Innovation for Sustainability and Networking

Editors
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PART ONE:
THEORETICAL FRAMING

Regarding innovation and change

Teresa de Noronha

Change for Development

Throughout human history, innovation has been the main factor in adapting humanity to its settings. On the basis of earlier practice, human creativity allows the finding of new, permanent ways to do things. Their applications encourage new spaces, new necessities and new lifestyles. Innovation has been an element of human capacities from its earlier stages, but it has been recognized only recently as a clear device of social and economic change. Schumpeter (1934; 1954), Freeman (1987), and Fagerberg (2003) are among the most important contributors to this view. Following their works, diversified groups of academic studies appeared, giving rise to different positions and concepts including some that have been classified as "fuzzy" (Markusen, 1999) due to a lack of focus; this is a frequent characteristic of emerging scientific areas.

The long-term economic change, defined by Schumpeter as development, was initially explained in the Marx-Schumpeter model as a result of a need for more competition in a capitalistic economy. New combinations of resources and knowledge should encourage a positive effect on business opportunities and define permanent change. Whether or not permanent change is always possible is, however, a different theoretical issue. Frequently, the existence of specific organizational patterns interferes with the abilities of institutions to undergo the required adjustments, in spite of innovative performances and new opportunities. Such slowness in the process of growth may be classified as hindrances (Perez, 1983) to the continuous process of change.

One of the methods to induce the process of change is to contemplate the continuous production of new products or processes that are adapting at the same time as society is absorbing them. This represents a very accurate attempt to combine knowledge and consumption in an interactive model for innovation that imposes the coordination capacity of the organizations to manage the knowledge assets. It comes as no surprise that several authors such as Hall (2004) and Lundvall (1988, 1992, 1994) have pointed out the trade-off between technology and organizations as an additional research subject with consequences on the analyses of the diffusion of new technologies; they have also noted proposals for public policies for development and innovation. Others referred to the particulars of the overall dynamics of technological change, sustaining the continuity of the underlying process (Antonelli and Calderini, 1999).

Innovation and Knowledge

Much work has been done by Posner (1961), Krugmann (1979), and Fagerberg (1988, 2003, 2004) to prove that, for analyses at a cross-country level, the presence or lack of innovation

may "affect differential growth rates". An imitative or innovative *modus operandi* may explain different levels of development among countries or regions, the so-called technology gap or even the north-south asymmetry. Thus, Schumpeter's concern with the tendency of innovations to cluster, in spite of the closed link between innovation and economic growth, implies that its use as an instrument for public policy, in view of fast development, may have to be given more detailed attention.

Fagerberg (2004) offers a complete revision of the scientific work related to innovation and structural change and suggests promising directions for further research related to the topic. Using his work, it may be helpful to discuss some of the epistemological limitations of this field and the most generally accepted findings:

- Cross-disciplinary: no single discipline deals with all aspects of innovation.
- Undetermined causality: a lot of what happens in innovation has to do with learning, and learning is a cognitive science.
- Path dependency: due to uncertainty, chosen innovative paths may lead to cost disadvantages that would not have occurred at a different moment in time.
- Pluralistic-leadership: the need for flexibility to accept the application of different ideas and managerial solutions.
- Systemic approach: innovation takes place in open environments and simultaneously affects multiple and transversal relationships.

Starting off with the works of Penrose (1959) and Wernerfelt (1984), the drivers of innovation may be better perceived from the resource-based view of the firm and accepting their heterogeneous character. The approach takes the firm as a unit of analysis and studies its resources and capabilities in order to understand the firm's strategic behaviour (Knudsen, 1995). In this context, knowledge is recognized as a key resource for firms and other economic agents, and both codified knowledge and tacit knowledge are pertinent aspects for innovativeness.

Although the first studies on knowledge assets focused on the firm's own codified knowledge with particular emphasis on its internal R&D capacities, researchers now accept the major role of external sources of knowledge in the capabilities of firms to innovate (Albino *et al.*, 1999; Nooteboom, 1999). The recent contributions from Lester (2005, 2006) and Lester and Piore (2004) emphasized the role of universities in the competitiveness of local economies, thereby proposing the concept of local innovation systems.

Networks of Innovation

The emphasis on the geographical localization of the innovation factors started to become the core of discussions at a much earlier time. In his many works, Camagni (1991) started to investigate the special perspective of innovation networks.

Today, discussion continues as to whether the co-operation between research institutes and industrial firms enhances innovation or are of minor importance, as defended by Diederen *et al.* (2000). In any case, it seems to be commonly agreed that the impact of co-operation with research institutes is sector-related. In general, high tech firms tend to co-operate more often with research institutes compared to firms producing in low technology areas.

Additionally, some authors have stressed the key role of the city (Acs, 2002) or, more specifically, of the need for good communication between industry and research institutes for the successful transfer of technological knowledge (Kaiser, 2002). The lack of such factors could, at least partly, explain why low technology firms tend to be less innovative.

Indeed, the strategic choice of low tech firms regarding innovation is highly influenced by vertical co-operation with suppliers and customers. Frequently, in such cases, the development of new products or processes considers the new demands as well as the market changes as the foremost factors.

Moreover, when uncovering firms' attitudes towards the absorption of codified knowledge, it is important to underline that firms rely on the lessons from the success and failure of similar companies to improve their own strategic decisions. This is particularly true if, due to their small size, they lack the means to carry out exhaustive cost benefit analyses and cannot pay for innovations with high-risk profiles (Senker and Faulker, 2001). A major input for this discussion is also the measurability of the spillover effects of innovation, introduced by Fischer and Johansson back in 1993. A few years later, Geenhuizen and Nijkamp (1997) detected spatial variations in the process of innovation, related to a spatial differentiation in the receptivity of firms for new technologies, that were partly explained by organizational and strategic distances between actors. In this same direction, Cooke *et al.* (1998) based their new contribution on policy making, the regional systems of innovation and their institutional and organizational dimensions. Much of the continuity of this contribution was due to Asheim *et al.* (2009) by their study of the implications of knowledge flows, entrepreneurship and innovation for regional development, although Zahra and George (2002) had already elucidated the complexity of the factors for absorptive capacity.

After Nelson and Winter (1982), the first discussions were held on the particularities of tacit knowledge. Following Nightingale (1998) and Kaiser (2002), tacit knowledge was a less mobile resource derived from history (Wright, 1997), lifetime experience, practice, perception and learning. Many other contributions have proved its importance as a component of the innovation process (Nonaka and Takeuchi, 1995; Nonaka *et al.*, 2000). This has also been confirmed in the case of small or low-tech firms by Le Bars *et al.* (1998).

Creativity and Innovation

As knowledge becomes the most important resource for firms and organizations, and learning is its most important process (Lundvall and Johnson, 1994), sustainable growth depends on how knowledge creation is geographically taking place, how its use is occurring and, finally, how efficient its impact is across the space.

Porter (1998) explained how the location of sets of repeated companies could create clusters, promote advantages and new economics of competition and define clear patterns of innovation that seem to be possible to identify, quantify and design as pointed out in Noronha Vaz *et al.* (2006), Noronha Vaz and Nijkamp (2009) and Noronha Vaz *et al.* (2013).

As we advance further in this book, we justify the primary roots of innovation and knowledge in creativity. At times, creativity may occur or be hindered within organizations, either facilitating or blocking the innovation process. Therefore, we consider that a major component of this research is the understanding of creativity in the organizational process.

Creativity has been defined as the capability to generate something which is both innovative (original and unexpected) and useful. In this sense, creativity is conceived as a human skill and is highly individual. However, creativity can also be defined from a macro perspective and a more organizational one. Wallas (1926) was one of the first authors to work on the creativity concept and proposed four stages in the creativity process: preparation, incubation, illumination, and verification.

At an organizational level, authors studying creativity are concerned not only with the set of factors which facilitate, promote, or hinder the emergence of new ideas in the company but also with the creativity process within the organization. One of the most prominent authors working in the area has been Amabile (1996). In one of the most recent revisions of her model (Amabile, 1996), she proposes a combination of variables which influence organizational creativity; these variables include individual (cognitive characteristics, personality, motivation, and knowledge), group (cohesion, group size, leadership and diversity) and organizational (cultural influence, resource availability, mission and strategy, compensation policies, and structure and technology). Therefore, it is particularly interesting to understand how organizations foster or hinder climates of creativity when they are part of large innovation networks. In this direction, the works by Richard Florida (2004) are noteworthy.

The link between creativity and innovation has been somehow exploited in the literature, but less research has been conducted at a macro level of analysis, one which goes beyond organizational boundaries and tries to understand how creativity and innovation are bound together across territories.

Most of the work presented in this volume resulted from research developed in the context of the project PTDC/CS-GEO/102961/2008, financed by the Portuguese Foundation for Science and Technology. Some results have already been submitted for publication to international journals. However, the intent of joining these results together represents without a doubt a step forward to better understand the dynamics of innovation taking place in Portugal. Also, the theoretical contributions framing this book advance important and novel methods to model and quantify networking systems of innovation.

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The universal law of gravitation and the death of distance

Peter Nijkamp

Newton and Social Science

Novel scientific insights into the mechanism and dynamics of our world have often been induced by seemingly simple discoveries. In this thrilling book '*The Great Equations'*, the author Robert P. Crease (2008) offers a fascinating record of universal equations that have decisively influenced the history of science. He mentions inter alia the equations ascribed to – or developed by - Pythagoras, Newton, Euler, Maxwell, Einstein, Schrödinger and Heisenberg.

Newton's *Law of Universal Gravitation*, sometimes coined the 'high point of the scientific revolution', is as simple as it can be in its pure form. It stipulates that gravity is a universal force among all bodies, while the gravitational strength between two bodies depends directly on their masses and inversely on the square of the distance between their centers. This law was not invented overnight; it took Newton almost four years (1684-1687) to conceptualize it as a full-proof truth in the form of a single mathematical equation.

The idea that all objects attract each other with a force that is proportional to the product of their masses and inversely proportional to their squared distance has been a center piece in the development of physics and astronomy; it brought more or less together terrestrial physics and celestial physics.

Clearly, Newton's law has decisively influenced the scientific progress in the natural sciences. However, there has been an ongoing complementary strand of literature in the social sciences, called *social physics*, which has also boosted a great popularity of the gravitational law in spatial interaction phenomena. In particular, in such disciplines as economics (e.g., international trade), demography (e.g., migration behaviour), transportation science (e.g., travel behaviour), geography (e.g., spatial allocation) or regional science (e.g., commuting), a great many conceptual and empirical studies on spatial interaction have been published. The present chapter has two aims: (i) to provide a concise overview of some prominent and interesting applications of gravity theory in the social sciences ('*social physics'*), and (ii) to critically review the arguments that in a digital '*death of distance*' the Newtonian gravitational principle would no longer hold. We arrive at the conclusion that gravitational principles are likely to be valid also in a virtual reality, albeit in a modified way.

Newton in a Social Science Perspective

Newtonian physics was based on the identification of laws in a material world. But the space-economy is a mix of tangible and physical regions and often intangible human-behavioural

constellations. The spatial economy is not a result of a random nor of a deterministic process, but emerges out of rational decisions and interactions of a multiplicity of actors. For example, the rise of large industrial concentrations near accessible places and the growth in international trade of industrial goods are not separate developments, but two interlinked factors. The structure of the spatial economy may seemingly look rather complex, but has at the same time a deep underlying economic foundation. This can be exemplified by referring to the work of one of the founding fathers of structured land use analysis, Johann Heinrich von Thünen, who was able to combine locational market advantages with transport and production in order to derive a consistent relationship between land rent and a hierarchical ordering of industrial activities in geographical space.

The spatial economy does not only have a rational structure, but also a systematically organized interaction and flow system (transport, mobility, trade, telecommunications). The conceptual basis for a systematic analysis of spatial interactions in relation to centres of human activity and distance friction costs stems from Newtonian gravity theory. This theory has served as a conceptual and analytical framework for many flow analyses in the social and spatial sciences, e.g. in the analysis of migration, trade, tourism, and commuting flows. It has become a mainstream toolkit in regional and urban economics, in economic geography, and in trade and transport economics. A thorough analysis of the underlying principles of Newton's gravity concept reveals that the application of this concept to spatial interactions and flows is supported by two principles, viz. agglomeration advantages and distance friction costs. Consequently, the use of gravitational principles in quantitative spatial interaction analysis can be justified on theoretical-economic grounds (the so-called '*social physics*') (see also Nijkamp and Reggiani 1988).

It is not a widely known fact that one of the earliest fathers of '*social physics*' was a Polish scholar, Benon Janowski. In 1908 in Cracow, he published (in Polish) an important book, *On Distances as a Factor of Cultural Development. A Socio-natural Study.* After a hundred years this work has recently been translated into English, finally becoming available to an international audience (see Janowski 2013).

The permanent popularity of the gravity principle in the spatial sciences has also prompted the recognition of a hierarchical structure in the organization of space. This is not only reflected in central place theory à la Christaller or Lösch, but also in subsequent statistical regularities known as the Zipf law and its companion, the Gibrat law. Both laws have been the subject of intensive quantitative research in the past decade and have highlighted the existence of hierarchical systems in spatial economics and in industrial organization (see also Reggiani and Nijkamp 2013).

Another new trend which is noteworthy in the context of spatial interaction phenomena is the emergence of the digital world. This phenomenon has led to many speculative remarks on the future of the spatial economy, such as the '*death of distance*' hypothesis. In reality however, ICT development has not yet led to the disappearance of the importance of space; the digital world is for the time being not a substitute for the material world, but reinforces existing physical patterns determined by cost frictions. Consequently, agglomeration formation and physical transport patterns have not yet shown a decline nor a fundamental shift. And it remains to be seen whether this will ever happen in the future. This intriguing phenomenon will be further discussed in Section 3.

There has been an ongoing debate over the past decade whether regional development is the result of autonomous forces which through centripetal and centrifugal impacts – in relation to size, scale and distance factors – determine the fate of a region (or system of regions), or whether regions are man-made geographical entities which through smart behaviour, self-organizing talents and effective policy interventions can decide on their actual and future fate.

In the recent literature we observe an increasing interest in the analysis of complex systems at the interface of Newton's principles and socio-behavioural systems. An interesting example is found in '*econophysics*'. This methodological approach deals with complex systems where properties cannot simply be derived and predicted from the knowledge of initial states of these systems (see Schinckus 2013). This approach follows earlier new advances advocated by Stanley *et al.* (1996), in which physical science principles are brought in the domain of economics (e.g. financial systems). Agent-based models are to some extent based on such principles.

Clearly, in reality the regional force field has proven to be a mix of human action and exogenous physical forces. Physical distance plays no doubt an important role in material flows, but the smart use of interregional networks – through the use of intelligent logistics and spatial connectivity linkages – may mitigate the traditional barriers imposed by physical and geographical distances. And consequently, digital distance mechanisms become increasingly important, such as electronic orders (e.g., call centres), or advanced business services (e.g., electronic mail). If electronic technology assumes such an important place, the question arises what the impacts will be on trade or transport or – in a more extreme case – whether the friction role of physical distance will vanish in a virtual reality.

Isaac Newton versus Waldo Tobler

The universal gravitational principle holds for the material world. This was clearly articulated by Newton when the stated: "It is inconceivable that inanimate Matter should, …, *without the Mediation of Something else, which is not material*, operate upon and affect other matter without mutual Contact" (Isaac Newton, *Letters to Bentley*, 1692/93). Consequently, he drew the inevitable conclusion: "Gravity must be caused by an Agent acting constantly according to certain laws".

Newton's gravitational principle has laid the foundation for spatial interaction and spatial gravity models. The first application of the gravity model to population flows dates back to Ravenstein (1885). In the post WWII period many gravity model applications were made, amongst others by Isard (1960), Tinbergen (1962), and Linnemann (1966), in particular in the context of transport and trade studies.

It is noteworthy that in the 1970's, when gravity principles found their first entry into the social sciences – and in particular, the spatial sciences – a law was formulated by Tobler (1970), which had a great resemblance to Newton's gravitational principle and was sometimes even based on an almost identical formulation. This so-called '*First Law of Geography*' was specified as follows: "*Everything is related to everything else, but near things are more related than distant things*". This law is clearly broader than Newton's law, namely in two respects: (i) it is not taking for granted an inverse squared distance effect, but a much more general distance friction; (ii) it

talks about 'everything', and not only about matter, so that also ideas, concepts or knowledge are encapsulated by this law. Especially the latter element is important in the context of our subsequent treatment of the digital world.

A new strand of literature can be found in the class of entropy models (see e.g. Wilson 1970), in which entropy principles were combined with distance frictions phenomena into the class of spatial interaction models. These models were mainly meso-macro in nature and depicted mainly systemic regularities, that were compatible with Newton's Law.

Another class of models closely linked to spatial interaction models is formed by discrete choice models (or random utility models), which were mainly based on micro-behavioural principles in space (see Tversky and Kahneman 1980). These models gained much popularity over the past decades, and laid the foundation for logit and probit analysis. Reggiani and Nijkamp (1988) were able to demonstrate the behavioural economic equivalence of gravity models, entropy models and discrete choice models.

More recently, Krugman (1995) argued that these spatial interaction concepts might be cast in the context of two main factors, namely agglomeration phenomena (masses in the Newtonian sense) and distance frictions costs. It is noteworthy that it seemed as though around the turn of century the class of spatial interaction models had reached a stage of maturity, leaving less scope for further innovative thinking. But then a challenging proposition was made by Cairncross (1997), when he formulated '*the death of distance*' hypothesis. This was a straightforward challenge to the validity of gravitation principles in a digital world. This will be further discussed in Section 4.

The Validity of the Gravity Law in a Digital World

The validity of the universal 'principle of locality' in physical space à la Newton may be questioned from the perspective of digital connectivity in virtual space. A seminal contribution to this issue has been provided by Castells (1996), who introduced the so-called '*space of flows*'. This notion has prompted new concepts, viz. '*virtual geography*' (see Batty 1997) in which a distribution was made between cyberspace and cyberplace, and '*internet geography*' (or '*cybergeography*' (see Gorman and Malecki 2000), which stipulates that also the Internet is not a homogeneous system with an equal spread or access around geographical space. Kitchin (1998a, 1998b) has argued in this context that the cyberspace depends on real world's fixities found in a concrete cyberplace. A review of the literature in this field can be found in Tranos and Nijkamp (2013), while a thorough treatment of this issue can be found in Tranos (2013).

The research on cybernetworks has centred on two flight paths, viz. (i) exploratory research on the complex nature of digital communication networks, with a particular view to the impact of distance factors (Reggiani *et al.* 2010; Tranos 2011), and (ii) explanatory research on the impact of physical distance – and broader relational proximities – on the formation of cyberspace in the context of gravity models à la Newton (see Barabasi 2012). Much of this recent research is undertaken in the spirit of the '*new network science*', with a focus on large-scale real-world networks and their universal, structural and statistical properties (see e.g. Albert and Barabasi 2002, Newman 2003, and Watts 2004).

The above described two-step procedure has been extensively experimented and tested by Tranos and Nijkamp (2013) by investigating the traceroutes of the overall Internet use on the basis of inter-city digital (IP) links during the period 2005-2008. The results on the nodes degree distribution of the Internet offer interesting pictures of a power law distribution for the most connected nodes of the IP network, and an exponential law for the least connected nodes, while also a Tanner function has been tested. This result is largely in agreement with general – physically-based – networks in geography (see Reggiani and Nijkamp 2013).

The next – explanatory – step in the analysis of Tranos and Nijkamp (2013) specifies a Newtonian distance-decay model, complemented with various types of relational proximities (see Boschma 2004, and Torre and Gilly 2000). The analysis of these proximity impacts on cyberplaces is based on cognitive, organizational and institutional proximity indicators, as well as on Newtonian mass variables (e.g. population). On the basis of a panel-data random effects model, the authors come to the conclusion that in all cases the Newtonian distance friction effects and the population masses play a major role. In addition, various proximity indicators play a role as well. The IP connectivity appears to be higher between neighbouring regions in terms of physical, technological, organizational and institutional distance.

Although the digital communication patterns are not necessarily subjected to Newton's universal gravitational principle in a physical world, it turns out that in practice they follow a similar principle. Consequently, it turns out that Tobler's '*First Law in Geography*' – referring to everything, and not only to physical matter – has a validity in a digital world. Thus, this generalized Newton principle reflects most likely a universal pattern In conclusion, we may conclude, that in a digital world Newton is likely right, but Tobler is more right.

Is the Digital World a Flat World?

Our planet is full of high- and low-density settlement patterns and industrial agglomerations. IP links more or less mirror this pattern, even though technically the Internet world might be completely flat. But in the real world there are apparently centripetal forces that lead to a spatial concentration of IP links in specific locations, which act as magnets of a digital infrastructure. Similarly, there are also centrifugal forces that serve less connected regions and hence provide a base level of connectivity for dispersed locations. Apparently, as result of agglomeration benefits, core-periphery patterns can be identified in the global digital connectivity patterns.

In an interesting article by Rietveld and Vickerman (2004), the authors argue that the hypothesis of the '*death of distance*' is premature. They mention several reasons: (i) the assumption of travel as an inconvenience to be minimized may be false; (ii) increasing real incomes have induced a heterogeneous preference for the range of goods consumed and the range of activities undertaken; (iii) there is a long-range simultaneous optimality of a range of locations which is much wider than a traditional residential-workplace choice. Thus, the digital world has to be positioned in a much wider behavioural context (Hayes 1997; Tranos 2011).

The above observations prompt the question whether the ICT introduction has seriously affected the geographical-economic landscape (see Dreier *et al.* 2005). Several studies have shown the remarkable stability of geographical settlement patterns. On the one hand, there is

an avalanche of literature on optimal city size (see Alonso 1971), while on the other hand there is an abundant strand of literature on scale and agglomeration advantages using total production factor analysis and data envelopment analysis (see Kourtit *et al.* 2013).

As mentioned above, the emergence of the digital world has prompted the challenging question whether near-to-zero distance friction costs would create a world with the '*death of distance*' (Cairncross 1997). This was further highlighted in a book by Friedman (2005) on '*The World is Flat'*, where traditional disparities in terms of densities on wealth or income may vanish. This has led to an interesting debate in the literature whether the world is 'flat' or 'spiky' (see McCann 2008).

