in some of their innovating activities, into the total number of private firms in the region (Table i).

Interpretation: A higher percentage of private firms who have cooperated with joined or associated Spanish companies or other Spanish market sources in some of their innovating activities, leads us assess the managerial commitment with fostering external collaborations, which often demands for external help from *"Category 2"* intermediary organizations.

Quality standards: The data was disaggregated applying the criterion of regionalization with regards to the location of the headquarters of the firm. The latter implies that the resources of the firm are assigned to regions according to the location of its headquarters.

Limitations: The indicator does not specify whether private firms who have cooperated with joined or associated Spanish companies or other Spanish market sources in some of their innovating activities have done it by themselves or thanks to the help provided by *"Category 2"* intermediary organizations.

INDICATOR C22: Private companies that have cooperated with joined or associated international companies or other international market sources in some of their innovating activities

Source of information: INE (Innovation in companies´ survey– EI-10-E.5.1.)

Period: 2008-2009

Definition: Private companies that have cooperated in some of their innovating activities with joined or associated international companies or other international market sources such as suppliers of equipment and materials, software and components, customers, competitors or other companies in the same branch of activity belonging to

international *"knowledge exploitation subsystems"*; expressed as a percentage of total private companies.

Aim: To assess the percentage of private firms who have collaborated with *"Category 2"* intermediary organizations in some of their innovating activities.

Required data: Total number of private companies that have cooperated with joined or associated international companies or other international market sources in some of their innovating activities; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies that have cooperated with joined or associated international companies or other international market sources in some of their innovating activities, into the total number of private firms in the region (Table i).

Interpretation: A higher percentage of private firms who have cooperated with joined or associated international companies or other international market sources in some of their innovating activities, leads us assess the managerial commitment with fostering external collaborations, which often demands for external help from *"Category 2"* intermediary organizations.

Quality standards: The data was disaggregated applying the criterion of regionalization with regards to the location of the headquarters of the firm. The latter implies that the resources of the firm are assigned to regions according to the location of its headquarters.

Limitations: The indicator does not specify whether private firms who have cooperated with joined or associated international companies or other international market sources in some of their innovating activities

have done it by themselves or thanks to the help provided by *"Category 2"* intermediary organizations.

INTERMEDIARY ORGANIZATIONS: CATEGORY 3

Definition: *"Category 3"* analyzes the presence TTAs, technical advisory groups, business and trade associations (...) facilitating firms incorporate technological options and adapt state-of-the-art to their own situation.

Aim of the study: To assess the presence of *"Category 3"* intermediary organizations taping into *"Gaps 3"* system problems between "*knowledge exploration" and "knowledge exploitation subsystems"* of Spanish RISs.

INDICATOR C31: Private companies located in science and technological parks

Source of data: INE (Innovation in companies´ survey– EI-10-A.6.)

Period: 2008-2009

Definition: Private companies located in science and technology parks together with other public or private organizations and/or institutions close to their corresponding knowledge frontier; expressed as a percentage of total private companies.

Aim: To assess the percentage of private firms who deliberately chose to locate in placements that facilitate external economies such as knowledge spillovers emanating from *"Category 3"* intermediary organizations which usually locate their headquarters in science and technology parks.

Required data: Total number of private companies located in science and technology parks; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies located in science and technology parks, into the total number of private firms in the region.

Interpretation: A higher number of private companies located in science and technology parks, leads us assess the managerial interest to locate their headquarters close to *"Category 3"* intermediary organizations. One of the main functions of these organizations such as trade associations, R&D companies, university science parks and the like, is to tap into *"Gaps 3"* across RISs.

Limitations: The mere location does not imply the use of the possibilities offered by scientific or technological parks. Some companies might locate in these parks just to improve their social image or other unrelated factors.

INDICATOR C32: Private companies that contracted R&D services to organizations and institutions belonging to Spanish *"knowledge exploration subsystems"*

Source of information: INE (Innovation in companies´ survey– EI-10-C)

Period: 2008-2010

Definition: Percentage of private companies that contracted R&D services to organizations and institutions belonging to Spanish *"knowledge exploration subsystems"*, such as universities, PAB, research organizations and technology centers, and /or private nonprofit organizations.