The general conclusion from the recent literature on 'spiky worlds' is that there is a great deal of heterogeneity in the socio-economic geographic landscape of our world, that is not reduced by ICT access and use, but is sometimes reinforced by the unequal spatial benefits emerging from the digital world. Thus, our conclusions is warranted that there is not sufficient evidence for the hypothesis that in a digital world location and distance do not matter. Instead, in the spirit of Tobler's '*First Law of Geography*' it seems plausible that in a digital space-economy location and distance matter more than ever before.

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PART TWO:
THE INNOVATION SCENE IN PORTUGAL

Innovation system efficiency and institutional change in Portugal: The emergence of new policies, actors and behaviours for innovation networks

Hugo Pinto

Introduction

Science, technology and innovation are suffering important changes in the contemporary world. The role of scientific knowledge, for centuries bounded in the limits of university's ivory towers, is seen as a crucial asset for the competitiveness of companies and, in this way, connected to the development of countries.

The importance of innovation to economic performance and growth was underlined in the last decades by the emergence of a systemic vision of innovation, as a multi-dimensional, multi-scale, multi-actor phenomenon. Innovation systems, whatever the scale and focus, are constituted by actors that stabilize networks with the goal to innovate. Absolutely critical in these innovation networks is the linkage between knowledge producers, commonly seen as the universities and other public research organizations, and knowledge users, firms and other entities applying accumulated knowledge to solve particular technical problems.

Innovation networks are institutionally embedded, meaning that the relationships of actors do not happen in a context free of informal and formal constraints and enablers of individual action. Networks are socially dependent, they depend from public policies, from supportive actors and from the socially accepted behaviours that stimulate the generation and consolidation of a specific kind of network. In this way, we can say that innovation networks are an institutional concept. In parallel, innovation networks are not static. They are dynamic, changing over the time to answer internal and external pressures. In this perspective, innovation networks are also an evolutionist concept.

Portugal is a country that lies between the group of most developed countries and those in development process. It is usually considered a member-state of European Union in a moderate position in terms of innovation when compared with other European countries. This situation was observed at national level in several studies (European Commission, 2010) and also at regional level (among others Pinto, 2009).

The Portuguese case shows that science, technology and innovation (STI) suffered huge pressures and the change was happening at a very fast pace. This chapter focus the institutional profile of Portugal, giving attention to static characteristics of the national innovation system (NIS), and providing a chronology of institutional change in Portugal. For this, the text is organized as follows. The first section presents theoretical contributions to analyse institutional frameworks in terms of static and dynamic approaches. Thus, a static analysis of Portuguese NIS based in the

varieties of capitalism identifies inefficiencies in different institutional dimensions. A dynamic analysis of the Portuguese NIS presents the institutional change, underlining the chronology of policies on S&T and instruments for the emergence and consolidation of innovation networks. The chapter concludes with policy implications.

Institutional Dimensions, Change and Institutionalization

The 'Static' and 'Dynamic' Perspectives of Institutional Architectures

The relevance of including several institutional dimensions in the economic analysis is justified by the fact that national economies are characterized by different institutional architectures that affect the performance of countries and create path dependencies (Hollingsworth and Boyer, 1997). Coordination mechanisms provide actors specific vocabularies and logics in the pursuit of their own goals. Market allocation does not operate in a world without institutions, not always providing the efficient solution. National capacities depend on institutions, political, social and economic arrangements (Johnson *et al.*, 2003).

The concept of institution is complex (Reis, 2007). However, some common features emerge from the definitions that different authors use. Institutions are types of central structures in society, systems and prevalent rules (Hodgson, 2006), humanly created constraints that structure human interaction, consisting of formal constraints (rules, laws, constitutions) and informal constraints (self-imposed norms of behaviour, conventions and codes of conduct) and the frameworks that define the incentive structure in society (North, 1994), a pattern of self-sustaining social interaction, represented by rules with a meaning that all agents know how to incorporate and shared beliefs about how the game is played (Aoki, 2001). A clear understanding of institution should also consider its liberating dimension of individuals by defining sets of opportunities and fields of action for particular groups (Bromley, 2006).

The notion of institution of Streeck and Thelen (2009 | 2005) is compatible with the above mentioned proposals. Institutions have a mandatory character, formalized rules that may be imposed by an actor, the enforcer. Thus, both policies and organizations can be defined as institutions. Policies are institutions if they are rules for other actors apart from policy-makers. Organizations can be institutions if their existence and operation become public assured and privileged.

An in-depth understanding of economic performance should include aspects connected to institutional building blocks such as financial systems, corporate governance, inter-firm relations, industrial relations, skills and training, job creation, welfare state and innovation. Jackson and Deeg (2006) distinguish three contributions for 'static' institutional analysis that include these aspects, focusing on the performance of national economies and expanding the notion of innovation system. The first one is based on the vision of the varieties of capitalism (Hall and Soskice, 2001), a second is related to national business systems (Whitley, 2007), and a third approach regards the social systems of production and innovation (Amable, 2004).

These 'static' institutional analyses often fail to understand processes of institutional change because they treat institutions as rigid elements with a binary character. This means that the existence of specific institutional arrangements is viewed as being present or absent (Tolbert and Zucker, 1996). This is one of the main criticisms made of the theories based on the varieties of capitalism, anchored in a sense of stability that abstracts the elements of change and temporal variant elements (Streeck and Thelen, 2009|2005). Even when there is a possibility of change, this fact is considered as exogenous condition which will originate a new equilibrium. The change process is often characterized in a simplistic way, distinguished as incremental or abrupt, where the results are continuity or discontinuity. One approach to change based on assumptions of stability is limited to understanding the process of institutionalization, that occurs in a continuum rather than crystallizing from one moment to the next. This means that there is place to study partial and incomplete processes of institutionalization (Owen-Smith, 2011). An alternative approach for institutional comparison is in this way, instead of a 'static' evaluation of different cases, for example based in national level data, the analysis of different time periods and changes in specific aspects of the same national case, presenting a chronology of institutionalization (Voigt, 1999).

Institutionalization and Institutional Change

The study of the dynamic character in the economy requires that there is place to study partial and incomplete processes of institutionalization (Owen-Smith, 2011). Institutionalization is a complex and continuous process of change regarding the embedding of particular values, routines, practices and modes of behaviour within a specific social system that result from the combination of two central aspects: habituation and legitimacy (Berger and Luckman, 1999|1966).

Habituation is a central element for social reproduction, making the interaction between actors standardized and more predictable. It results from the frequency of a particular action, a pattern that can shape and be performed with less effort. Certain actions are transformed into habits, retained and integrated with meanings as routines, becoming relevant elements of collective understanding and organizational memory. Institutionalization occurs whenever there is a reciprocal typification, by types of actors, actions become habits. Stated differently, any one of these typifications is an institution. These institutional typifications are reciprocal and shared, become available to all actors, evolving from pre-existing frameworks of thought and action.

Legitimacy refers to the process of deepening the understanding and crystallization of institutions, of how things should be done, developing different bodies of knowledge, and ultimately the creation of a symbolic universe, with normative meanings, beliefs and practices. Legitimacy is the perception or assumption that certain widespread actions are appropriate and even desirable in a given social system. The legitimacy is ensured by the existence of self-reproduction processes that transform these actions into habits and practices, having a meaning shared by the actors.

A complementary view to study the institutionalization process is as a gradual institutional change process (Streeck and Thelen, 2009|2005). Here the transformation in institutions does not always happen abruptly but often gradually in five formats:

- Shift, when new models emerge,
- Layering, when successive reforms produce a new institutional framework unreachable with an immediate attempt to change,
- Drift, when institutions are eroded with non-decision,
- Conversion, an existing institution is redirected to new targets and functions, and,

- Exhaustion, the institutional breakdown, collapse generated by social arrangements, creating a self-destructive and unsustainable dynamics.

Colyvas and Powell (2006) analyzed, with these assumptions, the institutionalization of the university-industry relations in the US, through the case study of Stanford University. The weak legitimacy of the university-industry relations was revealed by the researcher's minor acceptation as well as constant request for justifications of knowledge transfer activities, limiting the involvement of academic staff in these activities. A weak legitimacy coincides with strong and consistent boundaries between the worlds of university and firms, but as it increases, the interactions become more complex and there is room for more stable definitions of what activities fall on one side or the other. The boundaries blurred with companies participating in R&D with universities, co-property registered patents and licensing of IPRs, with scientists participating in the boards of companies or becoming themselves the founders of new spin-offs. In an advanced stage of legitimacy, transparency of information is assumed as a key element in mitigating problems. Different sorts of innovation networks are publicized with various scientists, departments and universities. The relationship between universities and firms no longer needs to be hidden or lacks of justification.

With greater legitimacy, university-industry relations become more accessible to all members of academia and business, promoting the expansion of the organizational scope of innovation mediators, such as technology transfer offices (TTOs). When legitimacy is strong, support processes become increasingly elaborate and a higher proportion of key-decisions are taken by intermediate-level elements in the organizational hierarchy. Habituation, through shared activities and conventions, is a central element of social reproduction. The daily activities of technology transfer are unfamiliar but, with specialized intermediate actors, they become better understood. This context may generate some inertia because surprises become rare as the situations and solutions are classified, disputes are accommodated and contained.

Vocabulary is an essential structure for habituation by creating common patterns among the elements of a group (Berger and Luckman, 1999|1966). It is in an intermediate stage of institutionalization of university-industry relations that new hybrid vocabularies, incorporating the guidelines of public and private activities, are developed. In a final stage, routines are established and shared, with a mutual understanding of various phenomena. The structuring of new employment positions and comparable organizations encourages stabilization and its affirmation as a professional field by facilitating the exchange of knowledge between members in that area (DiMaggio and Powell, 1983). At an early stage of habituation to the transfer of knowledge, vocabularies and classifications are vague and arbitrary. In a final stage, settings become less contingent, gain accuracy with legal, procedural and organizational meanings.

At an early stage of institutionalization it is difficult to cross borders and categories. Who does that keeps behaviour contrary to the collective identity and is penalized. With habituation and legitimacy of technology transfer activities, self-reproduction allows these transgressions in university-industry.

Colyvas and Powell (2006) emphasize two particularly relevant aspects. The first refers to the fact that institutionalization is not always formalized or coded. In institutionalization processes in which there is a very high component of habituation, where routines are assumed as certain and always available, an external enforcement is redundant since practices are taken for granted. A second aspect refers to practices that are exogenously imposed and miss institutionalization because are not legitimated nor taken for granted, what prevents its absorption by the actors.

After analyzing chronologically the process of institutional change in university-industry relations in the US, Colyvas and Powell (2006) defined stages on the way to institutionalization. The first phase is called idiosyncratic, when transfer relations still happen sporadically, the second is the standardized phase, when rules and routines are already matured and coded, and finally, the institutionalized phase, when the commercialization of science self-replicates and is already solidified and protected against antagonists.

Performance of the Portuguese Innovation System

The diversity of profiles regarding innovative and competitive capabilities depends largely on the architecture, complementarities and institutional arrangements that form in a certain context. Institutional architectures have a critical impact on individual and organizational behaviours. Even though it is difficult to precisely define institutional efficiency (Crouch, 2005), a broader understanding of NIS allows to comprehend that institutions are not neutral and that reveal different missions and levels of ability according to its institutional architecture. The notion of innovation system is central to understanding the behaviour and performance of the set of institutions that structure long-term innovation processes, and thus influencing economic development. Institutional efficiency is marked by the weight of past decisions, path dependencies arising from organizational and technological learning (Niosi, 2002).

The study that most influenced the following analysis was the vision of social system of innovation and production (SSIP). Here the SSIP is presented based on a triangle of three central activities: science, technology and industry (Amable, Barré and Boyer, 1997). This triangle is embedded at the crossroads of three institutional dimensions: education, industrial relations and financial system, which structure the economic performance of countries. Their empirical approach mixes analysis of statistical indicators with an analysis of a qualitative nature, focusing on the historical process of national economies and the central role of the State in regulating the economy.

A recent contribution presented elsewhere (Pinfto and Pereira, 2013) created a typology of NIS for sixteen European countries based in their profiles of capitalism. This analysis assumed that the State, education, employment and industrial property regime have an impact on the central core of each NIS, the public and private systems of STI developing a set of innovative activities, the NIS in its strictest sense, conditioning and strengthening the economic performance of each country. It was included in the analysis a relatively wide range of variables, originating from diverse sources of information (European Commission, 2009a, 2009b, 2007; CEMI, 2008; OCDE, 2009) to explain each dimension in institutional analysis. These variables were chosen taking into account its theoretical significance in each analytical dimension that was structured around the central building blocks in the dynamics of NIS. The creation of institutional efficiency measures where based in the comparisons of best and worst performance of all the cases under review, the closer to 1 the greater the degree of efficiency presented (Table 1).

Table 1: Institutional Building Blocks and Economic Development

Country	Employment	Education	State	IPR Regime	Public System of STI	Private System of STI	Institutional Efficiency (Mean)	Economic Performance
Austria	0.549	0.430	0.726	0.654	0.341	0.395	0.516	0.464
Belgium	0.726	0.393	0.429	0.491	0.423	0.421	0.480	0.506
Czech Republic	0.385	0.220	0.533	0.381	0.565	0.461	0.424	0.291
Germany	0.531	0.455	0.513	0.522	0.382	0.611	0.502	0.341
Denmark	0.722	0.664	0.856	0.744	0.502	0.447	0.656	0.379
Spain	0.353	0.267	0.405	0.371	0.508	0.281	0.364	0.425
Finland	0.545	0.696	0.660	0.419	0.699	0.679	0.616	0.401
France	0.615	0.398	0.323	0.422	0.539	0.362	0.443	0.371
Ireland	0.319	0.473	0.617	0.820	0.290	0.396	0.486	0.560
Italy	0.553	0.156	0.381	0.238	0.240	0.288	0.309	0.251
Netherlands	0.531	0.629	0.881	0.401	0.318	0.553	0.552	0.479
Norway	0.883	0.725	0.607	0.332	0.462	0.322	0.555	0.619
Portugal	**0.220**	**0.202**	**0.390**	**0.281**	**0.145**	**0.255**	**0.249**	**0.263**
Sweden	0.756	0.774	0.744	0.455	0.447	0.689	0.644	0.465
United Kingdom	0.707	0.626	0.324	0.564	0.304	0.412	0.490	0.502

The distance to 1 is considered the distance to institutional efficiency in that specific dimension (a measure of inefficiency). The scores in specific dimensions are justified by the institutional architectures and also by institutional incoherence between particular aspects of the building blocks that create limits to economic performance, the result of dislocations and contradictory incentives.

After the index creation the countries were grouped using a formal clustering analysis. The European western countries were organized in NIS belonging to liberal market economies, social-democrat economies, continental European capitalism and south European capitalism. Portugal belongs to this latter group, which presents the major constraints in all dimensions analyzed. The results underlined that the behaviour in science, technology and innovation affects the economic performance of each country. Using the institutional building blocks, specific dimensions and data collected in Pinto and Pereira (2013) it is worth analyzing in-depth the specific case of Portugal.

Portugal had a performance indicator of 0.22 in employment. This is the worst performance of all countries included. It results from a weak labour market dynamics, with average employment rates among the countries analyzed and increasing unemployment rates, resulting in a low employment level. The quality of employment is also limited, justified by the inequality in income distribution, a focus on reduced labour costs of large enterprises and a negligible weight of skilled jobs based on knowledge. Amable (2005) points out that in the case of Southern European countries there is a dual labour market where individuals coexist receiving excessive job protection, linked to government and large corporations, and individuals of "flexible jobs", characterized by fixed-term, part-time and other forms of precarious work. This coexistence is not easy and was particularly exposed weaknesses in the rapid growth of unemployment after 2008. This author emphasizes that in this kind of institutional architecture is recurrent the wage conflicts in the relationship with the employer associations to put pressure on wage bargaining to reduce labour costs. The wage bargaining process is centralized in government who normally tries to present active employment policies.

The State has a significant weight in the Portuguese economy that does not result in a high degree of country capacity ensuring high performance in this area. In the analysis, the aggregate score for Portugal in this building block was 0.39, ahead of Spain and the Czech Republic, and the liberal market economies, Ireland and the UK. The relevance of the State in the Portuguese economy is evident in the analysis of public debt, public spending, public employment and public contracting, but that still does not take a weight much higher than the average of the countries under review. As noted by Amable (2005) South European countries have a moderate level of social protection, with an expenditure structure oriented combat poverty and support pensions, subsisting a strong state involvement in such activities. Expenditure on social protection is relatively high, but percentage of people coming out of poverty after social transfers is low. Moreover, other aspects taken into account reveal the high abstention rate and a limited degree of trust in political institutions.

The institutional building block of Education is a major South European deficit. Amable summarizes the problems of the innovation systems belonging to this variety of capitalism: low public expenditure, low levels of tertiary education, fragile higher education system, weak vocational training, less attention to life-long learning, focusing on general skills. Portugal has an efficiency of 0.20. This value is only higher than that achieved by Italy and is probably one

of the biggest problems for national economic performance. Despite increasing in recent years, the number of graduates and PhDs is still lower than other developed European countries. The participation in the learning process throughout life is very limited and dropout youth remains high. The involvement of individuals in the Information Society is also reduced.

The regime of Industrial Property in Portugal is characterized by a weak performance in the use of these mechanisms. With performance of 0.28, once again, only Italy presents a NIS less efficient in this respect. This may relate not only to the lack of promotion but also with the lack of State capacity to enforce respect for property rights. In Portugal, the registration of patents, trademarks and industrial design remains at very low levels, despite increase resulting from various substantive policies to promote and encourage their use and that will be explained in the next section. The time allocated in knowledge transfer offices to licensing issues and the number of licenses per thousand publications in countries belonging to the European Southern capitalism also shows that this dimension of IPRs protected effectively is not being sufficiently exploited.

The public side of the system of Science, Technology and Innovation is the aspect analyzed in which Portugal has a lower score, only 0.145. The country is the worst performer among all analyzed. Despite intense improvements the last decade, the level of spending and personnel in R&D are still low. The scientific production has registered considerable increases. The public system has important deficits in the interconnection with the business, particularly with little attention to research contracts. The technical staff in knowledge transfer shows a modest level compared with other countries, both in the number of staff assigned to these activities of university-business, both in terms of formal powers presented either in their previous experience working in the industry.

The private side of Science, Technology and Innovation (STI) is usually presented as a major problem of the Portuguese NIS. In the case of this analysis confirmed this finding with the performance of the country to be what got the weaker score from the set of countries analyzed (0.255). The deficits are related to the low private expenditure on research and innovative activities, a limited proportion of human resources in industries and services of medium/ high-technology and R&D. Companies are also insipidly participating in the Information Society, with low levels of broadband access and expenditure on information technology. The collaborative behaviour is low, resulting in limited innovation networks, because of low scientific cooperation between SMEs, the enterprise participation is also low in knowledge production, verified by the number of co-publications. A positive indicator is worth highlighting. The ability of business creation is positive, particularly university spin-offs encouraged by the attention given by technology transfer offices.

The economic performance reflects the behaviour of the country in its various institutional dimensions. As expected the Portuguese score (0.263) is higher than just the Italian. The deficit remains large in economic terms, still far from the values of GDP and productivity of other economies in the analysis. The country's growth was also low underlining the divergence of Portugal in the last decade compared to other more developed economies. The export capacity and foreign direct investment have below average levels, as well as the high importance of SMEs in the Product and employment. The financial system also reveals a weak performance. Amable (2005) indicates clues to this behaviour: weak protection of external shareholders, a strong concentration of ownership, corporate governance based banks, weak sophistication of financial markets, narrow development of venture capital, strong banking concentration.

Having paid attention to the 'static' performance of Portugal in various institutional dimensions the next section focuses on institutional change in Portugal in the field of innovation.

Change in Policies, Actors and Behaviours in 'Academic Science'

Change in the Portuguese Science, Technology and Innovation Policies

STI policies in Portugal had a late entry, a slow evolution and implementation with little results. These are corollaries of several analyses that focus on the evolution of government intervention in this area (e.g., Caraça, 1999; Bonfim and Viseu, 2005; Laranja, 2007). Based on these analyses is possible to systematize the evolution of public policies in STI that set the pace of institutional change in university-industry relations and the generation and consolidation of innovation networks.

The STI policies in Portugal date back to the 1970s with the participation of national teams in work promoted by the OECD. This participation has contributed to emerge in 1967 the National Board of Scientific and Technological Research (JNICT) with the mission of coordinating intersector public intervention in this field. In the '70s, Portugal pursued a path connected to the emergence of State large laboratories with thematic scope, a logic inspired by public intervention resulting from a linear model of innovation. By the early eighties the governance of STI in Portugal was based on a highly vertical structure in which it was assumed that the benefits from scientific research came mechanically and sequentially to companies. This period was marked by the birth of several public universities in Portugal, some with regional scope, and marking the end of the concentration of higher education in Coimbra, Lisbon and Porto (Malcata, 2001).

In the '80s, back in the pre-accession period to the European Economic Community (EEC) and the instability after the change of political regime dilute, comes the first National Technology Plan which aimed to strengthen the technological infrastructure, new and more flexible institutions, launching programs to support R&D and industrial potential of pilot demonstration. There was an obvious fragmentation between ministries with the responsibility of JNICT, linked to science, and with the tutelage of the industry-based Plan. The beginning of this decade was marked by this disjointed and compartmentalized approach that would restrict the STI in Portugal for several years.

In the second half of the 1980s Portugal enters the EEC. There is a new momentum in this area, with a specific budget for Science and Technology and the first Mobilisation Programme for Science and Technology intending to achieve the target of 1% of GDP of expenditure on R&D, something that only came to realize after more twenty years in 2007.

The first Community Support Framework (CSF I - 1988-1992) helped to provide the country of physical infrastructure base for STI. In this context programs PEDIP (Specific Programme for the Development of Portuguese Industry) and SCIENCE (Creation of Infrastructure for Science, Research and Development) took over as central instruments but with a lesser degree of articulation.

In 1991 appears the program STRIDE Portugal, which results in an application for a Community initiative of the same name (STRIDE - Science and Technology for Regional Innovation and Development in Europe) and sought to encourage the development of S&T community in the regions. The use of funds from STRIDE stands out the creation of the Innovation Agency (AdI).

AdI had the ambition to strengthen the mechanisms of interaction between the scientific and technological enterprises, valuing the results of scientific research and promoting technology transfer, diffusion and innovation. According to Laranja (2007) AdI was never able to fulfil this role fruit of tensions that stemmed from his dual ministerial supervision.

In parallel, there are a number of public institutes such as the Institute for Support to Small and Medium Industrial Enterprises (IAPMEI) and the National Institute of Industrial Property (INPI), who came to play an important role in the implementation of instruments to promote STI.

In the context of PEDIP it is defined a set of infrastructures, technological centres, institutes of technology and new centres of technology transfer, built in the geographical areas of industrial relevance. Although, as mentioned by Laranja (2007: 143-144), the creation of these interface bodies seem appropriate, these infrastructures, many of which were coordinated by university professors, overly focused its assistance for R&D and academic international relations and less to local collaboration with business, as was the original plan.

With a new government in 1995, there were significant changes. The CSF II (1994-99) had been prepared by the previous government, maintained the same focus on human resources and infrastructure but emerged with concerns about sustainability of infrastructure created though. It appears a Ministry of Science and Technology, which divides JNICT into three bodies, the Foundation for Science and Technology (FCT), the Institute for International Scientific and Technological Cooperation (ICCTI) and the Centre for Science and Technology (OCT). At this stage, the agency *Ciência Viva* was created, concerned with communication and public understanding of science, focused mainly on younger audiences.

The FCT has become particularly relevant as the main funding agency of S& T in the country. It consolidates itself as the entity responsible for the evaluation of science based in regular and independent panels. Associated laboratories inspired by the CNRS - *Centre National de la Recherche Scientifique* in France are created to pursue research objectives according to public science policy and meeting minimum structure, size and excellence requirements.

AdI operated as driving force of business R&D in the Ministry with the responsibility of S&T. The PRAXIS II-PEDIP focus on consolidation, financing and implementation of projects but maintains the tradition of separation between programs on the side of science and the business side, even when complementarities were already at the time, evidenced.

The design of the National Economic and Social Development Programme (PNDES) for the implementation of the CSF III (2000-2006) was inspired by the Lisbon Strategy that stated the transformative potential of S&T for a more cohesive European Union and competitive based on knowledge and innovation (IFDR, S/D). In terms of operational programs, this view was not stabilized, because the Operational Programme for Science, Technology and Innovation (POCTI), which replaced the PRAXIS and the Economy Operational Programme (POE) that replaced PEDIP II, held the same logic of distance. The distance between operational programs and ministries and the influence of the Lisbon strategy underpinned the launch of the Integrated Support Innovation, the PROINOV (Rodrigues, Neves and Godinho, 2003). This program proposed to explicitly streamline the NIS in Portugal, promoting business R&D, strengthening the population qualifications and a more favourable environment for innovation. The program ended to be short-lived and confined to an implementation and reflection workshops early due to the resignation of the XIV Constitutional Government of Portugal, in December 2001. The PROINOV had the merit of giving innovation a policy dimension that was absent, endowing an institutional and evolutionist rationale of intervention. The PROINOV also gave attention to the importance of the private sector in the dynamics of science and relevance of clusters, trying to bring together various stakeholders for the creation of innovation networks.

This phase coincides with the exploration of a regional dimension of STI policies. Influenced by Article 10 of the ERDF Technical Assistance, CCDRs, regional development coordination commissions, created the regional dynamics of reflection on the STI, with dialogue between actors, strategies and promoting regional consensus. Following these strategies, the Programme of Innovative Actions secured additional funding for the implementation process of innovative projects and a bottom-up approach of STI heavily influenced by the paradigm of regional innovation system.

Even with short duration, the PROINOV influenced the creation of the Agency for the Knowledge Society (UMIC) with the aim of promoting the Portuguese NIS. However, this entity has not assumed its original role, focusing excessively measures for inclusion in the Information Society and technological modernization and management of public administration. The rationale of the new government came to show up with a more utilitarian concept of innovation focused on business (Laranja, 2007). This view is evident in the proposal for financing the R&D units based on quantitative indicators of scientific production and in designing outreach activities focused on collaboration with industry through licensing of IPRs, contract research and spinning-off (Pereira, 2004b).

Another novelty was the promotion of a revision of the Code of Industrial Property in 2003, under the Ministry of Economy. The implementation of this new framework, followed by a revision to the decree-law n. 143/2008 of 25 July, sought to promote the use of IP with simplified procedures. The reforms of 2003/2008 in the field of industrial property coincide with the implementation of a large group of incentives for effective protection of IPRs. Several STI entities, fruit of protocols with the INPI, were exempted from payments in cases of national registry, removing a major barrier to patents, its cost. IPR liaison offices spread a network of small operating units in universities, science parks and technology, the GAPIs. On the other hand, financial incentives promoted the inventive efforts, creativity and innovation of businesses, inventors, independent designers, entrepreneurs and organizations working in research through co-financing of expenditure relating to the protection of IPRs. The paradigmatic example is the creation of the Incentive Scheme for Use of Industrial Property (SIUPI) within the POE. This initiative, launched in 2001, was open until the end of 2006 and in 2005 had about eighty projects in execution (Laranja, 2007: 210), focused primarily on international patenting. Along with all these changes, INPI was introducing new price lists, simpler and less expensive.

By the end of the CSF III, the POE becomes PRIME - Incentives Programme for the Modernisation of the Economy (PRIME, 2010), emerging a wide range of initiatives managed by AdI that focused explicitly knowledge transfer activities: NITEC, IDEA, DEMTEC, among others. Under POS_C, two specific initiatives were launched creating important seeds for structuring the transfer of knowledge in Portuguese universities, NEOTEC and OTIC, designed and accompanied by UMIC, and executed by ADI. The initiative NEOTEC - New Technology Based Companies sought to monitor the launching of business projects from the proof of concept to the first year of activity of the new firm. In this program, 220 applications were submitted with 116 business projects

approved. The NEOTEC also included a line of «Valuing Entrepreneurial Potential» which sought to stimulate activity in support of innovative ideas by funding S&T entities in promoting entrepreneurship. The initiative OTIC - Offices for Technology Transfer and Knowledge promoted a network of exploration centres of research results and the transfer of ideas and innovative concepts to the business. These offices operated in institutions of higher education, universities and polytechnics, and strengthened cooperation between universities and firms, identifying opportunities for commercial exploitation of knowledge and technology to strengthen university-industry relations. In 2006, 22 OTICs had been approved, involving all Portuguese public universities except the University of the Azores (POS_C, 2010).

The launch of these two initiatives, in 2005, coincided with the formation of a new socialist government, XVII Constitutional Government of Portugal, which assumed the target of technological advancement. The Technological Plan emerged in this context as an agenda for change to meet the challenges of modernization in Portuguese society mobilizing public administration, businesses, families and other institutions in a combined effort. The Technological Plan led the implementation around three central themes: knowledge, fostering structural measures aimed at raising the educational levels of the population, technology, investing in strengthening national scientific and technological skills, and innovation, facilitating the modernization of companies and innovative capacity (UCPT, 2006). This plan, which recovered the spirit of PROINOV, was assumed to be a priority for public policy and constitutes itself as a key part of the National Action Programme for Growth and Jobs (PNACE), which reflected the implementation of the priorities of Strategy Lisbon in Portugal. In the economic turmoil it has lost the prominence in public policy and media attention.

This period was marked by the acceleration of scientific and technological system, mainly stimulated by government spending, the change of knowledge institutions and the institutionalization of assessment practices and participation in science and internationalization of the actors of the system (Pereira, 2004a).

With the NSRF - National Strategic Reference Framework (CSF III Observatory, 2007) that came to structure the application of funds from the Cohesion Policy of the European Union for the period 2007-2013, some of the problems of distance between the operational programs were mitigated. The NSRF was divided into three main strategic areas that embody the three thematic operational programs that articulate with the Technological Plan and the goals of the Lisbon Strategy: the Operational Programme for Competitiveness Factors (POFC), the Operational Programme for Human Potential (POPH) and the Operational Programme for Territorial Development (POVT). The aim of this study is not to evaluate the programs of the NSRF. It is still too early to understand their real impact on the Portuguese economy. However, it is likely that its success has been conditioned by the economic turmoil.

The POFC, later baptized as COMPETE, focused on the support they sought to stimulate sustainable growth potential of the Portuguese economy (POFC, S/D). The incentive systems under this program focused the substantial portion of support related to STI as the POPH gets a role, also relevant, but restricted to issues of human resources development. Another measure to stimulate university-industry for this period was the creation of UTEN - University Technology Enterprise Network. This network, launched in March 2007 by the FCT with the support of INPI, explored a five-year program based on a set of partnerships with American universities, subsequently extended to other European scientific and technological entities with which the Portuguese government decided to collaborate with view the absorption of good practices in different domains (UTEN, S/D). The program assumed that the technology transfer offices in Portugal were already in a stabilized phase and that lacked in this moment of greater professionalism. The US practices were presented as a benchmark to follow in the process of knowledge transfer. Network activities focused training of human resources, through international workshops, internships in foreign partner entities and attempts to evaluate the initial performance of national transfer activities.

Through its activities the UTEN proposed not only to equip intermediation actors in Portugal for more professional and systematic processes of knowledge transfer in university-industry relations, but also to strengthen the network of the various partner organizations (UTEN, 2010, 2011).

Emergence of Actors and Behaviours in the Portuguese NIS

The impacts of the CSF III policies were reflected in the emergence of new actors in brokering national public science and the technological system. Infrastructure built in the 1980s and 1990s were added, with programs GAPI, NEOTEC and OTIC, with a number of organizations, which explicitly focused its activity on the relationship between universities and business, through the transfer of knowledge in an attempt to marketing research with economic potential. These programs have allowed the existence of such entities more evenly distributed throughout the territory, created in proximity to S&T entities.

In parallel, the Portuguese universities faced the international trend of a wider role for higher education institutions (HEIs). This change is institutionalized with Law n.º 62/2007 of 10 September which embodies the new legal regime of higher education institutions (RJIES). This law created a new framework for HEIs, its constitution, function, organization, functioning and powers, the authority and supervision of the state and the relationship with their autonomy. In addition to educational activities and scientific research that these entities should develop, this statute refers, in Article 2, paragraph 4 that HEIs have the right and duty to participate, individually or through their units, in activities in connection with the society, namely diffusion and knowledge transfer, as well as the economic value of scientific knowledge.

This trend, which had been ongoing since the beginning of the decade, was accelerated by this legal framework, creating the landscape to Portuguese HEIs reflect on their functions, reorganization of the governance system and an increased interest in connection with the society in general and firms in particular.

The implementation of RJIES originated the formalization process of knowledge transfer activity in the organic structures of many entities. In most cases, these new structures were based on a complete transition and utilization of skills and human resources involved with the installation of OTICs and GAPIs in universities. OTICs had a strong mobilizing effect and allowed some internal dynamics in universities and polytechnics, particularly in gauging the potential for commercialization of research, but the short duration of the program led to the dissolution of the network that was beginning to glimpse. The role of GAPIs was particularly important in the promotion of IPR, facilitating information and support in the process of registration. The various GAPIs structured a network that was consolidated and retained some dynamic interaction

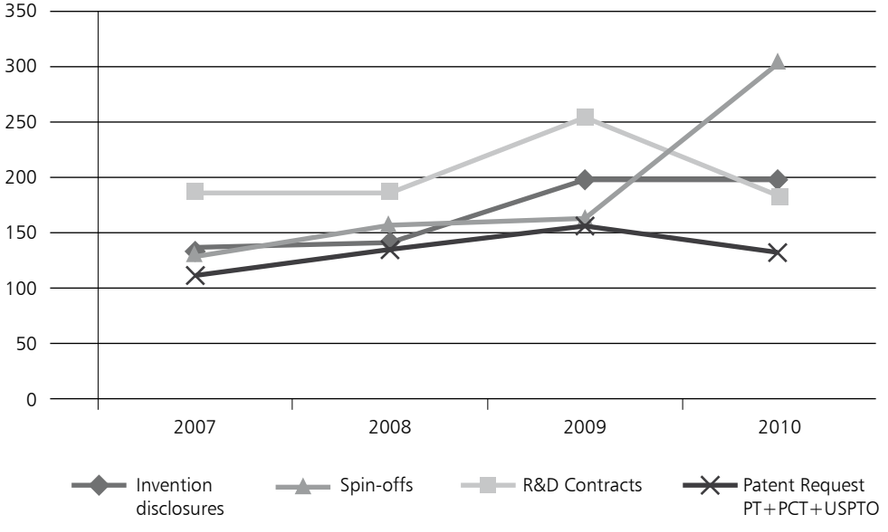
between the various members, even with the end of funding of INPI.

Even if, as reported by Laranja (2007: 209), the GAPIs installed in academia had insignificant results, coupled with a static view of the valorisation of IPRs, its operating logic was crucial to give visibility on the issue of patents and trademarks, having limited attention by potential users in Portugal (Pereira *et al.*, 2004). Assessments made by UTEN (UTEN, 2010, 2011) identified the intermediation bodies in Portugal. Table 2 shows the relevance that GAPIs and OTICs had in the emergence of such actors.

These reports also illustrate some relevant aspects. A substantial part of technology transfer offices settled in Portugal recently, and only one had more than ten years old. Most TTOs were created after 2003 and have a low degree of maturity. The number of officers in each TTO varies between one and sixteen, summing less than a hundred (81). The technical team splits time for various functions, entrepreneurship (23%) and licensing of industrial property (22%) are the most relevant. Obtaining of funding (18%) and connection to the industry (13%) are also listed. The diversity of TTOs is also reflected by a significant proportion (5%) that asserts a primary function other than the four previous (UTEN, 2011: 73).

The funds vary considerably from TTO to TTO in Portugal, between 50,000 Euros to more than 200,000 Euros a year. Funding sources also differ widely but most TTOs receive funds from their host entities to ensure their activities, even though some underline not receiving any financial support from their host entity. TTOs remain very dependent on project funds, with all respondents obtaining funding through projects (UTEN, 2011: 73).

Figure 1: Commercialization Activities in Portuguese KTOs



[Source: Based in UTEN (2011: 74-75)]

Table 2: Main Intermediation Actors in Portugal NIS

Name	Location	NUTS II
AIBAP – Associação da Incubadora Beira Atlântico Parque – BIC Beira Atlântico	Mira	Centro
Avepark – Parque de Ciência e Tecnologia	Caldas das Taipas	Norte
Biocant	Cantanhede	Centro
CPIN – Centro Promotor de Inovação e Negócios	Lisboa	Lisboa
IGC – Instituto Gulbenkian de Ciência	Oeiras	Lisboa
INESC Porto – Instituto de Engenharia de Sistemas e Computadores do Porto	Porto	Norte
INOVA – Instituto de Inovação Tecnológica dos Açores	Ponta Delgada	Açores
INOVISA – Associação para Inovação e Desenvolvimento Empresarial	Lisboa	Lisboa
Instituto Politécnico do Porto, ESTSP – Escola Superior de Tecnologia da Saúde do Porto	Porto	Norte
Instituto Politécnico do Porto, OTIC IPP (Oficina de Transferência de Tecnologia e Conhecimento)	Porto	Norte
Instituto Superior Técnico, TT@IST	Lisboa	Lisboa
IPN – Instituto Pedro Nunes	Coimbra	Centro
ISCTE – Instituto Universitário de Lisboa, AUDAX (Empreendedorismo e Empresas Familiares)	Lisboa	Lisboa
Madeira Tecnopólo, GAPI	Funchal	Madeira
Parkurbis – Parque de Ciência e Tecnologia da Covilhã	Covilhã	Centro
Sines Tecnopolo	Sines	Alentejo
Spinpark - Centro de Incubação de Base Tecnológica	Guimarães	Norte
Taguspark (includes GAPI)	Oeiras	Lisboa
Universidade Católica, Escola Superior de Biotecnologia, TRANSMED (Valorization of Biomedical Knowledge and Technologies)	Porto	Norte
Universidade da Beira Interior, Instituto Coordenador da Investigação (ICI), Divisão de Investigação e Desenvolvimento (ID) and GAPI (Gabinete de Apoio a Projectos e Investigação)	Covilhã	Centro
Universidade da Madeira, TECMU (OTIC)	Funchal	Madeira
Universidade de Aveiro UATEC (includes GAPI_UA and OTIC)	Aveiro	Centro
Universidade de Aveiro, grupUNAVE	Aveiro	Centro
Universidade de Coimbra, Divisão de Inovação e Transferências do Saber	Coimbra	Centro
Universidade de Évora, Divisão de Projectos e Informação dos Serviços de Ciência e Cooperação	Évora	Alentejo
Universidade de Évora, Fundação Luís de Molina	Évora	Alentejo
Universidade de Lisboa, INOVAR	Lisboa	Lisboa
Universidade de Trás-os-montes e Alto Douro, OTIC-UTAD (includes OTIC and GAPI)	Vila Real	Norte
Universidade do Algarve, CRIA (Divisão de Empreendedorismo e Transferência de Tecnologia includes OTIC and GAPI)	Faro	Algarve
Universidade do Minho, TecMinho (includes OTIC and GAPI)	Guimarães	Norte
Universidade do Porto UPIN (includes GAPI and OTIC)	Porto	Norte
Universidade Nova de Lisboa, Faculdade de Ciências e Tecnologia (Unidade de Promoção do Empreendedorismo e Transferência de Tecnologia)	Caparica	Lisboa
Universidade Nova de Lisboa, NOVA Empreendedorismo	Lisboa	Lisboa
Universidade Técnica de Lisboa, OTIC – UTL (Empreendedorismo | Transferência de Tecnologia)	Lisboa	Lisboa
UPTEC (Science & Technology Park)	Porto	Norte

[Source: Based in UTEN (2010: 108-9)]

The set of policy changes and the emergence of new actors have resulted in a change of behaviours in university-industry behaviours. The second half of the 2000s is marked by an increase in attempts at commercialization of science in Portuguese university. These changes are evidenced in reports UTEN (2010, 2011) particularly with regard to patenting and the creation of spin-offs (Figure 1). These areas are the channels that KTOS regard as essential to their evaluation.

Conclusive Remarks

Innovation systems are crucial theoretical tools to analyse innovation. They facilitate the mapping of the relevant actors, the understanding of the existing linkages, what we can understand as innovation networks, and the overall performance of the system. Nonetheless the theoretical relevance and easy adaptation to policy-making, this rationale only marginally incorporates analysis of the change in the system.

This chapter tried to summarize some contributions that may be helpful to incorporate a dynamic perspective on innovation. It suggested a method of designing a chronology of events of policy change, identifying the consequences in terms of the emergence of new actors and modifications of innovative behaviours that impact in the formation of innovation networks.

The Portuguese NIS presents several inefficiencies and is the worst performer in several of the analytical dimensions under consideration. The institutional change in Portugal was evidenced by the emergence of different policies and instruments to support the strategic direction of policy makers for a more integrated view of innovation. The implementation of these policies provided stimulus for the emergence of several players brokering the connection between science and business. TTOs in Portuguese universities emerged in the last decade, benefiting from the initial stimulus of GAPI and OTIC programmes, and secondly, with attempts to professionalize this type of activity involving the UTEN.

Despite the merits of the various programs, the lack of continuity and dependence of the structural funds of GAPIs and OTICs, and the focus of UTEN on experiences difficult to adapt to the Portuguese context, limited the impact of these initiatives. Notwithstanding substantial improvements of TTOs in Portugal, they continue to lack critical mass and resources (Teixeira, 2011). The behaviour of actors has changed substantially by paying greater attention to technology transfer outputs, which not only sets up a change of behaviour towards the use of these interaction channels as an instrument of transfer, but that seems to include a change in the shared meaning of innovation networks.

A central question in this debate is how to take a decisive step towards the institutionalization of university-industry relations in Portugal and the consolidation of innovation networks. Institutional change is not always abrupt, it is important to ensure that, after all the efforts and improvements in the last decade, because of short term constraints like the ones resulting from the economic slowdown and the austerity measures, the Portuguese national innovation system is not affected by an institutional drift with unpredictable results.

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Regional innovation dynamics: Behavioural patterns and trends

António Xavier
Teresa de Noronha

Introduction

It is widely accepted that innovation is central to the growth of output and productivity, and that it plays a key role in Europe (Parvan, 2007). Based on the concept of the knowledge-based economy, it is common understanding that the performance of competitive environments depends primarily of human capital and those activities and incentives that are geared towards the creation and diffusion of knowledge (Observatório da Informação e Conhecimento, 2004) as a first determinant of innovation.

Since 1986, Portugal has received several financial supports from the European Union, which helped to modernize and invest in certain areas. Since innovation is a key factor for the competitiveness of firms and regions, the development of innovation systems has become a major discussion in the country, also as a tool of regional development.

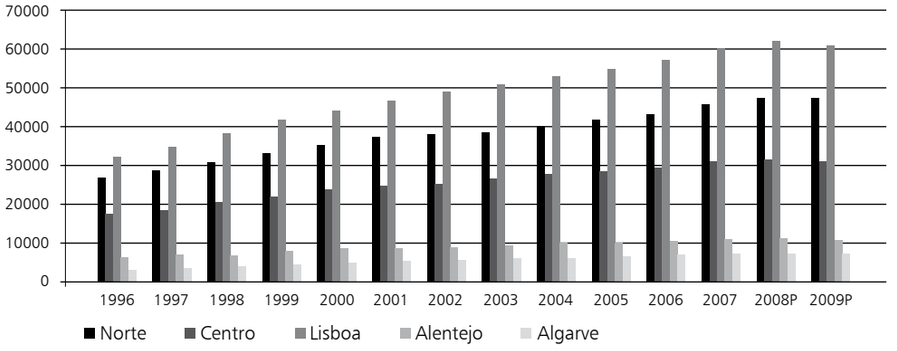
In this line, the recent decades brought to Portugal some benefits from European cohesion policy which imposed national efforts towards innovation in organizations and more investments in R&D (Noronha *Vaz, e*t al., 2013, Vaz, E., et al., 2014). However, despite significant national growth rates in the 1990s as well as a successful attempt to cope with the EMU – are lagging behind the EU average with respect to gross production, investment or employment creation (Noronha Vaz, et al., 2013, Vaz, E., et al., 2014).