Aim: To assess the percentage of private firms that contracted R&D services to *"Category 3"* intermediary organizations.

Required data: Total number of private companies that contracted R&D services to organizations and institutions belonging to Spanish *"knowledge exploration subsystems"*; and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies that contracted R&D services to organizations and institutions belonging to Spanish *"knowledge exploration subsystems"*, into the total number of private firms in the region.

Interpretation: A higher number of private companies that contracted R&D services to organizations and institutions belonging to Spanish *"knowledge exploration subsystems",* leads us to assess the presence of *"Category 3"* intermediary organizations smoothing and facilitating the connection con collaboration between *"knowledge exploration"* and *"knowledge exploitation subsystems".*

Limitations: The aggregation procedure of the EI-10 questionnaire does not permit to collect individual information on organizations that –following our literature strand- are included in the knowledge exploration subsystem. Besides, the current indicator does not provide information on the quality of the interactions and transactions between these organizations and the firms. The latter could only represent their mutual interest to access, for example, public grants that demand collaboration agreements. The indicator does neither provide information about the location of these *–knowledge exploration subsystem*- sources, which can be found at different regional or national levels.

INDICATOR C33: Private companies that have cooperated with sources belonging to Spanish *"knowledge exploration subsystems"* in some of their innovating activities

Source of information: INE (Innovation in companies´ survey– EI-10-E.5.1)

Period: 2008-2010

Definition: Percentage of private companies that have cooperated with sources belonging to Spanish *"knowledge exploration subsystems"* such as universities, PAB, research organizations and technology centers belonging to knowledge exploration subsystems; in some of their innovating activities.

Aim: To assess the percentage of private companies who have cooperated with *"Category 3"* organizations.

Required data: Number of private companies that have cooperated with sources belonging to Spanish *"knowledge exploration subsystems";* and total number of private firms in the region (Table i).

Calculation procedure: We divide the total number of private companies that have cooperated with sources belonging to Spanish *"knowledge exploration subsystems"* into the total number of private firms in the region.

Interpretation: A higher number of private companies that have cooperated with sources belonging to Spanish *"knowledge exploration subsystems"*, leads us to assess the presence of *"Category 3"* intermediary organizations smoothing and facilitating the connection con collaboration between knowledge exploration and exploitation subsystems.

Quality standards: The data was disaggregated applying the criterion of regionalization with regards to the location of the headquarters of the firm. The latter implies that the resources of the firm are assigned to regions according to the location of its headquarters.

Limitations: The aggregation procedure of the EI-10 questionnaire does not permit to collect individual information on organizations that –following our literature strand- are included in the *"knowledge exploration subsystem"*. Besides, the current indicator does not provide information on the quality of the interactions and transactions between these organizations and the firms. The latter could only represent their mutual interest to access, for example, public grants that demand collaboration agreements. The indicator does neither provide information about the location of these *–knowledge exploration subsystem*- sources, which can be found at different regional or national levels.

INTERMEDIARY ORGANIZATIONS: CATEGORY 4

Definition: *"Category 4"* analyzes the presence of venture capitalists or BAs facilitating firms overcome financial difficulties of RISs.

Aim of the study: To assess the presence of *"Category 4"* intermediary organizations taping into *"Gaps 4"* system problems between *"knowledge exploitation"* and *"regional policy subsystems"* of RISs.

INDICATOR C41: Public loans addressing private companies´ innovative activity

Source of information: INE (Innovation in companies´ survey – EI-10-D.3).

Period: 2010

Definition: Total amount of public financial resources (loans) received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels.

Aim: To assess the presence of *"Category 4"* intermediary organizations dedicated to the improvement of the financial possibilities of private sectors across regions.

Required data: Total amount of public financial resources (loans) received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels; and the population of the regions (Table ii).

Calculation procedure: We divide the total amount of public financial resources (loans) received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels, into the population of the regions. We multiply the result by 1000. We get the total amount of public financial resources (loans) received by private firms per one thousand inhabitants of the region.

Interpretation: We employ the total amount of public financial resources (loans) received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels, as a proxy to assess the presence of *"Category 4"* intermediary organizations facilitating the access to credit.