From 1996 to 2008 Portugal's GDP knew a positive growth, see Figure 2. This statistical evidence hides, nevertheless a quasi constant decreasing rate of growth. This rate passed from about 9 per cent, in 1998, to a little less than 3 per cent, in 2008 just before the explosion of the global crisis. In 2009, Portugal's GDP followed the global trend and met a negative growth of almost -1 per cent.

In absolute terms, GDP in the region of Lisbon dominates largely all the other regions. The north and the center region follow, but Alentejo and Algarve stayed behind with a lower GDP in absolute terms. From 1998 to 2009, Algarve achieved a growth of more than 115 per cent [1] GDP per capita.

1. Sources: http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=152751847&att_display=n&att_download=y and Autor's computations

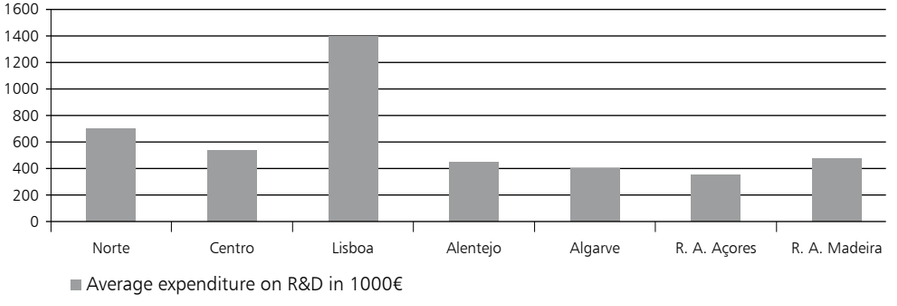
Figure 2: Gross Domestic Product by NUTS 2 (previous year's prices; annual)



Sources : http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=152751680&att_display=n&att_download=y
http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=152751847&att_display=n&att_download=y

It is important to stress that Lisbon and the Algarve are the more prosperous areas in terms of GDP per capita: Algarve based on tourism and Lisbon as a capital of services, keeps the leading role in the Portuguese economy – biggest concentration of universities, science and technologies parks and the most concentrated amount of R&D investment, as in Figure 3.

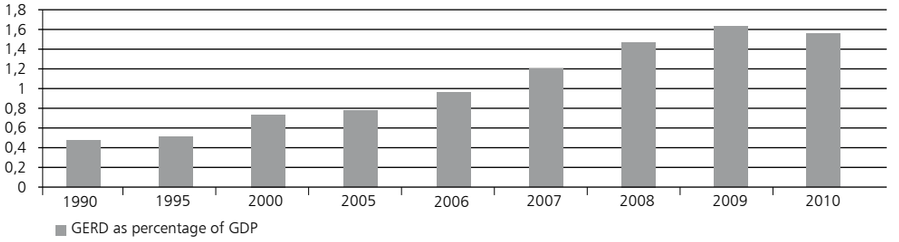
Figure 3: Average expenditure on R&D per region in 2010 (in thousands of Euros)



Sources: http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=152751680&att_display=n&att_download=y
http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=152751847&att_display=n&att_download=y

Theoretical evidences indicate that investment in R&D improves regional attractiveness of local business. In fact, R&D intensive clusters rang among the best drivers of such investments and the Portuguese expenditure in R&D did not cease to increase during the last 20 years, to reach in 2010 a level of 2748 billion Euros, representing almost 2 per cent of the national GDP, as in Figure 4.

Figure 4: Gross Expenditure on Research & Development as percentage of GDP



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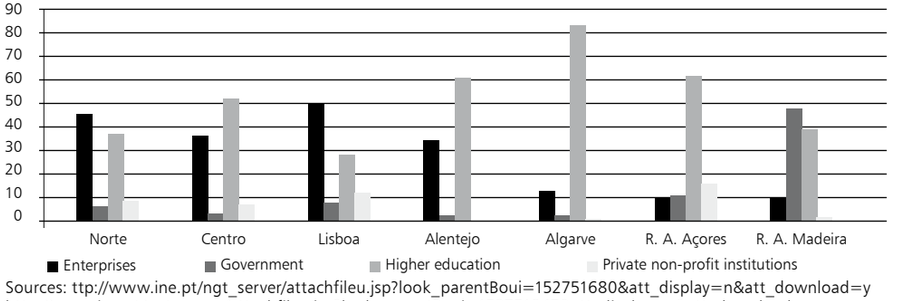
http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=152751847&att_display=n&att_download=y

Another important aspect is the relative importance of the actors involved in the R&D process which influences the dynamic distribution of the expenditure among regions. The importance of the private enterprises increases substantially as they become the most important investor of the R&D in Portugal. Although, public R&D expenditure[2] represent still an important component of the total expenditure (but still less than 1 per cent of GDP, in 2010), the raise in scientific outcomes, the quantity of scientific publications per GDP still stays under the OECD median[3]. See Figure 5.

We consider that there is a favorable environment for knowledge creation in Portugal that should be followed by a better understanding of how the firms' contribution to national and regional growth occurs, their possible obstacles and eventual impacts. Quantitative methods providing objective criteria to access the ability of firms to innovate in contexts of regional imbalances is of upmost importance these days (Noronha Vaz, et al., 2013, Vaz, E., et al., 2014).

By proposing an analysis of Portuguese firms' capacity to innovate and their paths to develop further in a competitive and constrained context we are addressing a major problem of regional development in Portugal. The suggested methods (such as Biplot methodology at regional level and clustering activities) work out as monitoring tools of political success and failure.

Figure 5: Repartition in percentage of Portuguese R&D total expenditure in 2010



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2. Public expenditure = Government + Higher education.

3. Sources: stat link : http://dx.doi.org/10.1787/888932690757

Analytical Instruments

As it becomes important to measure the innovation capacity of firms in the context of regional development it also matters to make a comparative analysis of the different NACE activities. They generate different spillovers that tend to concentrate at the geographic level (Evangelista *et al.*, 2001).

Community Innovation Survey (CIS) – a survey of innovation activity in enterprises located in different EU member states (Parvan, 2007) is one of the most accurate sources of European organizations on innovation. CIS allows collecting information at the firm level in the inputs and outputs of the innovation process in different firms in the different member states of the European Union, allowing comparisons between companies, regions and countries (Noronha Vaz, et al., 2013, Vaz, E., et al., 2014). Evangelista *et al.* (2001) showed that CIS data, and a set of selected indicators, are able to quantify the contribution of the different regions to the National System of Innovation and identify the different technological profiles of regions and to measure the technological performances of regional systems.

This chapter is inspired in such previous works as well on other studies applying the Biplot method to analyze the behavioral pattern of innovation in organizations (Galindo et al., 2011, Noronha Vaz, et al., 2013, Vaz, E., et al., 2014).

The advantage of using CIS data set is significant: although not of a primary nature, it still can be applied at a regional basis and address specific issues at sector level. However some methodological aspects should be emphasized: i) A first and very general issue has to do with the extent to which "administrative" regions can be used to identify distinct and coherent sub-national innovative patterns, since in some instances, regions are composed by a variety of localized productive subsystems of firms characterized by rather different technological profiles (Evangelista *et al.*, 2001); ii) A second issue, has to do with the fact that the CIS data cannot be regionalized according to the actual place where innovation activities are performed, since the basic unit of observation of CIS is the "firm" and it can lead to an underestimation of the technological potential of regions which host production units controlled by headquarters located elsewhere (EUROSTAT, 1996, cited by Evangelista *et al.*, 2001). Also with an analysis such as this one cross-region and intra-firm technological spillovers cannot be taken into account; ii) Finally, the CIS has been designed also to capture the systemic nature of innovation activities, emerging from the existence of technological interactions between firms and the other relevant institutional actors involved in the innovation process. However, no specific information is provided regarding the geographical horizon of such interactions (Evangelista *et al.*, 2001).

In Portugal has been implementing these surveys since the 1990s, known as "Inquéritos Comunitários à Inovação" (GPEARI, 2010) which has been carried out in the field by the National Statistics Institute. The first CIS implemented in Portugal was the CIS 1 (execution period 1991-1992) and since the last decade the following ones were implemented: CIS3 (reference period 1998-2000); CIS Light (reference period 2003), CIS4 (reference period 2002-2004) CIS 2006 (reference period 2004-2006), CIS 2008 (reference period 2006-2008) and CIS 2010 (reference period 2008-2010). However, the availability of data at a regional level is irregular: For the most recent ones, it was possible to obtain fairly complete data sets regarding the different NUTS II regions, which may eventually allow determining evolutionary trends. This information is available for CIS 2004, 2006 and 2008, but not for CIS 2010. By sectors we can also get a great detail of information in all years at national level.

The Methodology

The Biplot Methods

The Biplot analysis is a multivariate analytical technique proposed by Gabriel (1971) which allows the simultaneous graphical representation of individuals and variables (Martín-Rodriguez *et al.*, 2002) and provides a useful tool of data analysis for large data matrices (Gabriel, 1971).

According to Gabriel (1971), any matrix of rank two can be displayed as a Biplot which consists of a vector for each row and a vector for each column, chosen so that any element of the matrix is exactly the inner product of the vectors corresponding to its row and to its column. If a matrix is of higher rank, one may display it approximately by a Biplot of a matrix of rank two which approximates the original matrix. More specifically, according to Gabriel (1971), a Biplot is a graphical representation of a data matrix X (n $\times$ p) using markers 1…., n $a_1 \ldots a_n$ for rows and markers b_1 ; b_j for columns, chosen in such a way that the internal represents the element x_{ij} of the matrix X′, which is obtained as follows $x_j^i = a_i^T b_j$ (Bradu and Gabriel, 1978; Martín-Rodriguez *et al.*, 2002; Villardón, W.D.).

The initial matrix can be written according the singular value decomposition:

$$X=UDV' \tag{1}$$

where U is the matrix of eigenvectors of the matrix XX′; D is the matrix of eigenvalues of the previous matrix ordered from the largest to the smallest, and V′ is the matrix of eigenvectors of the matrix X′ X.

According to the initial studies in this area possible factorings are:

$$G = U_k \Lambda_k^a \tag{2}$$

$$H = V_k \Lambda_k^{1-a} \tag{3}$$

where U (n x p) and V (p x p) are matrices of singular vectors and Λ (p x p) is a diagonal matrix of singular values. U is the matrix with columns corresponding to the p orthogonal eigenvectors of XX′ and V is the orthogonal matrix corresponding to the eigenvectors of X′X. The value of k determines the dimension of the approximation (typically k=2). Finally, *a* is a constant that can take different values.

When the value 1 is selected in *a*, the result is called a JK or RMP (row metric preserving) Biplot. In this display the distances between pairs of rows is preserved and the display is useful for studying objects. When the value 0 is selected, the result is a GH or CMP (column metric

preserving) Biplot. This display preserves distances between the columns and is useful for interpreting variance and relationships between variables.

There are two types of Biplots: CMP-bi-plot Column Metric Preserving and RMP-Biplot -Rows Metric Preserving; but also presented the SQRT (symmetric Biplot), which is a compromise situation, as follows:

$$G = U_k \Lambda_k^{1/2} \quad (4)$$

$$H = V_k \Lambda_k^{1/2} \quad (5)$$

However, improvements were needed and the Biplot methods have gain developments since its creation in 1971. Therefore, Galindo (1986) updated these kinds of methodologies and created what she called the HJ-Biplot. This is a symmetric, simultaneous representation technique similar in some way to correspondence analysis, but not restricted to frequency data. It is closely related to the main component analysis, as variance and covariance matrix are plotted on planes which account for most of the inertia.

This method achieves an optimum quality of representation for both rows and columns, as rows and columns are represented on the same reference system, over passing some problems from previous studies. It was demonstrated that the HJ-Biplot was able to produce better results than the previous classic Biplot methods proposed by Gabriel (Galindo, 1986).

A representation HJ-Biplot (Galindo, 1986) for a data matrix X containing the units is defined as a graphical representation by multivariate markers j_1, j_2... j_n for lines and h_1, h_2,. .. h_n for the columns of X, selected so that both markers may overlap in the same reference system with high quality representation. The lines are represented by dots and columns by vectors. Thus, the HJ-Biplot is based on singular value decomposition (SVD) of the data matrix (Galindo, 1986; Villardón, W. D.; Silva, 2010), and any real matrix characteristic r ($r \leq \min(n, p)$) may be factored as the product of three matrices such that:

$$X_{(nxp)} = U_{(n\Lambda r)} \Lambda_{(r\Lambda r)} V'_{(r\Lambda p)} \quad \text{with} \quad U'U = V'V = I_r \quad (6)$$

where:

$U_{(n\Lambda r)}$ is the matrix of eigenvectors of XX ';

$V_{(p\Lambda r)}$ is the matrix of eigenvectors of X'X;

$\Lambda_{(r\Lambda r)}$ is a diagonal matrix of $\lambda_1 \lambda_2 \lambda_3 ... \lambda_r$ corresponding to the r eigenvalues of XX 'or X'X.

The elements of $X_{(nxp)}$ are given by:

$$X_{ij} = \sum_{k=1}^{r} \sqrt{\lambda_k} u_{ik} v_{jk} \quad i = 1,2...,n \quad j = 1,2...,p \quad (7)$$

Therefore, using the SVD, the selection of markers for dimension q for lines and columns of matrix X is calculated, as follows:

$$J_{(q)} = U_{(q)} \Lambda_{(q)} \quad (8)$$

$$H_{(q)} = V_{(q)} \Lambda_{(q)} \quad (9)$$

For a correct interpretation of the HJ-Biplot, several measures are essential: the Relative Contribution of the Factor to the Element relates to the part of the variability of the element explained by the axis; and the Quality of Representation is the sum considered factors' Relative Contribution of the Factor to the Element and only the points with good quality of representation can be interpreted correctly (Garcia-Talegon *et al.*, 1999). In the HJ-Biplot representation, the distance between row points is interpreted as similarity, and the angle formed by the vectors (variables) is interpreted as correlation. Finally, if a row point is close to a column point (variable), this is interpreted as preponderance (Garcia-Talegon *et al*., 1999).

Previous Studies

Several examples of the studies used as reference are presented as follows. Grünfeld *et al.* (2011) presented a set of innovation indicators applied to the Nordic countries. WIPO (2012) presented the Innovation Global Index (IGI) which measures the degree to which countries and companies integrate innovation into their spheres of business, political and social. The IGI contains a series of metrics that help provide a continuous assessment of innovation performance and policy innovation. Kutlaca (2008) presented a series of indicators for Serbia, which are interrelated and when they are aggregated to produce overall innovation capacity. Flor and Oltra (2004) reviewed the indicators of technological innovation activities of enterprises and classify them, then applying their study to an industrial sector in Spain.

For the European Union, Hollanders and Tarantola (2011) presented the methodological specifications of the Innovation Union Scoreboard (IUS), which is a EUROSTAT publication which allows the classification of the several European countries and that uses several types of indicators divided into the groups: "Enablers" - capture the main drivers of innovation, which are outside the company such as human resources and finance and support; the "Firms' activities", that incorporates dimensions such as links and entrepreneurship, and captures innovation efforts that firms undertake recognizing the fundamental importance of firms' activities in the innovation process; "Outputs" that capture the outputs of activities of companies. The IUS is based on data from the Community Innovation Survey (CIS) for 8 of its 25 indicators, which were collected directly from the United States, and that none of the regional data were validated by Eurostat. The Regional Innovation Scoreboard includes regional data from 12 of the 25 indicators used in the IUS (Hollanders *et al.*, 2012).

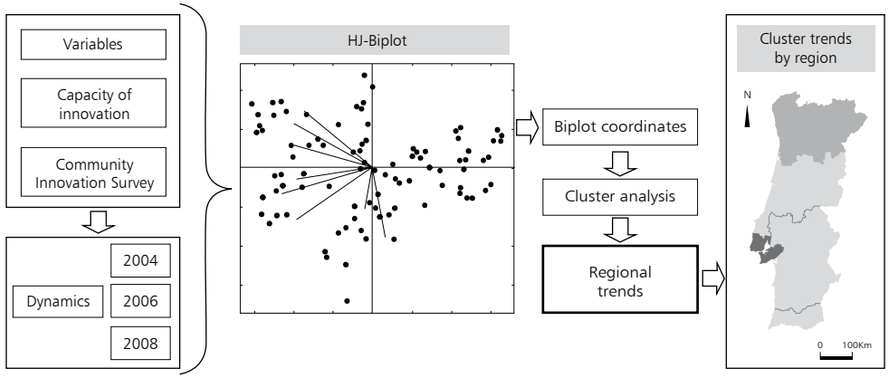
For Portugal, the Observatório da Informação e do Conhecimento (2004) made a proposal for mapping indicators of knowledge and innovation in Portugal. Based on this, Fernandes and Noronha Vaz (2005) also tried to investigate new indicators for the modes of learning in innovative firms of less advanced regions like Portugal and proposed a methodology to address

a different approach from those that have been used for more advanced regions. The overall implication of the results was that no one existing index dominates in explaining how firms attempt to innovate. Instead, we require a richer conceptual perspective that combines diverse issues. Noronha Vaz and Cesário (2008) identified a number of variables supposed to be able to characterize firms and regional performances towards different forms of innovation and demonstrate that firms' capacity to innovate is a complex attribute whose determinants change. Galindo *et al.* (2011), Noronha Vaz, et al. (2013) and Vaz, E., et al. (2014) presented a set of 10 indicators using binary variables for measuring the institutional capacity of dynamically innovate.

The Final Methodological Design

The methodological approach proposed combines a HJ-Biplot methodology for analyzing the NACE activities and regions through the years and for defining their dynamics and recognizing innovation path (Silva, 2010; Oliveira, 2011) existing a set of coordinates for each point that represents the situation of a region in a certain year. However, a methodology which only considers a HJ-Biplot methodology is limited, even with complemented with cluster analysis, for identifying regional dynamics, since it cannot visually present the spatial patterns of the territory. Therefore, we combined this analysis with a cluster analysis and a mapping of the detected variable behaviors, using a Geographical Information System (GIS). The following Figure 6 summarizes the methodological approach proposed.

Figure 6: General framework of the methodological approach



The methodological approach requires the implementation of several methodological steps in a sequential manner using a HJ-Biplot methodology, a cluster analysis and the mapping of resulting data in order to identify the individual regional innovation trends and it is divided in 5 main steps:

1. Data collection and selection of the indicators for measuring the innovation capacity of the areas or NACE activities.
2. Application of a HJ-Biplot methodology, in which the Regions position through the years of 2002-2004 (CIS 2004), 2004-2006 (CIS 2006) and 2006-2008 (CIS 2008) is represented in a HJ-Biplot visual representation. This allows identifying the situation of the several regions and initially to analyze the individual paths.
3. Application of a cluster analysis using the HJ-Biplot coordinates. If we are analyzing the NACE activities, the methodology would end in this step.
4. Identification of the regional trends and identification of common evolution paths.
5. Mapping of the detected clusters and respective trends.

The process of selection of the indicators aimed to valorize the indicators presented in the CIS that could better represent the capacity of innovation of the several Portuguese Regions and sectors. The indicators were selected considering not only the best representation of the regional capacity of innovation of Portuguese firms, but also the available information considering the CIS limits for analysis. Another key issue was the definition of a limited number of indicators that could easily be used by a HJ-Biplot methodology.

In our case, an initial set of indicators using as basis the CIS data was proposed as in Table 3. These indicators analyse not only the innovation developed within firms' activities, but also their capacity to create outputs and the cooperation with other entities (customers, firms or universities). All these indicators are expressed in percentage namely percentage of firms as provided by the CIS.

For analyzing the current Portuguese situation, we defined 2 lines of implementation of the methodological approach: 1) Development of a static HJ-Biplot analysis applied to the NACE activities; 2) Dynamic analysis of the regional tendencies. The analysis of the situation of the several NACE activities (rev. 2) is static and reports only to CIS 2008 (due to lack of data and methodological changes). The main dynamics of the regions are analyzed accounting three periods of analysis of each CIS: CIS 2004, CIS 2006 and CIS 2008.

Table 3: The set of indicators proposed for the analysis

COD	Description
INOPRO	Firms with product innovation
NOPRC	Firms with process innovations
INORG	Firms with organizational innovations
INMARK	Firms with marketing innovations
FINEST	Firms with technological innovations that received public support
ENMERCI	Innovator firms that sell in the international market
IEDIN	Firms with technological innovation that develop R&D activities in-house
MARK	Firms that develop marketing activities
NOVPR	Firms that produce new products to the market
DESP	Expenses in innovation
ECOOP	Firms with cooperation

Then, for the first line of this approach a 23 rows per 12 columns matrix is presented in Table 4. Furthermore, also a second matrix (21 rows per 12 columns) was built. The selection of the best HJ-Biplot representation, according to the process of data transformation was made by the analysts, and was selected the process double centering for both ones.

For defining the different homogenous groups, we used a hierarchal cluster analysis, where we selected the Euclidean distances as a dissimilarity index and for the linkage method we considered the ward's method, which means that it uses an analysis of variance approach to evaluate the distances between clusters.

Finally, for the technical application of this methodology we used a MultiBiplot beta version of 2012 developed by Vicente-Villardón, 2012.

Results and Discussion

Trends by Sector

The analysis of the situation of the several Portuguese NACE activities was made for the CIS 2008 (2006-2008). We used as method for transforming the data the double centering, and we chose to retain two axis for analysis, with 73.374% of the accumulated inertia. The relative contributions of the factor to the element are presented in Table 5.

Table 4: The absorption of the inertia

Axis	Eigenvalue	Expl. Var.	Cummulative
Axis 1	11729.721	53.023	53.023
Axis 2	4502.063	20.351	73.374
Axis 3	2229.449	10.078	83.452

(source: model results)

The axis 1 seems to be highly correlated with the following variables: firms with organizational innovation (INORG), innovator firms that sell in the international market (ENMERCI), firms with technological innovations that develop R&D activities in-in-house (IEDIN), expenses with innovation (DESP), firms with cooperation (ECOOP), firms with innovation activities (EINO). Therefore, this axis represents the research, organizational innovation activities and cooperation.