Limitations: The indicator does not permit disaggregation (region, state, international) so as to know the origin of the loans. This information could be very interesting in order to understand the real investment regions incur to support their firms.

INDICATOR C42: Public subsidies addressing private companies´ innovative activity.

Source of information: INE (Innovation in companies´ survey – EI-10-D.3).

Period: 2010

Definition: Total amount of public subsidies received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels.

Aim: To assess the presence of *"Category 4"* intermediary organizations dedicated to the improvement of the financial possibilities of private sectors across regions.

Required data: Total amount of public subsidies received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels; and the population of the regions (Table ii).

Calculation procedure: We divide the total amount of public subsidies received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels, into the population of the regions. We multiply the result by 1000. We get the total amount of public subsidies received by private firms per one thousand inhabitants of the region.

Interpretation: We employ the total amount of public subsidies received by private firms destined to innovation activities, rooted on local, regional, state and/or international administration levels, as a proxy to assess the presence of *"Category 4"* intermediary organizations facilitating the access to subsidies.

Limitations: The indicator does not permit disaggregation (region, state, international) so as to know the origin of the subsidies. This information could be very interesting in order to understand the real investment regions incur to support their firms.

INDICATOR C43: Total venture capital operations.

Source of information: Spanish Venture Capital Association (ASCRI)

Period: 2005-2011

Definition: Total number of operations performed by venture capitalists across Spanish regions; expressed in total number per hundred thousand of regional inhabitants.

Aim: To assess the degree of involvement of *"Category 4"* intermediary organizations across regions.

Required data: Total number of operations that have been performed by venture capitalists, and the regional population (Table ii).

Calculation procedure: We divide the total number of operations performed by venture capitalists across Spanish regions, into the regional population. We multiply the result by one hundred thousand. We get the total number of operations performed by venture capitalists per one hundred thousand regional inhabitants.

Interpretation: A higher number of operations is employed as a proxy to explicate the presence and the involvement of "Category 4" intermediary organizations taping into *"Gaps 4"* across RISs.

Limitations: The indicator does not permit to acknowledge the performance of several *"Category 4"* intermediary organizations that also tap into *"Gaps 4"* such as Banks or BAs.

SUPPLEMENTARY INDICATORS

INDICATOR AGR: Employed population by branch of activity, sex and AC: Agriculture

Source of information: INE (Survey on Adult Population Involvement in Learning Activities – EPA-12)

Period: 2012

Aim: To assess the agricultural employee´s share across regions.

Required data: Total number of agricultural employees; and regionalized working population (Table iv).

Calculation procedure: We divide the total number of agricultural employees into the regionalized working population. We get the relative importance of agricultural employees compared to the total working population of the region.

Interpretation: A higher relative importance of agriculture should predict lower economic development output and lower integration.

INDICATOR IND: Employed population by branch of activity, sex and ACven: Industry

Source of data: INE (Survey on Adult Population Involvement in Learning Activities– EPA-12).

Period: 2012

Aim: To assess the industrial employee´s share across regions.

Required data: Total number of industrial employees; and regionalized working population (Table iv).

Calculation procedure: We divide the total number of industrial employees into the regionalized working population. We get the relative importance of industrial employees compared to the total working population of the region.

Interpretation: A higher relative importance of industry should predict higher economic development output and higher integration.

INDICATOR SERV: Employed population by branch of activity, sex and AC: Services.

Source of data: INE (Survey on Adult Population Involvement in Learning Activities– EPA-12).

Period: 2012

Aim: To assess the service sector employee´s share across regions.

Required data: Total number of service sector employees; and regionalized working population (Table iv).

Calculation procedure: We divide the total number of service sector employees into the regionalized working population. We get the relative importance of service sector employees compared to the total working population of the region.

Interpretation: A higher relative importance of the service sector should predict higher economic development output and higher integration.

TABLES

Table i Total number of private firms with 10 or more employees (2008-2010)	
Andalusia	24.343
Aragon	5.169
Asturias	3.277
Balear Islands	4.476
Canary Islands	6.819
Cantabria	2.022
Castile Leon	7.602
Castile La Mancha	6.508
Catalonia	32.108
Valencia	17.782
Extremadura	2.870
Galicia	9.467
Madrid	26.716
Murcia	5.614
Navarre	2.869
Basque Country	9.212
La Rioja	1.497
Source: Spanish Official Statistical Institute (INE)	

Table ii: Regional population (2012)	
Andalusia	8.302.923
Aragon	1.345.473
Asturias	1.085.289
Balear Islands	1.095.426
Canary Islands	2.103.992
Cantabria	589.235
Castile Leon	2.563.521
Castile La Mancha	2.081.313
Catalonia	7.475.420
Valencia	5.094.675
Extremadura	1.102.410
Galicia	2.796.089
Madrid	6.386.932
Murcia	1.446.520
Navarre	630.578
Basque Country	2.172.175
La Rioja	321.702
Source: Spanish Official Statistical Institute (INE)	

Table iii: Medium and high-tech sectors	
CNAE 2009 SECTORS	
High technology manufacturing sectors	
21	Manufacture of pharmaceutical products
26	Manufacture of computer, electronic and optical products
30.3	Manufacture of aircraft and spacecraft and machinery thereof
Medium-high technology manufacturing sectors	
20	Chemical industry
25.4	Manufacture of weapons and ammunition
27 A 29	Manufacture of electrical material and equipment; Manufacture of machinery and equipment n.e.c84.; Manufacture of motor vehicles, trailers and semi-trailers
30-30.1-30.3	Manufacture of other transport equipment, except: naval construction; aircraft and spacecraft construction and machinery thereof
32.5	Manufacture of medical and dental instruments and supplies
High technology or state-of-the-art services	
59 a 63	Motion picture, video and television programme activities, sound recording and music publishing; Radio and television programming and broadcasting activities; Telecommunications; Programming, consultancy and other activities related to IT; Information services
72	Research and Development
Source: Spanish Official Statistical Institute (INE)	

[84] *Not elsewhere classified*

Table iv: Regionalized working population (2012)	
Andalusia	2.627.800
Aragon	533.700
Asturias	376.200
Balear Islands	464.700
Canary Islands	750.900
Cantabria	229.200
Castile Leon	943.300
Castile La Mancha	710.900
Catalonia	2889.200
Valencia	1804.600
Extremadura	336.200
Galicia	1039.400
Madrid	2741.100
Murcia	535.200
Navarre	258.500
Basque Country	875.300
Rioja, La	121.600
Source: Spanish Official Statistical Institute (INE)	

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The Role of Intermediaries in Solving System Problems in RISs

Competitiveness builds across the boundaries of Innovation System´s components, innovation-relevant organizations and entrepreneurs. Accordingly, the System Innovation stream of economics claims interaction to be a central feature of integrated systems. However, the latter characteristic does seldom occur automatically, denoting the existence of various problems that curtail development potentials. Importantly, problems constitute opportunities for the intermediary outlook. Intermediary organizations encompass an increasing role in overcoming them while they facilitate knowledge interchange among dissimilar organizations and institutions. Still, the literature does not adequately recognize the great influence intermediaries have on the connectivity of innovation environments.

The dissertation produces a methodology set out to assess potential system problems as well as the association between these problems and the existence -or absence- of specialized intermediary organizations. The so-called “human resource gaps”, “openness and learning gaps”, “technological gaps” and “financial gaps” are identified within a logical examination. Second, the dissertation categorizes intermediaries according to the specific system problems they tap into. This clear-cut sorting produces “pairs” between system problems and intermediary categories, while it nurtures simplicity and precision in the functional and structural definition of the latter. Besides, the existence of commonalities in the purpose and activity performed by the categories suggests the possibility to arrange them in a common framework. These categories will also be aggregated in a new “Associative Component” which will be projected as a central –piloting- new subsystem of Innovation Systems.

Multivariate techniques lead us to the presentation of typologies. The first one sorts systems according to their level of integration. The second arranges them according to the relational density levels of their “Associative Components”. We also explore relationships among these typologies. Our statistical output proves that the relational density of the “Associative Component” could be a valid predictor to explain integration across Spanish regions (i.e. Navarre, Basque Country, Catalonia or Madrid). On the other hand, we also find that inactive or inexistent “Associative Components” come together with disintegrated Regional Innovation Systems (i.e. Andalusia, Extremadura, Murcia).