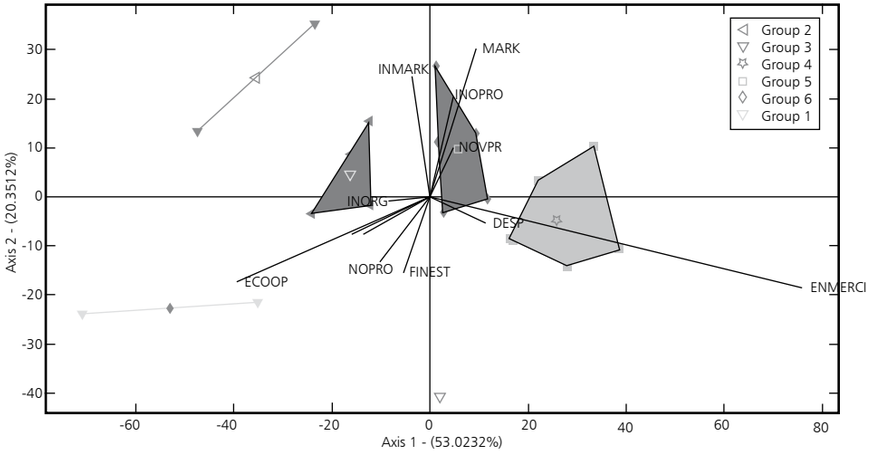
Table 5: The relative contributions of the factor to the element

Column	Axis 1	Axis 2
INOPRO	30	569
NOPRC	167	282
INORG	402	1
INMARK	16	755
FINEST	60	451
ENMERCI	925	55
IEDIN	232	49
MARK	72	755
NOVPR	66	335
DESP	123	28
ECOOP	733	143
EAINO	338	102

(source: model results)

Regarding the variables mostly represented in axis 1, it seems to be a strong correlation between the innovator firms that sell in the international market (ENMERCI) and the expenses in innovation (DESP). The innovative firms that develop organizational innovations (INORG) seem to be inversely correlated with the innovative firms that are selling of products in the international market (ENMERCI). Also there seems to be an inverse correlation of the firms that sell in the international market (ENMERCI), with the ones that develop activities of cooperation (ECOOP). There also seems to be a strong correlation of the firms with cooperation (ECOOP), with the variables firms with innovation (EINO) and the developing of activities of R&D inside the firms (IEDIN), which means that cooperation is a key aspect for the research activities and for innovation within the firms.

Figure 7: Bidimensional representation HJ-Biplot- NACE activities



With respect for the variables better represented in axis 2, we are able to conclude that there is s strong correlation of the firms with marketing innovation (INMARK), the firms that develop marketing activities (MARK), the firms that develop innovations in the product (INOPROD) and the ones that introduce new products to the market (NOVPR). We are also able to conclude that there is a inverse correlation between the firms with marketing innovation (INMARK), the firms that develop marketing activities (MARK), the firms that develop innovations in the product (INOPROD) and the ones that introduce new products to the market (NOVPR) and the enterprises that receive public funding (FINEST).

The application of this method allows us to identify the emphases that sectors give to the different kinds of innovation, namely:

- **Group 1** – *Sectors oriented towards organizational or marketing innovation:*
  - Telecommunications and computer consulting (61 to 63),
  - Law, accounting activities and social networks (69 to 70),
  - Residual waters and decontamination (37 a 39),

- **Group 2** – *Sectors oriented towards organizational or marketing innovation:*
  - Human health (86)
  - Financial activities and insurances (64 to 66).
- **Group 3** – *Sectors oriented towards a high financial support from the government*:
  - Construction (42 to 43)
- **Group 4** – *Sectors oriented towards the international market, also tending to invest in innovation:*
  - Textiles, clothes and leather (13-15)
  - Informatics, electric equipment and motor vehicles (26-30).
- **Group 5** – Sectors multi-oriented towards emphasizing product innovation:
  - Food industry, drinks and tobacco (10 to 12)
  - Gross and retail commerce, vehicle reparation (46 to 47)
  - Architecture, engineering and publicity (71 to 73)
- **Group 6** – *Highly cooperative sectors, developing R&D activities in house and also oriented towards processes innovation*:
  - Electricity gas and water (35);
  - Water distribution and extraction activities (36).

Trends by Region

For analyzing the regions and their trends, we retained two axis with 69,93 % of the accumulated inertia (Table 6).

Table 6: The absorption of the inertia-regions

Axis	Eigenvalue	Expl. Var.	Cummulative
Axis 1	9325.284	40.88	40.88
Axis 2	6626.541	29.05	69.93
Axis 3	2534.798	11.112	81.042

(source: model results)

The relative contributions of the factor to the element are presented in Table 7.

Table 7: The relative contributions of the factor to the element -regions

Column	Axis 1	Axis 2
INOPRO	633	180
NOPRC	625	151
INORG	190	690
INMARK	20	342
FINEST	357	252
ENMERCI	710	152
IEDIN	13	68
MARK	92	285
NOVPR	761	1
DESP	282	275
ECOOP	392	100
EAINO	635	274

(source: model results)

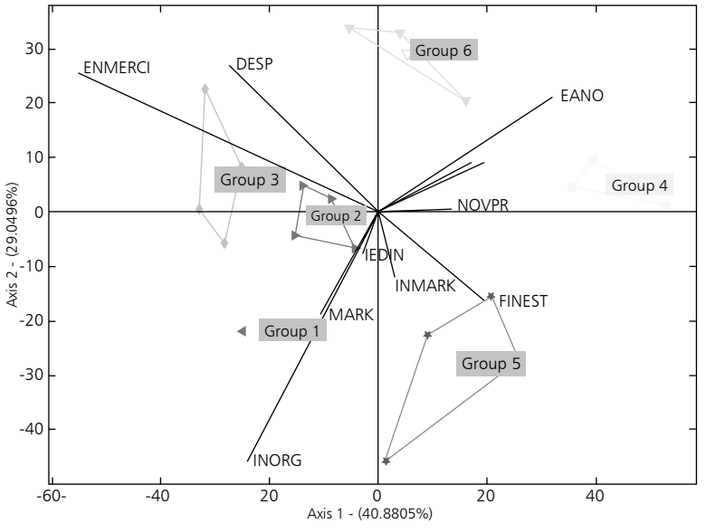
The interpretation shows that the axis 1 seems to be highly correlated with several variables such as: firms with product innovation (INOPRO), firms with process innovation (NOPRC), firms with technological innovations that received public support (FINEST), innovative firms that sell in the international market (ENMERCI), firms that produce new products to the market (NOVPR), expenses with innovation (DESP), firms with cooperation (ECOOP), innovative firms (EAINO). Therefore, this axis represents the technological and product innovation and research activities.

The axis 2 is also highly correlated with firms with organizational innovations (INORG), firms with marketing innovations (INMARK), firms with marketing activities (MARK). Therefore, it seems to represent the organizational, marketing and selling activities. Its bidimensional HJ-Biplot representation is presented next in Figure 8.

With respect for the variables better represented in axis 1, it seems to be a strong correlation between firms with and product (INOPRO) and the ones that present process innovation (NOPRC) and activities of cooperation (ECOOP). The firms that produce new products to the market (NOVPR) are also correlated with these ones. The enterprises that sell in the international market are correlated with the expenses in innovation.

Regarding the variables better represented in axis 2, the firms with organizational innovations (INORG) are highly correlated positively with the ones that develop marketing activities (MARK), but also with the firms with technological innovation that develop R&D activities in-house (IEDIN). There is also an inverse correlation of these with the firms with product and process innovation and activities with cooperation.

Figure 8: The bidimensional HJ-Biplot representation



(source: model results)

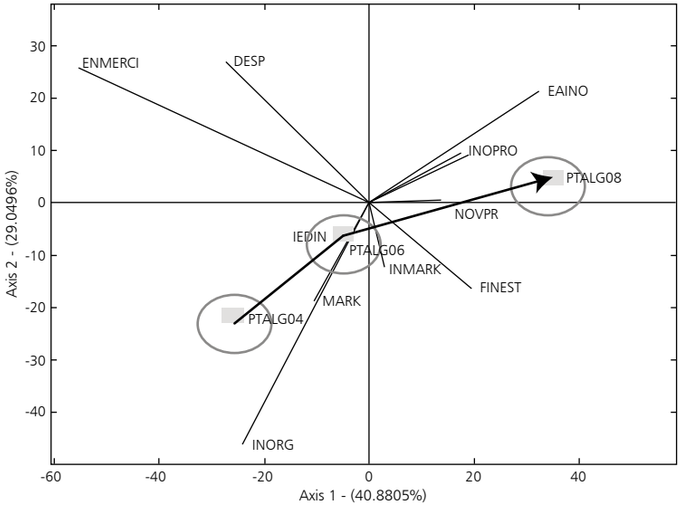
Therefore, the following groups were identified:

- **Group 1** – *Regions mostly developing organizational innovation and marketing, also where the firms tend to develop R&D activities in-house:*
  - Algarve in CIS 2004
  - Alentejo in CIS 2004
- **Group 2** – *Regions where firms tend to sell in the international market by producing organizational innovation, with government support and the development of R&D activities in-house.*
  - Centro in CIS 2004 and CIS 2006
  - Algarve in CIS 2006
  - Alentejo in CIS 2006
- **Group 3** – *Regions oriented to invest in innovation and the presence of innovative firms that sell in international markets.*
  - Norte in CIS 2004 and 2006Lisboa in CIS 2004 and 2006
- **Group 4** – *Regions with cooperative enterprises, bring new products to the market and process and product innovation taking place.*
  - Algarve in CIS 2008
  - Madeira in CIS 2008
  - Azores in CIS 2008
- **Group 5** – *Regions with innovative firms supported by the government and that tend to introduce innovation in their marketing activities*.
  - Madeira in CIS 2004 and 2006
  - Azores in CIS 2004 and 2006
- **Group 6** – Regions with a mixed highly innovative profile. These present a good investment in innovation and try to sell their products in the international, insisting in several innovations activities.
  - Norte in CIS 2008
  - Lisboa in CIS 2008
  - Centro in CIS 2008
  - Alentejo in CIS 2008

Regional Patterns and Trends

Firstly, an individual detailed analysis of the path and tendencies of each region is presented. Figure 9 illustrates the potentialities of this methodology showing that, for example, the Region of Algarve (in the CIS 2004) was oriented towards marketing activities, although firms were not oriented towards process or product innovation. In the CIS 2006 this same region developed towards a composed profile with evidence of investment in other aspects of innovation. In the CIS 2008, a clear increase of more innovative firms introducing new products to the market is to be observed. Crucial to be highlighted in this case is the decrease of the number of firms that sell in the international market.

Figure 9: Example of detailed analysis of individual tendencies

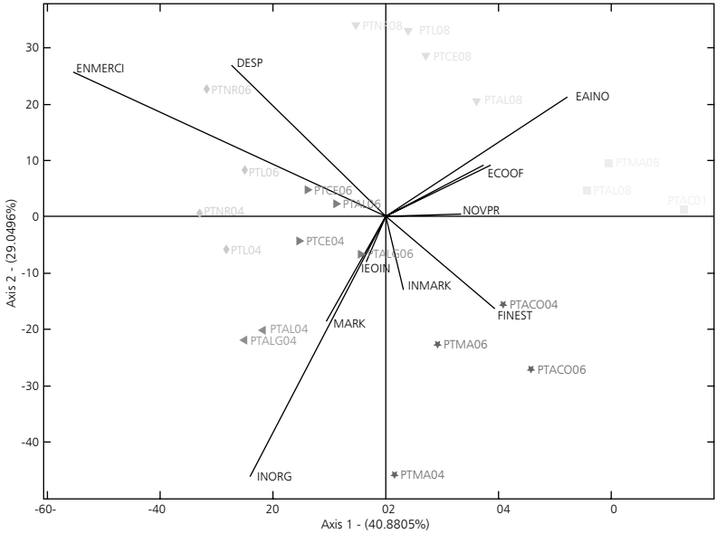


(source: model results)

The following up of regional patterns trough the attentive observation through the years adds a dynamic character to our study, defining regional trends T, as presented in Figure 10:

- T1 – Represents regions with a trajectory towards internationalization, tending to a highly innovative mixed profile and with a great investment in innovation.
- T2 – Represents regions with a mixed trajectory towards internationalization, tending to a mixed innovative profile. Considering the different groups, they evolved from group 2 to group 6.
- T3 – Represents regions tending to decrease investments in marketing activities evolving towards a more mixed profile, and introducing process innovation.
- T4 – Represents the change of emphases on organizational innovation and abundance of marketing activities and R&D in house towards the introduction of product and process innovation. Interesting to note that these regions tend to not valorize the selling of products in the international market.
- T5 – Represents those regions with most of their innovative firms supported by the government. These tend to introduce innovation in marketing activities, promoting product and process innovation. Also these regions tend to not sell their products in the international market.

Figure 10: Representation of individual tendencies



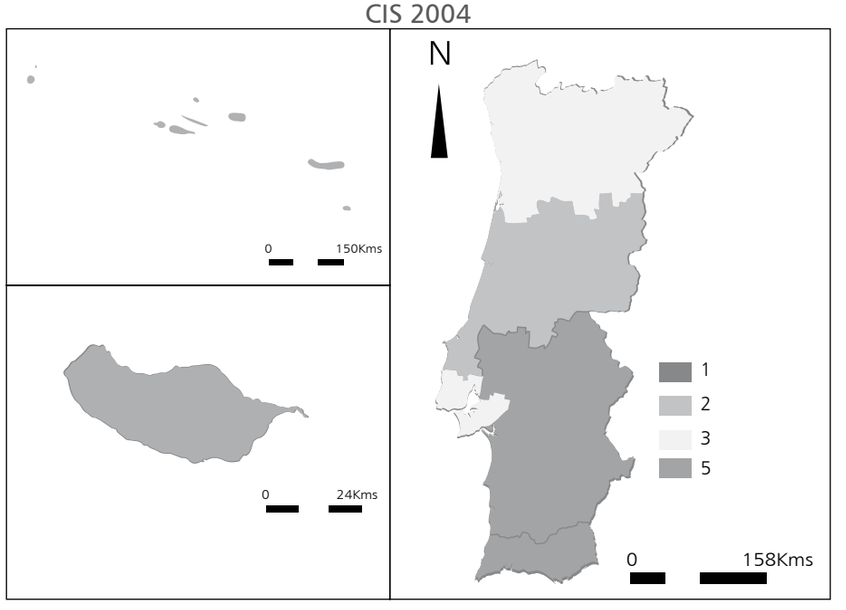
(source: model results)

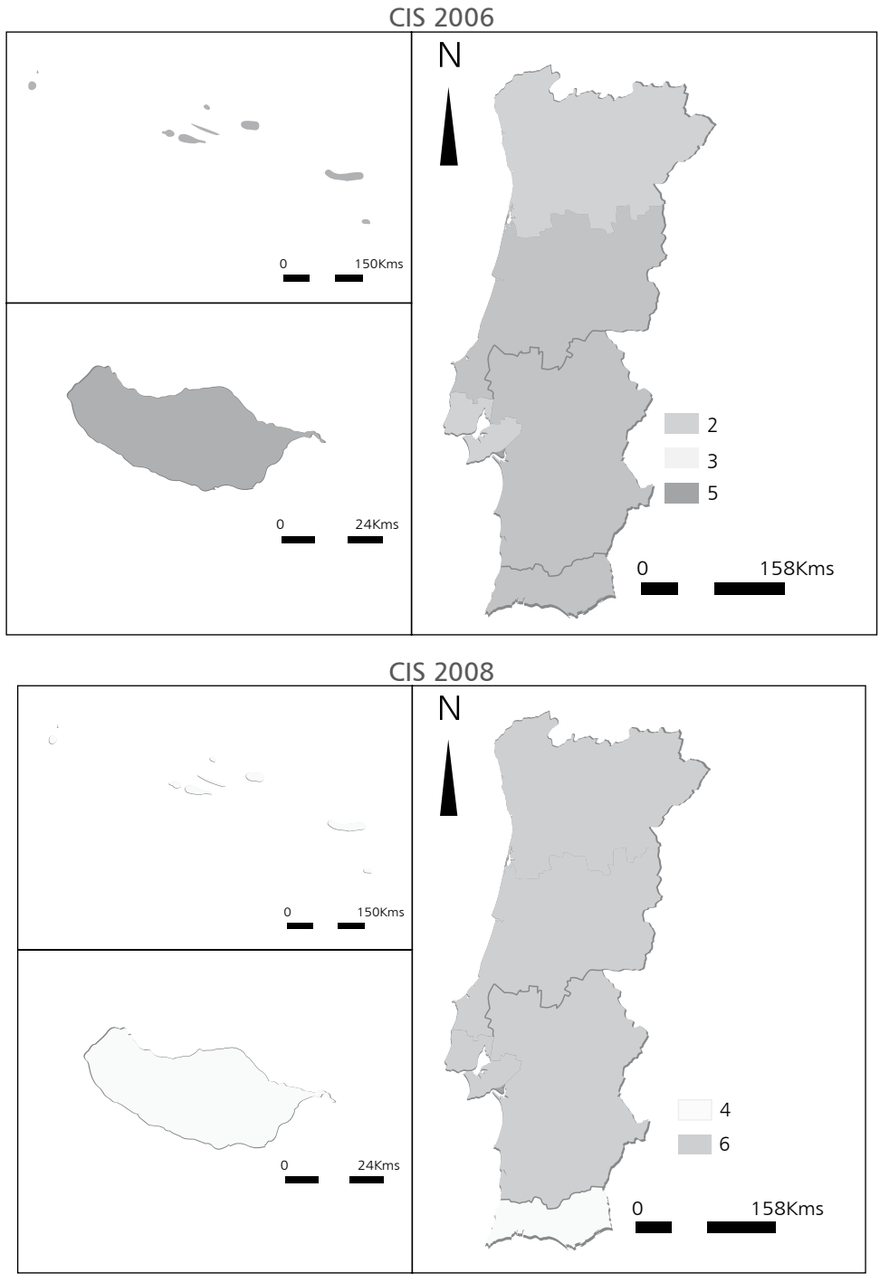
The trends identified above focused on the changes that took place in the several years considered, by region are mapped in Figure 11.

In the years 2002-2004 (CIS 2004) the southern Portuguese regions were integrated in the group 1, which means that they were more oriented towards organizational innovations and marketing activities. The Norte and Lisbon Regions were integrated in group 3 which means that they had a considerable expense in innovation and that the firms were oriented towards the selling of products in the international market. They were more internationalized regions. On the other hand, the regions of Açores and Madeira were integrated in the group 5 and they were characterized by the fact that the firms tried to innovate in marketing activities there was considerable financial support from the government. Finally the Centro region presented a mixed medium profile with a small orientation for innovational organizations and for selling products in the international markets.

In the CIS 2006 (2004-2006), the autonomous regions (Açores and Madeira), Norte and Lisbon did not change. Algarve and Alentejo, integrating group three, with mixed innovation characteristics.

Figure 11: Sectors trends by region

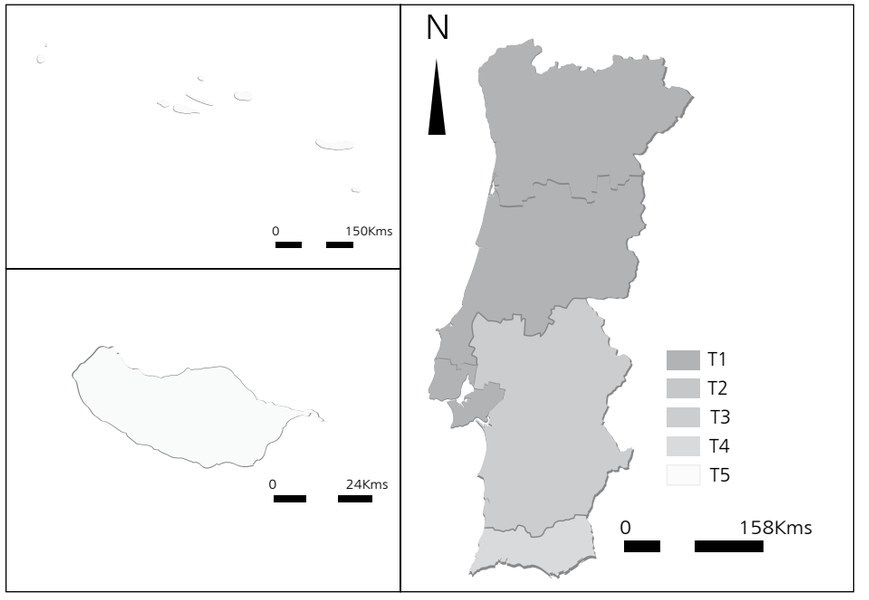




Finally, in the CIS 2008 (2006-2008), several changes took place: All the regions in continental Portugal with the exception of the Algarve integrated in the group four, meaning a more innovative profile and an orientation towards innovative firms to be investing more intensely and selling in the international market.

The paths followed by the regions can be grouped in tendencies, which are summarized in the Figure 12. It shows that the tendencies of each region are regionalized, some of them being integrated in the same group.

Figure 12: The spatial representation of the regional tendencies



(source: model results)

Concluding Remarks

The methodological approach presented in this chapter allowed achieving the main objectives of the work, providing a careful and detailed picture of the main Portuguese regional firm's innovation trends. More specifically, the methodological approach was able to analyze the main dynamics of innovation in the Portuguese regions and to assess the current situation of NACE activities. It was proved that the methodological approach was able to identify regional spatial patterns, being a relevant tool for policy analysis and for policy evaluation.

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Innovation networks and cooperation flows in the Portuguese innovation system: The determinants of new product development

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Chanda Faustino

Introduction

Innovation is a relational process that involves a diversified group of actors connected by linkages with different degrees of intensity (Fløysand and Jakobsen, 2010). It is characterized by a variety of cooperative activities centered in the development of new products and processes and to increase competitiveness. The systemic perspective of innovation is particularly relevant as it integrates complex interrelations among enterprise, science and technology, and governance spheres, infrastructure, and institutions. Even if initiated with a focus in nation-states performances, the attention to sub-national scales gave prominence to territorialized visions of the innovation dynamics. One example is the term 'regional system of innovation' (RIS) that came into use in the early 1990s, informed by in-depth research on a number of European industrial regions (Uyarra and Flannagan, 2013).

Territorialized visions of the innovation system are commonly understood as innovation networks and institutions that are geographically defined, administratively supported, that interact regularly and strongly to enhance the innovative outputs of firms (Cooke and Schienstock, 2000). Innovation networks are in essence the sets of relationships, ties or links between nodes that represent the existent innovation actors, persons, firms, organizations, interacting in the generation, use and dissemination of new knowledge (Fischer, 2006a), allowing learning and innovation (Lundvall, 1992; Capello, 1999; Asheim, 2007). There are distinct configurations, origins and implications for networks. The concept of network is a major focus of analysis of the economics of innovation but remains unclear the explanations about internal features and the identification of effects on economic dynamics.

In the present chapter, we are focused in the determinants of innovation networks. It is particularly important to understand how innovation relates with different patterns of cooperation activities regarding knowledge production, exchange and transfer. In parallel, we are interested in understanding the variety of innovation actors and their likelihood to engage in innovation given behavioral constraints.

To these goals, the chapter is organized as follows. A first section reviews evolutionary and institutional perspectives on innovation networks, clearly separating this notion from other interconnected, knowledge network. Two catalysts of innovation networks are explained with

additional detail, absorptive capacity and knowledge spillovers. A second section presents methodological notes about the empirical analysis and the interrogations that this study is trying to address. A third section presents an econometric exercise that provides insights for the determinants of innovation networks. The chapter concludes with policy implications.

From Knowledge Flows to Innovation Networks

Evolutionary and Institutional Perspectives on Innovation Networks

The evolutionary and institutional perspective of innovation has a complex approach when compared to simplistic models that assumed only economic relations in the territory based on geographic proximity as the basis of innovation dynamics. Largely influenced by Nelson and Winter (1982) and Lundvall (1992), this perspective unveils a multifaceted and multi-stakeholder process, characterized by different types of relationships at various levels, such as social, historical, cultural, beyond a narrow economic approach. Territorial dynamics of innovation is defined in a systemic way based on a complex environment and how this complexity defines the innovative capacity.

A first premise is that current innovative dynamics is a consequence of evolution, resulting in a sequence of trigger decisions along the pathway. Reality is therefore not static but dynamic, evolves over time and is path-dependent. In this framework, it is impossible to predict a priori the agents behaviour. A second premise is that processes underlying relations linked to innovation, knowledge creation and transfer, relate to interactive learning (Kirat and Lung, 1999). A third premise is that knowledge is a process itself, not only coming from R&D, since there are many ways of learning, through learning by doing, learning by using, learning by interacting (Lundvall, 1992), the so-called DUI mode of learning. The existence of these evolutionary processes of learning and knowledge are rooted in the territory.

Territory is essential for the creation of innovation. Geographical proximity increases the transfer of tacit knowledge based on face-to-face contacts. The territory becomes the environment where the process of knowledge creation happens, which depends on the competitiveness of regions and existing companies. Geographical proximity is important, but other types of proximity are also relevant (Boschma, 2005).

This idea is diffused by the concept of learning economy (Lundvall, 1996), reflecting that a key factor to competitiveness is the constant pursuit of interactive learning that occurs in the territory. Therefore, an essential feature of this type of economy is a high degree of innovation, with a very rapid rate at which skills become obsolete and new competencies are developed. In addition to the relationships and interactions of learning, the *milieu innovateur* is endowed with a driving force of innovation. It is essential the attitude of the community toward the promotion of interactive learning, requiring an intention of agents in developing innovation processes and creating synergies in the territory (Capello, 1999; Camagni and Capello, 2009). The territory is seen as a relational space (Capello and Nijkamp, 2009), understood as the space based on collective action, in interpersonal synergies, informal cooperation that empowers and guide actors' behaviour (Bramanti and Riggi, 2009).

This chapter assumes three basic elements that give continuity and a logical framework to the process of knowledge creation in territory: institutions, routines and cumulative knowledge. Institutions provide the foundations for the innovation process, creating stability in uncertainty. They refer to habits, rules, traditions of a given society that are embedded within history, culture and the specific developmental trajectories, humanly devised constraints that structure political, economic and social interactions (North, 1991). Routines are created and followed by actors, conferring more predictability to performance. Routines reflect embedded knowledge in organizations, which were created through experience. According to Nelson and Winter (1982), routines shape the behaviour of firms in order to enable the ability to have a decision before the problems emerge. Knowledge is cumulative as current knowledge depends on the previous accumulated knowledge, defining future developments regarding the direction of innovative enterprises and path dependencies from which territories can hardly escape (McCann and Van Oort, 2009). More precisely, in the view of Storper (1997), relationships that emerge within a given territory define the technological trajectories that may be more or less favourable to innovation.

In contrast, territories do not have the same record of accomplishment of innovation because these three elements function as stabilizers, are disparate among regions, as well as the interaction within each territory is distinct. From the systemic perspective of Edquist and Hommen (1999), these differences are recognized and considered fundamental to understanding the complexity of innovation in the territory. This theoretical perspective represents a systemic approach in a broad sense. Based on the analysis of Chaminade and Edquist (2006) systems derive from the fact that innovation is the result of continuous and complex interaction between agents, and not separate components. An innovation system is a set of actors that interact with the aim of creation and diffusion of knowledge, involving a number of different agents turned to the promotion of new knowledge and its economically useful application, innovation. The commitment between actors may be or not formal, as different types of interactions occur within the innovation systems (Edquist and Hommen, 1999, Capello, 2009b). Essentially, there is a focus on cooperation to foster knowledge flows. It is assumed that the greater the interaction, commitment and cooperation between the actors involved, the larger the innovation promoted within the system. The innovation system is based on the possibility that innovation process flows do not follow a route defined a priori. This is only possible by assuming that knowledge derives not only from scientific knowledge but also from the combination of different synthetic, analytical and symbolic forms of knowledge (Cooke and Leydesdorff, 2006; Asheim, 2007).

Innovation system approach can focus different scales and perspectives, from National Systems of Innovation (Lundvall, 1992), Sectoral Innovation Systems (Malerba, 1999) to Regional Innovation Systems (Cooke, 1998, Cooke and Leydesdorff, 2006, Asheim, 2007). The National Innovation Systems (NIS) have their main contributions in Lundvall (1992), Freeman (1995) and Nelson (1993), whose basic argument is that innovation comes from a socially embedded process of learning which can only be understood if framed in the institutional architecture, historical context and culture of a particular nation-state. According to this view, the dynamics of innovation regard to the fact that all individuals belong to a nation, defined by common culture, language and ethics, which are obtained in a single geographical space under one central state authority. The concept of Regional Innovation System (RIS) is inspired by the concept of NIS and coincides in several issues with other territorial models of innovation such as clusters or

industrial districts (Asheim, 2007). The similarities with the NIS are notorious, in the sense that also emphasize that the dynamics of innovation depends on elements that are embedded in both the territory and society, to the extent that these elements promote interactive learning. However, the importance is given to the regional level rather than national. This focus is justified by the existence of cultural and institutional differences between regions, different types of interactions that are developed specifically within each region (Cooke, 1998). RIS combines a focus on regions with a systemic approach (Cooke and Leydesdorff, 2006). Moreover, regions would be more prone to the establishment of systemic relations between the actors (Asheim, 2007), through the strengthening of relations of trust (Cooke, 1998) that exists at the regional level, given the geographical and cognitive closer relation.

Furthermore, in the innovation system perspective the linear model is replaced by chain-linked versions (based in Kline and Rosenberg, 1986), admitting multiple interactions in many different ways, loopbacks and feedbacks among actors as an essential source of innovation and self-reinforcing processes (Edquist and Hommen, 1999). In this perspective, innovation systems are not tangible or restricted, are internally "alive" and relate primarily to knowledge. Refers to a network of complex relationships which allow knowledge flows to reproduce continuously. For this continuity to occur, innovation systems have to be opened, linking with other systems of innovation (Bramanti and Fratesi, 2009; Bramanti and Riggi, 2009), giving relevance to the role of networks and connections of territorial actors with other external networks (Fratesi and Senn, 2009). Each system has its own channels that enable and allow its existence. More precisely the relationships between agents, which are the essence of an innovation system, when developed for a certain period of time, and being continually enhanced, promote the stabilization of networks (Chaminade and Edquist, 2006).

Networks may have different origins and be constructed in different ways. Knowledge sharing gives a special feature to the dynamics of innovation systems, shared knowledge usually results in the increasing of the reservoir of knowledge, contrasting with other economic inputs and factors of production that seem to diminish (Sveiby, 2001). This situation created a growing emphasis on networks as a fundamental strategy for competitiveness. In the words of Storper (1997), if mass production was the recommended strategy three decades ago, currently the best strategy is the participation in networks. Networks in the context of knowledge economy imply the need for two key elements: cooperation and intentionality (Visser, 2009). Cooperation involves necessarily not only companies but other actors such as universities, research institutes, laboratories, public agencies and government. Knowledge networks are strategic processes in the sense that they are intentional, selective and repetitive, albeit temporary, of knowledge exchange between innovation actors.

Three aspects derive from the ideas explained above: first the existence of knowledge networks is a prerequisite for the dynamics of innovation in a systemic approach. The second aspect involves the attribute of trust. Networks involve a certain stability of relationships, so there is a central role for trust among the agents involved. Trust is the foundation for the promotion of knowledge sharing as it allows the reduction of risk and uncertainty (Capello, 1999). Trust is so important in the dynamics of innovation that the breach of trust is fatal to the successful operation of systemic interaction (Cooke, 1998). The third aspect derives from the recognition that for one hand, innovation involving creation and transfer of knowledge is essential for economic competitiveness, on the other it is assumed that new knowledge does not always necessarily lead to economic gains. Not all new knowledge is innovation. This last point raises a question, how to ensure that knowledge flows effectively become economically useful?

The relationship between knowledge and economic growth is no longer clear or obvious in evolutionary and institutional frameworks. More precisely, knowledge networks alone do not guarantee economic gains. Knowledge generated must be channelled in a specific way for promoting its economic valorisation, transforming invention into innovation, which is new economically useful knowledge, often connected with new product development. It is necessary that knowledge networks evolve into innovation networks, which require intense and fluid knowledge flows (Camagni and Capello, 2009; Cooke, 1998).

In sum, it is argued that innovation networks have three additional features beyond the cooperation and intentionality characteristics of knowledge networks (Nijkamp *et al.*, 2010):

- Endowned with intelligent agents in the sense that they have a purpose, not only to work, but with the ability and intention to search for learning in a broad sense, aimed at the continuous creation, assimilation, use and transfer of knowledge with a logical and useful purpose. Agents do not only receive knowledge passively but are creative, find new solutions, actively contributing to the increasing complexity of knowledge.
- Exchange relations of knowledge are intense. The idea of intensity refers not only to the amount of knowledge exchanged in time. The intensity is related to the proximity of interests and with the opening of mentality, towards an open exchange and spontaneous knowledge. There is a focus towards the quality of relations and a real commitment to knowledge sharing and interactive learning.
- Thirdly, innovation networks have a dynamic synergy. This aspect comes from the cognitive environment that involves innovation networks, ensures the strengthening of networks and the continuity of evolutionary dynamics of the innovation system. It fosters innovation and provides the economic purpose of the network.

Altogether, innovation networks originate robust innovation systems, having an internal renewal capacity, making flows complex, as they create and distribute knowledge (Smith, 2002). A system of innovation is a framework that will encompass internal innovation networks but also external connectedness. In short, it is very important to emphasize that networks have an essential role on the systemic approach. Innovation systems consist of relationships and networks are the channels that enable these relationships.

Absorptive Capacity and Spillovers as Catalysts for Innovation Networks

Companies expand and enhance innovation networks by strengthening internal and external interaction, creating impacts at the individual level. These impacts reflect in increased awareness and absorptive capacity of individual knowledge, which in turn will lead to an improved ability of the firm to leverage the individual capabilities and increasing absorptive capacity to absorb knowledge at the enterprise level. Absorptive capacity is the capacity created by the company to explore, evaluate and use external knowledge. This ability depends on prior knowledge that can be derived from the basic knowledge, as a common language, to the latest technological

knowledge (Cohen and Levinthal, 1990). Building this absorptive capacity involves complex issues related to the interaction between the internal components of the firm and the external environment. These interactions are systemic and self-reinforcing.

Therefore, it is observed that absorptive capacity, although a critical element of the innovation process by shaping the learning ability, depends on complex interactions between the company and its internal elements. There is a reciprocal learning, creation and use of knowledge between the individual and corporate level, mutual reinforcement in the creation of new knowledge. This issue is also related to the interaction between the firm and its external environment, to explore outputs of others' R&D. Absorptive capacity is essential to learning, since a company is not able to assimilate external knowledge passively.

The intrinsic logic of this approach is that external spillovers encourage companies to invest in internal R&D. These investments, when performed collectively favour spillovers. More knowledge flows from firms stimulate more investment in R&D. Companies seek to have greater absorptive capacity to benefit from advantages from available external knowledge. This view is closer to systemic approaches on knowledge creation in the firm (Nonaka, 1991; Sveiby, 2001). Here both the organization and its cells, people who work in the company, are not mere functional departments but actual entities able to create new knowledge. There is an interaction between people-company-external environment, jointly developing a systemic process for knowledge creation.

This broad understanding of absorptive capacity as a systemic phenomenon, which involves both internal and external dimensions of the company from a perspective of mutual strengths, stresses two key ideas already discussed. The generation of knowledge does not imply economic usefulness (Bramanti and Riggi, 2009). Moreover, the process of learning that underpins the dynamics of innovation is a complex process that involves complex relationships between the company and its internal elements, as well as the external environment.

The concept of absorptive capacity puts emphasis on the need to balance the development of internal and external knowledge both from the point of view of companies (Fabrizio, 2009) and from the point of view of the region (Bramanti and Riggi, 2009; Fratesi and Bramanti, 2009). In this context, an analysis of spillovers and enabling the interaction between the firms and the creation of knowledge is essential.

Starting from the initial vision of Marshall (Marshall, 1920) based on the existence of knowledge spillovers that occur outside companies, but within a given territory, these knowledge flows relate to specialized knowledge within the industrial sector. More precisely, Fischer (2006) argues that spillovers are externalities that flow between producers and/or users of innovation. These externalities are essentially knowledge flows. Maintains the idea that spillovers are spatial phenomena because are geographically bounded (Audretsch and Feldman, 1996; Capello, 2009a; Fischer *et al.* 2009).

Innovation is the result of an interaction between local actors, government and research institutions, within these interactions enable companies to overcome their internal needs through relationships established in the territory (Fratesi and Senn, 2009). This dynamic tends to be self-reinforcing, since the companies tend to seek external knowledge. As knowledge becomes more complex, the knowledge produced internally is no longer sufficient.

Starting from a basic assumption that geographical proximity effectively promotes the exchange of tacit knowledge through face-to-face contact, there is nevertheless a broader perspective on how this dynamic develops. Tacit knowledge is essential for creating competitiveness through innovation, by its own intrinsic characteristics: it is hardly codified, takes extensive time periods to be acquired and is obtained primarily through experience, is extremely expensive and sensitive to the social context (Maggioni and Uberti, 2008). Therefore, this kind of knowledge is central in the economic sense, it is hardly imitable or transferable to other regions and may be a source of competitiveness. Consequently is physical proximity that enables the transfer of tacit knowledge. However, physical proximity is not sufficient to ensure knowledge flows that create the knowledge spillovers. It takes intrinsic aspects of the territory, which enable these flows arising. These aspects of the territory are connected with the social capital (Putnam, 1995) referring to the characteristics of a given society as networks, trust, norms that facilitate coordinated action and function as the glue that facilitates cooperation and learning (Cappellin and Steiner, 2002). The social capital is a complex phenomenon that involves the relationship and value of a particular group of players that can be activated to produce benefits to those that possess it (Field, 2003). It relates directly to the notion of embeddedness (Granovetter, 1985), suggesting that the actors do not work outside a social context, but are not limited to fulfilling a pre-determined role in accordance with the socio-cultural categories that occupy within the network. Social capital is configured as crucial for innovation as it has impacts both the performance of businesses and regions (Cooke *et al.*, 2005) due to the impact that has on the innovative dynamics of both. More precisely the economic, social, cultural and historical yields a certain social capital, which in turn defines the cognitive models and learning in each region in each moment. It is worth noting that social capital is a spatial phenomenon. The first reason relates to the spatial distribution of actors that possess social capital. But other reasons are also relevant. A dense network of relationships is easier to maintain with proximity. This is even more true for weak links that need to be consistently lubricated, and are seen as crucial to the innovative dynamics (Rutten et al., 2010).

The social filter (Rodriguez-Pose and Crescenzi, 2008) is the result of cognitive models and innovative within accumulated over time. A socially embedded component translates how a given society comprehends the knowledge and decides innovative directions to be taken. As a result of the social filter, social structures ensure that spillovers are translated into economic growth and innovation (*ibidem*). Thus, this filter shapes how innovation is produced, but also determines the extent and efficiency in the dissemination of knowledge and innovation (Rodriguez-Pose and Crescenzi, 2008).

Beyond the social filter, it is argued that the level of entrepreneurship in a region, which is a second element in the central dynamics of innovation that ensures that knowledge is transformed into economic gains (Audretsch *et al.*, 2005; Audretsch and Keilbach, 2008; Audretsch *et al.*, 2008; Capelllo and Nijkamp, 2009; Fischer and Nijkamp, 2007). Audretsch *et al.* (2008) develop the idea that social capital can flourish in a given society for entrepreneurial behaviour, favouring risk propensity, promoting the entrepreneurial capital. The development of entrepreneurial capital represents the dynamics in which knowledge generated by a company flows to market opportunities (Audretsch *et al.*, 2008). In this process there is a systemic relationship between firms and the environment. More precisely, Fischer and Nijkamp (2007) show that the entrepreneur has a key role as agent of economic change. Entrepreneurs' decisions are driven by goals of effectiveness where the action is

sought new and creative. Under such conditions, the business environment is exceedingly important: opening the exchange of information, face-to-face interaction, the presence of knowledge centres, R&D facilities, skilled labour force, reliable and robust codes of conduct.

In short, social capital - established norms and rules based in social, cultural and historical aspects - provide a social filter - a template that filters social recognition and use of new knowledge so innovative decisions can be taken - and determines the degree of entrepreneurial capital - the aptitude of agents in incurring risks and the ability of the region to support and encourage entrepreneurship. Under this approach, Fischer and Nijkamp (2007) point out that knowledge spillovers are then an important condition to accelerate economic development in an economy embedded in a competitive space.

The assumption that spillovers are territorially bounded implies physical proximity to the territorial dynamics of innovation, giving relevance to notions such as cluster or regional innovation systems. Assuming that both RIS and clusters are rooted in the territory, the main difference between these two models lies in the understanding of the formation of spillovers and the dynamics of innovation. Note that RIS emanate from the territory, but its origin depends on social capital that conditions the social filter and entrepreneurial capital in favour of creating spillovers, which lead to an evolutionary process enabling or not the innovation system. In the case of clusters, these aspects are often neglected because in the cluster concept is implicit the idea that spillovers are automatic, whereas agglomeration originates necessarily innovation (Porter, 1998).

Apart from this aspect, a second distinction can be made between both concepts and through the role of the network. In the case of clusters, its essence is the concentration of similar businesses in the territory, where there are vertical and horizontal relationships, therefore networks of economic activity. In RIS, the assumption of the existence of knowledge networks, whose evolutionary process in the region will lead to innovation networks. These will be equipped with intelligent actors, intense relationships and dynamic synergies that, as Cooke (1998) points out, are committed to interactive learning. Specialization is important but diversity and complementarities of related actors and sectors is critical to the creation of Jacobs' spillovers in the RIS. This can be understood as 'related variety' (Frenken *et al.*, 2007). Innovation networks constitute relevant part of the RIS, as in the case of clusters, innovation networks may exist but are not a central dimension, once focus is in economic relations. The concentration, in the original concept of clusters, around particular economic activity in a given territory, may promote knowledge creation process but in the essence of the concept and explanatory theory there is no focus to prove that it has be done.

This distinction between cluster and RIS has at least two important implications: the first is that to analyze the dynamics of innovation in the territory, the focus can no longer be purely macro or micro economic, because these approaches do not capture the complexity of relational space. The analysis should take a mesoeconomic perspective, focusing on the dynamics of innovation networks. This level focuses on the relationships between the actors, instead of observing reality under a fragmented prism that is directed only to each participating element of innovation. Thus, a meso perspective provides a more satisfactory perception of the essence of the territorial structural changes.

Methodological Notes

Theoretical Framework, Data Collection and Selected Variables

Having presented the interest in studying innovation networks, as they are central for innovative dynamics and to structure robust innovation systems, in the following empirical section we will develop a confirmatory study about the types of cooperation flows that are prominent in innovation networks.

We depart from the notion that innovation networks to exist require the focus in the economic usefulness. This is the distinctive character of innovation when compared with invention. The analysis gives emphasis for new product development, one of the types of innovation (OECD, 2005) that more clearly relates to direct economic benefit.

The empirical study intends to underline how innovation is explained by different patterns of cooperation channels and agglomeration. The study also provides evidence of determining the probability of generating innovation given the behavioral constraints and the different types of entity. To this purposes it was necessary to gather data that provided information about the type of actors in the system, their spatial location, and the innovation-related cooperation activities.

The data collection was performed with a careful observation of 820 internet websites of innovation actors. The data collected refers to the Portuguese innovation system. Details on the relevance of this case can be found in Guerreiro and Pinto (2012). The database collection and sample are specified in detail in Galindo *et al.* (2011). The clean database comprised 623 organizations. The content analysis of the qualitative data on the websites facilitated the creation of 12 binary variables related with the cooperation flows (Table 8). Descriptive statistics for all variables are presented in annex.

Table 8: Selected Explicative Variables

Variables	Explanation	Number of 1s
CENTRAL_CITY	A dummy variable 1 if organization is located in the capital city (Lisbon)	181
FIRM	1 if the actor is a firm	297
UNIV	1 if actor is a university or other public research organization	128
ORI	1 if specific orientation towards innovation	262
COOP	1 if promoting partnership and cooperation	299
AET	1 if using external technologies	139
PRD	1 if promoting R&D	139
MG	1 if managing technology and knowledge	242
PK	1 if promoting scientific knowledge	314
SP	1 if studying productive processes	147
SE	1 if supporting entrepreneurship	81
KT	1 if transferring knowledge to external actors	273

This set of explicative variables facilitates the comprehension of the different aspects:

- the relative importance of an innovation actor to be located in the capital city[1] where agglomeration economies tend to be more intense;
- The types of actors that are more engaged in the creation of innovation through new product development - the firms are an almost obvious actor but academic actors are also engaged in this specific matter?
- Channels of cooperation activities that influence innovation dynamics;
- Channels of cooperation activities that influence innovation vary regarding the type of innovation actor.

The correlation analysis (Table 9) also shows some interesting preliminary aspects. New product development (NPD) correlates positively with all the cooperation variables but more intensively with using external technologies (AET), promoting scientific knowledge (PK), and transferring knowledge to external actors (KT). Location in the central city is positively correlated with the presence of universities but negatively with the presence of firms, showing that the agglomeration of academic actors is more intense than the private ones. In general, cooperation activities are not correlated with this variable. The pattern of correlation between cooperation activities also shows that there are different degrees of association among these variables. There exist two groups of variables that seem more connected, on the one hand, external technologies (AET), orientation towards innovation (ORI), knowledge management activities (MG), and on the other hand, cooperation and partnership (COOP), studying processes (SP), supporting entrepreneurship (SE) and promotion R&D (PRD). Activities for knowledge promotion (PK) and knowledge transfer (KT) seem to relate to both groups of variables.

Econometric Results

The econometric approach is inspired by a set of empirical contributions that focus the cooperation determinants on university-industry relations. Recent examples can be found in Gulbrandsen, Mowery and Feldman (2011) or Pinto and Esquinas (2013). A recent review of this type of analysis is presented in Perkmann *et al.* (2013).

The dependent variable of this analysis, considered a good proxy for innovation, is the new product development (NPD), connected with the economic usefulness of knowledge, that we directly associate with the origin of innovation networks (Table 10). The nature of this dependent variable, a binary variable, taking a value from 1 or 0, denoting the existence or absence of new product development, causes that a linear probability approach is inaccurate (Gujarati and Porter, 2010). Since the NPD is binary, the we use a logistic regression with a maximum likelihood estimator, the LOGIT model. This method facilitates the understanding of the change in the probability of the occurrence of an event with the modification of the explanatory variables under evaluation.

1 It is relevant to underline that Portugal is often seen as a centralized country. The European Regional Innovation Scoreboard 2012 is relevant to illustrate the relative discrepancies of Lisbon region to other Portuguese regions.

Table 9: Correlation

	CENTRAL_CITY	AET	COOP	FIRM	ORI	NPD	PRD	MG	PK	SP	SE	KT	UNIV
CENTRAL_CITY	1												
AET	-0.035	1											
COOP	0.115	0.402	1										
FIRM	-0.214	0.336	-0.244	1									
ORI	-0.009	0.501	0.681	-0.102	1								
NPD	0.014	0.725	0.461	0.218	0.492	1							
PRD	0.115	0.234	0.528	-0.179	0.301	0.314	1						
MG	0.091	0.487	0.707	-0.094	0.588	0.476	0.546	1					
PK	0.091	0.453	0.773	-0.161	0.743	0.529	0.464	0.668	1				
SP	0.079	0.398	0.410	0.050	0.373	0.467	0.513	0.437	0.535	1			
SE	-0.017	0.023	0.356	-0.187	0.376	0.002	0.068	0.142	0.365	0.022	1		
KT	0.132	0.432	0.786	-0.149	0.591	0.502	0.552	0.783	0.710	0.481	0.158	1	
UNIV	0.173	-0.176	0.149	-0.485	-0.112	-0.041	0.376	0.238	0.044	0.140	-0.067	0.207	1

Table 10: Number of Zeros of Dependent Variable (NPD)

Value	Count	Percent	Cumulative Count	Percent
0	439	70.47	439	70.47
1	184	29.53	623	100.00

The estimation of a general model, including all sample cases underlines the relevance of several variables for new product development[2]. In annex, the complete tables for the different logistic regressions are presented. Linear probability models were also estimated for all regressions as confirmatory process of signals.

The general model shows that the most relevant cooperation channels for new product development are, in this order:

- AET – using external technologies
- PK – promoting scientific knowledge
- KT – transferring knowledge to external actors
- ORI – specific orientation towards innovation

Entities that directly address managing technology and knowledge (MG) and the support of entrepreneurship (SE) have smaller probability to engage directly in innovation as both variables have negative signals. The other variables are not statistically significant. Additionally, being a firm is more relevant for the likelihood to new product development than being a university although both situations are positive and statistically significant. The location in the central city is not a critical factor for NPD.

Using the same principles, we estimated additionally three models for sub-samples. The goal was to understand the relative importance of the cooperation channels in the probability of generating innovation given the different types of entity. For the purpose it was created three groups of innovation actors, the first constituted by the 297 firms, the second groups of 128 universities and other public research organizations, and finally a third group of 198 other innovation actors. The results of these models are summarized in the Table 11.

Firms are more likely to innovate with new product development if engaged in cooperation activities of promotion of knowledge (PK) and the utilization of external technologies (AET). Specific orientation for innovation (ORI) also has a relevant impact in the probability to innovate.

Regarding universities, the most relevant aspect is the proactive management of knowledge (MG). Universities and other public research organizations that are proactive in the management of their knowledge reservoir have a higher probability to develop new product developments. Other relevant channel for innovation is the utilization of external technologies (AET).

Other innovation actors are more willing to engage in innovation if they use external technologies (AET) or have a strategic focus to innovation (ORI). Nonetheless, the utilization of two types of cooperation flows are significant but negatively associated with the new product development. Most relevant is management of knowledge (MG). On the opposite situation of the universities, where MG was a critical positive aspect, when this group of actors gives emphasis to the management of knowledge are less likely to develop new products. On the same basis, innovation actors that are worried in the support to entrepreneurship (SE) are themselves less likely to introduce innovations by their own.

Table 11: Cooperation Determinants of Innovation Networks

Variable	TOTAL SAMPLE	FIRMS	UNIVERSITIES	OTHERS
C – Intercept	----	----	----	----
Organization is located in the capital city	+	-	-	+
AET - Using external technologies	++++	++++	++++	++++
KT - Transferring knowledge	++	-	-	+
MG - Managing technology and knowledge	---	-	++++	----
ORI - Specific orientation towards innovation	+++	++	+	+++
PK - Promoting scientific knowledge	++++	++++	+	-
COOP - Promoting partnership and cooperation	+	+	+	+
PRD - Promoting R&D	+	-	-	+
SE - Supporting entrepreneurship	----	+	-	---
SP - Studying productive processes	+	-	+	+

[Symbols: - non-significant negative coefficient; -- significant negative coefficient at 0.1; --- significant negative coefficient at 0.05; ---- significant negative coefficient at 0.01; + non-significant positive coefficient; ++ significant positive coefficient at 0.1; +++ significant positive coefficient at 0.05; ++++ significant positive coefficient at 0.01].

Conclusive Remarks and Policy Implications

The systemic approach brought new understandings to the innovation activities because these phenomena are transformed simultaneously into origins and consequences. Systems function as circuits for multiple reciprocal relationships where the complexity of the innovation dynamics will be unveiled. More precisely, if on the one hand linkages among actors create spillovers - the increase of cooperation and knowledge sharing generate more knowledge flows outside of firms leading to spillovers - on the other hand, the existence of spillovers lead to networks because increasingly the flow of external knowledge leads to an increased need for channels that enable a shared and cooperative knowledge networks.

The roots of innovation processes are within the social capital, social filter and entrepreneurial capital. Assuming that in a given society social capital encourages interactive learning and knowledge flows, they tend to enhance the knowledge base by making it more complex. The complexity of the knowledge base and commitment to interactive learning, makes environment to embrace knowledge networks to answer to the need for proper channels of knowledge sharing. If there is an internal dynamics that favours the continuation of the process, knowledge flows become more intense having a qualitative effect on the interactions between agents. It

2 There is no measure of goodness of fit in LOGIT, like R-squared is to OLS estimation (Dougherty, 2011). Commonly used measures of the quality of the model are a pseudo R-squared (McFadden measure) or the predictive capacity (table in annex). These measures validate the quality of the estimated models.

creates linkages between actors and growing trust in the creation, exchange and sharing of knowledge as well as an increasing involvement with learning. This is surrounded by a dynamic environment, where the growing complexity of knowledge requires a dynamic synergy between agents creating innovation networks.

Innovation networks arise from knowledge networks, which reached a level at which knowledge flows are intensively shared. Innovation networks are instigated from knowledge spillovers and the absorptive capacity of firms. Although there are several possible ways of how this dynamics may evolve, after the existence of innovation networks, there will be positive effects on economic performance. It is assumed that if innovation networks do not bring economic benefits, they cease to be useful, leading to his own degeneration and loss of its internal dynamics. The economic aspect is part of the *raison d'être* of innovation networks and therefore the essence of innovation systems. Cooperative activities connect are connected with social capital, developing the preconditions for the dynamics of innovation occur. More precisely, to develop the entrepreneurial capital, without which the dynamics of innovation proposed here is unlikely to unfold.

Based in the Portuguese innovation actors, the econometric results were illustrative of the relevance of particular types of cooperation activities for innovations occur. Firstly, it is important to underline that agglomeration benefits to new product development were not evident in the estimation as the location of the innovation actors in the main city of the country was not statistically significant in any model. In this way, the determinants of innovation were more related with specific cooperation activities. The utilization of external technologies is of greater relevance. This is indicative that much of innovation within innovation networks can derive from absorbing external knowledge and incorporating new technologies in the productive processes. This means that this type of knowledge transfer channel should be taken seriously by policy-making and benefit from direct support for the improvement of the overall innovation system performance.

Other relevant feature regards the relevance of strategic orientation towards innovation. Actors that strategically orientate their activities are more likely to develop new products and thus creating innovation networks. This means that the qualification of strategic processes should also be targeted by policies that could improve the knowledge intelligence capacity.

Innovation actors are quite different in terms of what is determinant for them to innovate. It means that innovation policies that intend to develop networking and knowledge exchange need to address carefully the specificities of each type of actor. Besides the external linkages through technology acquisition, while for companies it is particularly relevant the active promotion of produced knowledge, universities need to develop the management of the existent knowledge reservoir. This implicates that firms should benefit from policies oriented to the promotion of the new knowledge produced in their networks, ie, mainly an external feature, when in parallel universities need to benefit from policies for the upgrade of their internal knowledge management capabilities.

Another interesting result is that the engagement in particular types of activities that are crucial for the innovation networks, as supporting entrepreneurship, does not grant to the actors a status of innovator. In the fact is the contrary, supporters of innovation are relevant actors but not the innovators themselves. This clarification is extremely helpful for decision and policy makers, at different levels, from governments to university boards, that begin to confuse often the functions of innovation intermediation actors with the role of firms and research entities.

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ANNEX

Table 12: A1: Descriptive Statistics for Explanatory Variables (Total Sample)

	CENTRAL_ CITY	AET	COOP	FIRM	ORI	NPD	PRD	MG	PK	SP	SE	KT	UNIV
Mean	0.291	0.222	0.479	0.476	0.421	0.294	0.223	0.389	0.503	0.235	0.130	0.439	0.206
Median	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000
Maximum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Minimum	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Std. Dev.	0.455	0.416	0.500	0.500	0.494	0.456	0.417	0.488	0.500	0.424	0.337	0.497	0.405
Skewness	0.920	1.339	0.084	0.097	0.319	0.903	1.328	0.455	-0.013	1.252	2.197	0.246	1.456
Kurtosis	1.847	2.792	1.007	1.009	1.102	1.816	2.763	1.207	1.000	2.567	5.829	1.061	3.118
Jarque-Bera	122.255	186.926	103.668	103.669	103.935	120.913	184.184	104.778	103.667	167.304	707.957	103.762	219.980
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	181.000	138.000	298.000	296.000	262.000	183.000	139.000	242.000	313.000	146.000	81.000	273.000	128.000
Sum Sq. Dev.	128.330	107.383	155.228	155.138	151.640	129.159	107.937	147.846	155.494	111.730	70.452	153.178	101.659

Table 13: A2: Descriptive statistics for Explanatory Variables (taking into consideration NPD)

Variable	Mean			Variable	Standard Deviation		
	NPD=0	NPD=1	All		NPD=0	NPD=1	All
C	1.000.000	1.000.000	1.000.000	C	0.000000	0.000000	0.000000
CENTRAL_ CITY	0.287016	0.298913	0.290530	CENTRAL_ CITY	0.452885	0.459031	0.454372
FIRM	0.405467	0.646739	0.476726	FIRM	0.491542	0.479287	0.499859
UNIV	0.216401	0.179348	0.205457	UNIV	0.412260	0.384690	0.404360
ORI	0.264237	0.793478	0.420546	ORI	0.441429	0.405914	0.494043
COOP	0.330296	0.836957	0.479936	COOP	0.470856	0.370413	0.499999
AET	0.027335	0.690217	0.223114	AET	0.163243	0.463666	0.416669
PRD	0.138952	0.423913	0.223114	PRD	0.346291	0.495525	0.416669
MG	0.239180	0.744565	0.388443	MG	0.427070	0.437295	0.487788
PK	0.332574	0.913043	0.504013	PK	0.471673	0.282540	0.500386
SP	0.107062	0.543478	0.235955	SP	0.309544	0.499465	0.424935
SE	0.129841	0.130435	0.130016	SE	0.336511	0.337700	0.336591
KT	0.277904	0.820652	0.438202	KT	0.448477	0.384690	0.496565
Observations	439	184	623	Observations	439	184	623

Table 14: A3: Logistic regression (total sample)

Dependent Variable: NPD | Method: ML - Binary Logit (Quadratic hill climbing) | Included observations: 623
Convergence achieved after 6 iterations | Covariance matrix computed using second derivatives

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-4.99144357777	0.526358288279	-9.48297706888	2.4712979773e-21
CENTRAL_CITY	0.0823833777669	0.313906070604	0.262445952728	0.792977648701
FIRM	1.710191267	0.448150205098	3.81611175794	0.000135571119085
UNIV	1.24714515082	0.482023837251	2.58731011715	0.00967284920544
ORI	0.835917823536	0.385963088129	2.16579732427	0.0303266779118
COOP	0.87065498258	0.537536446727	1.6197133941	0.105293857633
AET	3.16611590471	0.412425120958	7.67682603173	1.63078657252e-14
PRD	0.00766365302311	0.409781532226	0.0187018018637	0.985078990828
MG	-1.0067497437	0.438390793401	-2.29646643782	0.0216492260251
PK	1.8743857175	0.480033553482	3.9046972944	9.4343399094e-05
SP	0.383183524543	0.354945958358	1.07955455054	0.280340589653
SE	-1.15785871187	0.434443158052	-2.66515582167	0.00769526572054
KT	0.890953224988	0.484663785753	1.83829130869	0.0660194911242
Mean dependent var	0.295345104334	S.D. dependent var		0.456564306446
S.E. of regression	0.282484811249	Akaike info criterion		0.568477303936
Sum squared resid	48.6765778377	Schwarz criterion		0.661011982498
Log likelihood	-164.080680176	Hannan-Quinn criter.		0.604438324089
Restr. log likelihood	-378.079059465	Avg. log likelihood		-0.263371878292
LR statistic (12 df)	427.996758577	McFadden R-squared		0.566014895381
Probability(LR stat)	0			
Obs with Dep=0	439	Total obs		623
Obs with Dep=1	184			

The model with the substituted coefficients is presented below:
NPD=1-@LOGIT[-(-4.99+0.082*CENTRAL_CITY+1.710*FIRM+1.247*UNIV+0.871*COOP+3.166*AET +0.836*ORI+0.008*PRD-1.006*MG+1.874*PK+0.383*SP-1.158*SE+0.891*KT)] (1)

Table 15: A4: Predictive capacity of the LOGIT model for NPD

Prediction Evaluation (success cutoff C = 0.5)

	Estimated Equation			Constant Probability		
	Dep=0	**Dep=1**	**Total**	**Dep=0**	**Dep=1**	**Total**
P(Dep=1)<=C	413	48	461	439	184	623
P(Dep=1)>C	26	136	162	0	0	0
Total	439	184	623	439	184	623
Correct	413	136	549	439	0	439
% Correct	94.0774487472	73.9130434783	88.1219903692	100	0	70.4654895666
% Incorrect	5.92255125285	26.0869565217	11.8780096308	0	100	29.5345104334
Total Gain*	-5.92255125285	73.9130434783	17.6565008026			
Percent Gain**		73.9130434783	59.7826086957			
	Estimated Equation			**Constant Probability**		
	Dep=0	**Dep=1**	**Total**	**Dep=0**	**Dep=1**	**Total**
E(# of Dep=0)	390.498700396	48.5012994036	438.9999998	309.343499197	129.656500803	439
E(# of Dep=1)	48.5012996037	135.498700596	184.0000002	129.656500803	54.3434991974	184
Total	439	184	623	439	184	623
Correct	390.498700396	135.498700596	525.997400993	309.343499197	54.3434991974	363.686998395
% Correct	88.9518679718	73.6405981502	84.4297593889	70.4654895666	29.5345104334	58.376725264
% Incorrect	11.0481320282	26.3594018498	15.5702406111	29.5345104334	70.4654895666	41.623274736
Total Gain*	18.4863784052	44.1060877168	26.0530341249			
Percent Gain**	62.5924660133	62.5924661676	62.5924660905			

*Change in "% Correct" from default (constant probability) specification | **Percent of incorrect (default) prediction corrected by equation

Table 16: A5 - Model for Firms, Universities and Other Actors

Dependent Variable: NPD | Method: ML - Binary Logit (Quadratic hill climbing)
Convergence achieved after 6 iterations | Covariance matrix computed using second derivatives

Variable	**Coefficients FIRMS**	**Coefficients UNIVERSITIES**	**Coefficients OTHERS**
C	-4.09494335313***	-41.75243***	-3.879965***
AET	2.58147429231***	3.100644***	3.185391***
CENTRAL_CITY	-0.410701263873	-0.985823	0.632312
KT	-0.822918642143	-0.969875	1.579.426
MG	-0.488169277343	42.24936***	-2.824894***
ORI	1.91794797802*	0.075762	2.332494**
PK	3.08713713725***	0.088665	-0.775590
COOP	1.06937.367.143	0.892070	1.236.604
PRD	-0.128936838929	-1.315.824	1.247.319
SE	0.713202220582	-0.683801	-2.449849**
SP	129.236.332.581	0.796382	-1.128.311
McFadden R-squared	0.797514966235	0.3954	0.437364
Obs with Dep=0	178	95	166
Obs with Dep=1	119	33	32
Total Observations	297	128	198

***significant at 0.01, **significant at 0.05; *significant at 0.1.

The architecture of firms' innovative behaviors

Eric Vaz
Teresa de Noronha
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Introduction and Theoretical Framing

The Comprehensive Systemic Approach of Innovation

During the last decades the amount of studies published about innovation systems has been massive, originating a great interest for policy makers in search for scientific background and technical support to find out the most adequate strategies for development. Although from different perspectives, studies point out knowledge creation and innovation as the major drivers of change and growth, the consensus is broken, however, as soon as the complexity of innovation and knowledge are tackled: Innovation goes much beyond new product or process development due to its interactive nature, and knowledge surpasses the firms' attributes because, frequently, it is a spatial endogenous characteristic.

Scientists prompted a worldwide interest in the driving forces and socio-economic impacts of innovation and entrepreneurship (see Nijkamp 2009a, 2009b; Stimson *et al.* 2006) for which innovation has been a critical parameter of human intelligence and cognitive ability of human kind. Both factors are considered, nowadays, as the major drivers of socio-economic and technological change, able to stimulate the continuous production of new products or processes. To persuade society to continuously consume them requires a *systematic and integrative combination of knowledge assets* managed within a framework of institutions, regulations, and some kind of social cognitive mechanisms (Hall *et al.* 2005).

The Trajectories of Technological Development

The complexity of the innovation system is structured under conditions related to *governance systems and respective spatio-temporal industrial organization* and their cognitive capacity. This argument calls for Schumpeter's interpretation on the propensity of innovations to geographically group and generate clusters, encouraging innovation as a powerful instrument of growth. On this basis *innovation and its factors* became of crucial interest and tracing the complexity of governance systems one of the key vectors to explain the success of efforts to promote innovation. Countless efforts have been made to identify such factors: Some researchers adopted the resource-based view of the firm by accepting the heterogeneous character of firms emphasizing their strategic behaviour (Knudsen 1995 and Noronha Vaz and Cesário 2008).

When knowledge became recognized as a key resource for firms and other economic

agents, some authors demonstrated the essential role of linkages between industry and external research organizations for the successful transfer of technological knowledge among firms, later distended and referred to as the Triple Helix concept, a triangular interaction between the research community, governments and industries seen as the solution to successful innovation (Doloreaux (2005)

As linkages among institutions became long lasting and consistently robust, it became possible to addresses the consequential configuration in *forms of networks and/or industrial clusters*. In effect, a great variety of studies on clustering were influential in describing how and why institutions get together to react to competitive pressures. Westlund and Bolton 2006, for example, described clusters as geographical space with normative isomorphism, "*where managers and decision makers follow similar values, cognitive references, perceptions, and experiences therefore with propensity to connect and pursue analogous patterns of organizational behaviour*".

In such a context, the concept of *Regional Innovation Systems* (RIS) was introduced as "*a network of organizations, institutions and individuals, within which, the creation, dissemination, and exploitation of new knowledge and innovation occurs*" (Cooke *et al.* 2004), influencing the perception of the dynamics of clustering and admitting that for a given national or regional economy, technological and industrial development takes place following certain trajectories determined by spatial systems traced by groups linked firms, research organizations, policy institutions, government authorities, and financial actors (Teigland and Schenkel 2006).

Networking, the Strategic Choices of Firms and the Spatial Impacts

Basically, the previously pointed out structures when observed from a global perspective, tend to outline long-lasting technology trends that could, among others help explaining the difficulties in reducing the different growth capacities among countries and regions. In general, the causes for this diverse behaviour and the propensity to have a cyclic nature of disadvantages in many lagging parts of the world have attracted the attention of many researchers and policy makers since a long time (Hall and Wee, 1995 and Landabaso, 1997).

As proved by the Italian School founded by the GREMI group (Camagni, 1991, 1995a, 1995b) and, later on, by many other northern European researchers, such as Asheim and Isaksen (2003), *there is a direct contribution of individual firms or even of industrial clusters to foster regional growth*. Such has been even more emphasized in the research related to *spillover-effects*, developed by Kaiser, 2002 and Fischer, 2006. But yet, much stays unsolved:

- Fuzzy concepts related to the definition of firms' environment. Either from the geographical or from the geometrical perspective, the market area each firm and its dominant role vary in function of its nature.
- Teigland and Schenkel, 2006, argue that the firm's environment should be defined by those agents involved in the historical path-dependent development of skills.
- Other authors propose that the firm's environment is mostly responsible for all those strategic interactions that contribute to productive links within the firm's industrial structure.
- Sure is that firm's environment is highly influenced by the nature of the involved public institutions and their regulations as they may help or obstruct interactions.

Assuming that the firms environment is formed, and shaped coherently by the presence of significant linkages. Sometimes, and assuming that, in spite of uncertainty, the firms face future new needs of resources and clients, cluster formations are still emerging. In this case, it becomes important to detect if the strategic decision of firms is internally or externally driven: Langlois and Robertson (1995) first developed the idea that many questions related to firm strategy and firm boundaries are correlated. As assessed by Freel (1998), not much is understood on how technologically innovative firms grow, learn or adapt to transformations taking place in their environments: i. Will the strategic choices be solved by firms using market solutions? ii. And if so, through which decision-making process?

Frequently, innovative firms accumulate knowledge through learning, as a process to reduce uncertainty and not necessarily to get economies of scale. Therefore, facilitating the better decision, knowledge acquisition could engage the entrepreneur in strategic learning – an occasion to absorb economies of scope rather than scale. Thus, the routines of innovative firms are different from those of their non-innovative partners.

Empirical studies often underline the role of the firms' environment as the local context within which firms develop their activities (Keeble, 1997 and Freel, 1998) in and interactive mode between the parts and the set (Noronha Vaz *et al.*, 2004) and proving that organizational learning and institutional networking combine to boost the performance of innovative firms (Fagerberg, 2003).

Occasionally, firms find possible solutions in specific networks for technological learning through external sources and manage interfaces which help them to combine sources of technical know-how, information and relations (Stough *et al.*, 2007). In such cases, firms may also be organized in institutional local networks.

Measurements of Firms' Innovative Behavior at a Regional Context

At the same time that innovation and entrepreneurship were accepted as major factors of growth, the measurement of innovative activities received much scientific and public attention. However, the measurements related to this systemic concept still remain in progress. Since the 1990s, statistical surveys have supplied data concerning proxies such as R&D expenditures and number of patented inventions, for example. Sometimes such proxies were improved by adding up employment in R&D related activities or other data of similar kind but so far it cannot be confirmed that an unambiguous direct measure of innovation outputs is consensual.

Because the market structure influences the innovative activities and the extent to which technological change has an impact on the size distribution of firms, great part of the research done are of empiric nature and mostly related to advanced industrial countries. Rarely studies have observed rural or lagging areas (Noronha Vaz *et al.*, 2004). The debate already started up in 1991 by Acs and Audresch, 1991, invariably points out that there are considerable ambiguities and inconsistencies in the results of empirical studies directly relating R&D or patents to innovation and even more extensively in less favoured areas.

Innovation output indicators have been defined having as reference the total number of innovations. Kleinknecht and Bain (1993) proposed several methods for collecting data: postal surveys for self-assessment by managers of their innovations or literature-based counting of

innovations (in trade journals). Both these methods helped to highlight the issues, indicating related ways to work towards general inquiries. Applied in different countries, the first method in Great Britain, Norway, Denmark, Germany and the Netherlands and the second one in United States, the Netherlands and Ireland these methods proved to be quite subjective, making a scientific consensus difficult for the general use of the scientific community.

The European Community Innovation Survey (CIS), implemented by EUROSTAT to collect *firm-level data on inputs to and outputs of the innovation* process across a wide range of industries and across European member-states and, occasionally, across regions, finally a great toll facilitated in the progress of comparative analyses of innovativeness across firms, regions and nations. CIS has its limits but provides evidence of the actual composition of inputs engaged by the firms for implementing technological change: In terms of expenditures committed in the EU to innovative activities, formal R&D in labs corresponds to only 41% of the total, while product design costs represent 22%, and in trials, tooling up and training there are about 27% invested.

Also, at macro-level, data suggests that firms are job creators and engines of economic growth. However, such statements do not help to produce enough scientific evidence on the precise role that firms play in the growth mechanisms. Within the context of a learning economy, all enterprises have to adapt their technology to new standards of distribution and to logistic channels and in particular when included in an environment of large competition. There, all categories of enterprises, which may belong to different regional or local innovation systems, are interacting and competing for innovative and market activities, using the same tools and the same knowledge flows (Lester, 2006).

In our opinion, regional or local innovation systems result from historical, path-dependent processes, with high degrees of institutional and organizational specificities – *the technological regimes.* Firms are embedded in a technological regime and are defined by the level and type of opportunities for innovations, by the accumulation of technological knowledge, and by the means of knowledge transmission. The examination of the technological regime of an industry allows some predictability about the kind of enterprises which may innovate, because of the possibilities for protecting innovations, the strength of a dominant design, the nature and the continuity in the learning processes, and the *tacitness* of knowledge and the means for its transmission.

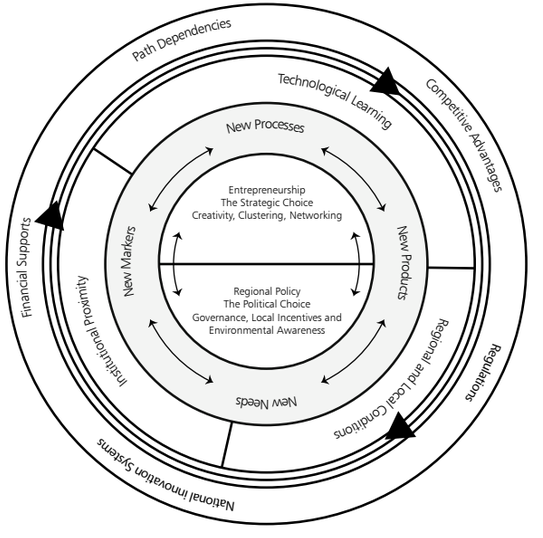
The above theoretical framing suggests that regional imbalances should be studied by means of a better understanding of the regional firms' capacity to dynamically innovate. The fact that such capacity may be quantitatively addressed and analysed helps to support the argument even further. Consequently, a key question for further investigation is to detect *firms' innovation patterns*, sorting out their structures and handle them as *facilitators of regional or local growth,* eventually development.

A Mesoeconomic Model to Evaluate the Structures of Innovation

A multilevel model able to improve the analytical tools is required for better understanding the complexity expressed by all the determinants of knowledge and innovation outlined earlier. Figure 13 supplies the model for which knowledge assets are circulating simultaneously between the micro- and macro-levels of economic activity:

- An exterior cycle represents the global conditions for change, in general mostly related to the macroeconomic conditions for growth such as GDP, employment, taxes, rates of interest, investment climate, inflation;
- The intermediary cycle, however, reproduces the knowledge diffusion taking place at the mesoeconomic where institutional relationships occur: Institutional proximity, technological learning and regional or local conditions:
- There is a permeable boundary between the previous cycle and the next, interior one. Economic effects cross this boundary in relevant issues associated to organizational management (entrepreneurship, strategic choices, creativity, clustering and networking) and regional policy, (political choices, governance, regulation and environmental awareness) determining an interior cycle which embodies knowledge application that may end in new products and processes. The core of the cycle illustrates a sharp microeconomic component confined to aspects such as market competition, costs, prices and marketing issues – they are the last facilitators of the success of new products and processes.

Figure 13: The knowledge circuit



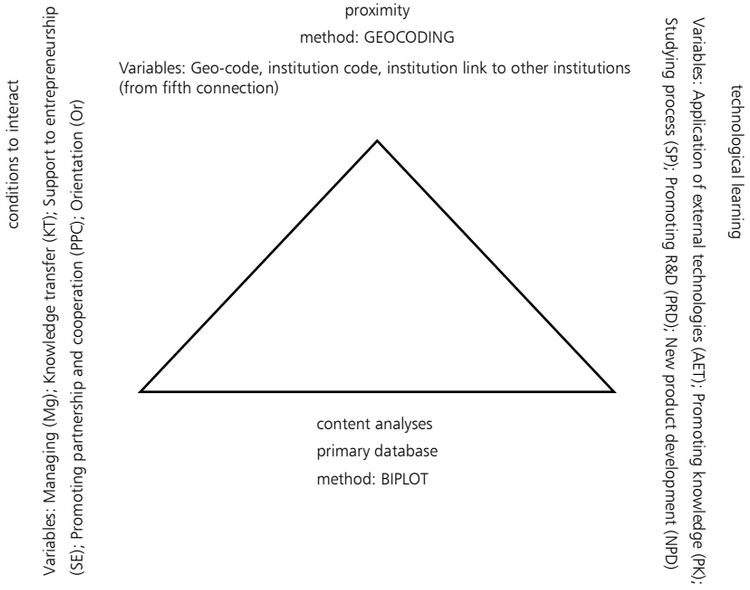
Source: Noronha Vaz and Nijkamp (2009)

In this chapter we concentrate our attention exclusively at the intermediary cycle, the mesoeconomic level. Our goal is to model the almost chaotic, eventually frenetic, state of relationships occurring among institutions, happening as result of the three vectors: *proximity, learning and cooperating* when in presence of *regional or local conditions to interact.*

We assume that firm's proximity can be detected by a GIS application to a statistically

significant sample of institutions, if possible, tracing their interaction with others actors belonging or not to the same sample. Learning and cooperating (measured as technological learning) and external conditions to interact are variables obtained by means of direct approach to institutions, either using questionnaires or by consulting the respective web-sites and with application of content analyses for the obtained primary data. In the next Figure 14, a model proposition for measuring firms' innovative behaviour is provided, for which spatial, institutional and environmental conditions combine.

Figure 14: Firms' innovative behaviour model (FIBE)



Application of FIBE

Our investigation applies the previous model (FIBE) to an extensive set of Portuguese private and public institutions detected by their WebPage contents on innovation: 820 Internet sites have been detected and interpreted, giving place to a filtered sample of 623 institutions (which have been considered to be able to provide reliable data through the respective websites). These institutions were classified into nine groups, each characterized by ten variables.

The selection of the variables was based on earlier developed research work (more details in Noronha Vaz and Nijkamp, 2009, for the theoretical basis, and Vicente *et al.*, 2010, for the measurement methods). The various constructed variables are assumed good proxies of factors favouring innovation and are identified *as attributes of innovation.* To follow our mesoeconomic model assumptions, these attributes (defined as variables in the model) have been grouped (as in Figure 14) in:

- Variables for technological learning: Application of external technologies (AET); Promoting knowledge (PK); Studying process (SP); Promoting R&D (PRD); New product development (NPD);
- Variables for improving conditions to interact: Managing (Mg); Knowledge transfer (KT); Support to entrepreneurship (SE); Promoting partnership and cooperation (PPC); Orientation (Or).

As grouping factors the following institutions, *actors of innovation,* have been considered: governmental agencies, associations, technological parks and science centres, R&D organizations, entrepreneurship support entities, technological schools, university interfaces, financial institutes – as well as venture capitalists or high risk investors and, finally, other institutions.

As pointed out in the theoretical model, a third group of variables was built to evaluate proximity. Those resulted from Geo-coding each innovative institution[1] and respective links to other institutions with whom each institution had kept cooperation (from first to the fifth connection) of any sort for the considered period of time. All the variables have been worked out by use of two different but complementary methodologies: BIPLOT and SPATIAL CONNECTIVITY. The results have been submitted to separate analyses and discussed in different contexts. The observed time period was the year 2006, so that the analysis has a static-comparative nature.

The Methods

The BIPLOT Analyses

The information used in our analysis was organized in an IxJ binary data matrix obtained from several innovation attributes, in which the I rows correspond to the above-mentioned 623 units (18 governmental entities, 297 companies, 70 associations, 20 technological parks and centres, 58 R&D organizations, 48 entrepreneurship support entities, 12 technological schools, 80 university interfaces, and 14 other entities) and the J columns correspond to the above-mentioned 10 binary innovation characteristics scored as binary variables, viz. present or absent: (PK), (SP); (Mg); (PRD); (KT); (SE); (NPD); (PPC); (AET); (Or).

1 Innovative institutions have been classified following the previous research inVicente *et al.*, 2010

The applied algorithm was described in Demey *et al.*, 2008. In Annex 1, we go into the detailed procedure to get the External Logistic Biplot based on a Principal Coordinates Analysis, and in a second step of the algorithm, adjusting a logistic regression model for each variable as illustrated in Figure 15.

The geometric results represent the principal coordinate scores in a map where the regression coefficients act as vectors indicating the directions that best predict the probability of presence of each variable.

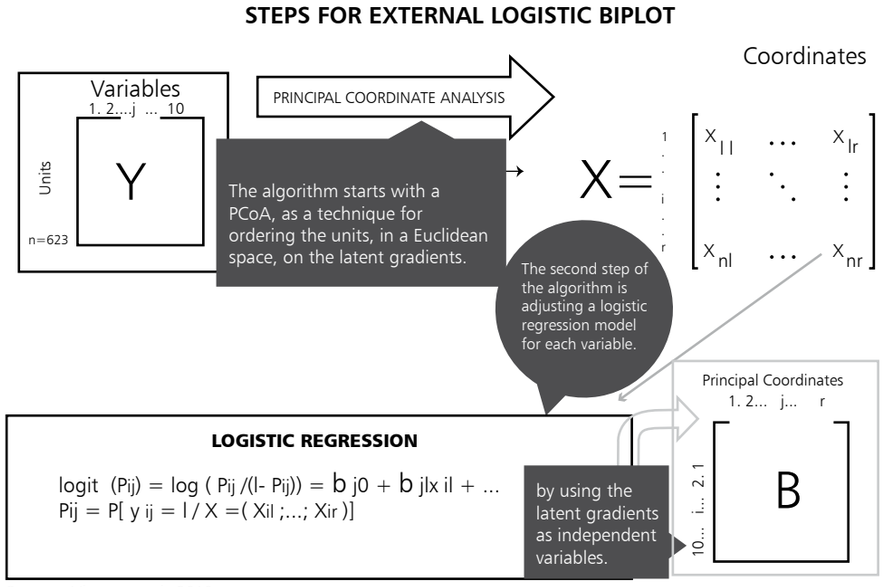
According to the geometry of the linear Biplot for binary data as Vicente-Villardón *et al.*, 2006, each variable is represented as a direction vector through the origin. For each variable, the ordination diagram can next be divided into two separate areas predicting presence or absence, while the two areas can be separated by a line that is perpendicular to the characteristic vector in the Biplot and cuts the vector at the point predicting a 0.5 probability.

The characteristics associated with the configuration are those that predict the respective presences adequately. Once the coordinates of the points which represent the entities (in our case the institutions) in the plane are obtained by the External Logistic Biplot, we can apply a K-Means analysis to identify the centroids of the resultant clusters. To produce an elegant solution, we may present a Voronoi diagram of the spatial relationships.

The above described method was applied to our sample, thus eventually indicating the existing force field of the Portuguese innovation system. Figure 16 represents a Voronoi diagram of the existing spatial relationships. Four well defined clusters can be detected, each characterized by the presence or the absence of the different sets of variables. Cluster 1 is characterized by the presence of SP, AET, and NPD and absence of SE; Cluster 2 is characterized by the presence of PK, PPC, OR, KT, Mg and PRD, and absence of SE; Cluster 3 is characterized by the presence of SE, PK, PPC, OR, KT, Mg and PRD and absence of NPD, AET and SP. Cluster 3 is characterized by absence of all the indexes of innovation. By the characteristics of the firms, Cluster 1 has been identified as the one comprehending the largest number of firms, therefore the most innovative one. Figure 17 represents the regional distribution of firms of Cluster 1 for the country, showing that it is mostly represented in the region of Lisbon and Norte.

The application of this method can be extended to different observation levels, including the regional or the local level. If the provided databases are at national level and location is a variable as it should be the case, it is possible to reach the local level. In such case the number of observations should be sufficient for the statistical application. As this is not always the case, in particular inside peripheral regions, the thickness of the entrepreneurial tissue constitutes the first major obstacle to the use of FIBE.

Figure 15: Steps for external logistic biplot



Source: Vicente *et al.*, 2010

Figure 16: Logistic BIPLOT and Voronoi diagram representations of spatial relationships and clusters

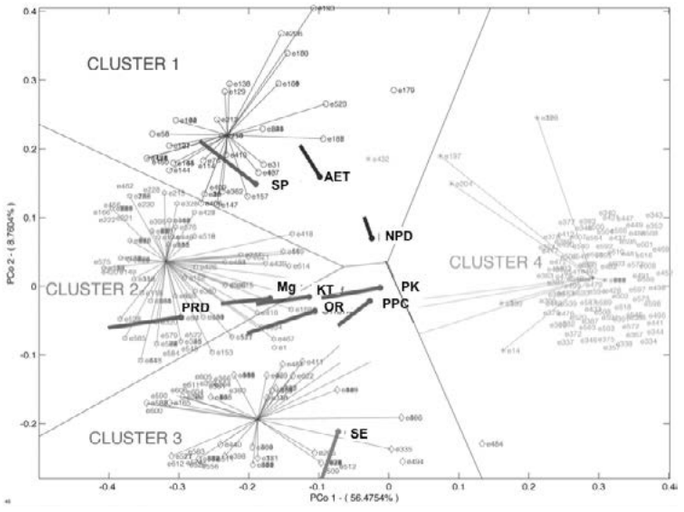
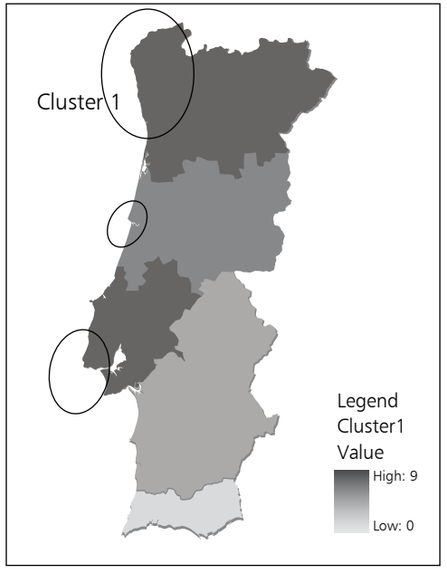


Figure 17: Regional distribution of Cluster 1



Spatial Connectivity

Spatial information has enabled the possibility to understand the relations over space of different types of features (Jankowski, 1995). The spatial properties of location of activities and respective impacts are still far from being completely understood, and have developed into a complex integration of economics, mathematics and geography. A reason for this is the underlying complexity of the spatial patterns formed (Gustafson, 1998), and the connectivity established among the different agents in a complex network of interactions over space, traditionally studies in Ecology (Moilanen and Hanski, 2002).

The possibility to merge the configuration of features with networks may be assessed elegantly through generating a network which connects spatial information of features. The connectivity of features in space, allows understanding and fostering the dynamics of collaborations of innovation from a spatial perspective. This was achieved by converting the provided street addresses of the businesses into a point vector in space. The address is categorized into its locational determinants entailing its street number, street name, and postal code. This was then added into ArcGIS 10.1 where the process of spatial connectivity – correspondent to the transformation of the address into a point – was carried out. The geocoded addresses were than exported into Google Earth, to match the consistency of the location through attribute properties of the surrounding area, as well as confirmation of metadata related to the geocoded feature.

In our precise case all the institutions belonging to Cluster 1, assumed to be the most innovative one were investigated and the respective links reported till the fifth connection – considered at any geographical level (local, national or international). Because several institutions had no reported links, the sample that was used for the mapping was reduced to 37 institutions in a total of 65 point features. The point features were than aggregated into groups corresponding their partners, defining of 15 aggregated groups. These groups of points were then connected by relevance of indicated partners, allowing establishing a spatial understanding of small networks with spatial connectivity. The points thus, were then converted into line segments and projected accordingly on the map.

Figures 18, 19 and 20 define the connections found at different scales: global, national and local and report to the 50 most innovative institution in Portugal, all included in Cluster 1 and considered to be the most innovative in the country. Only a few relations are pointed out to exist between the spatial component of countries and business innovators. In fact, most of the relations even at national level are formed only above the Tejo valley, being Lisbon and Porto the main hubs for partnerships.

Figure 18: Flow design for international connexions

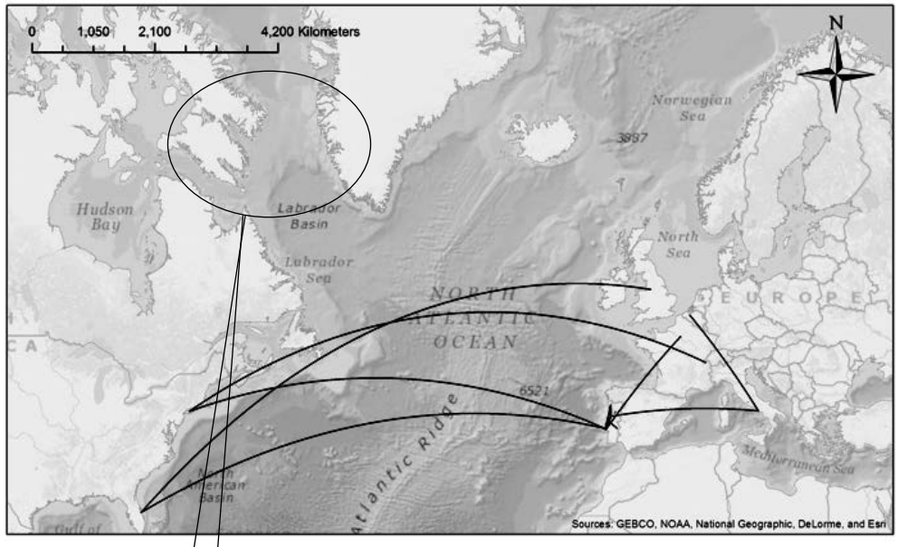
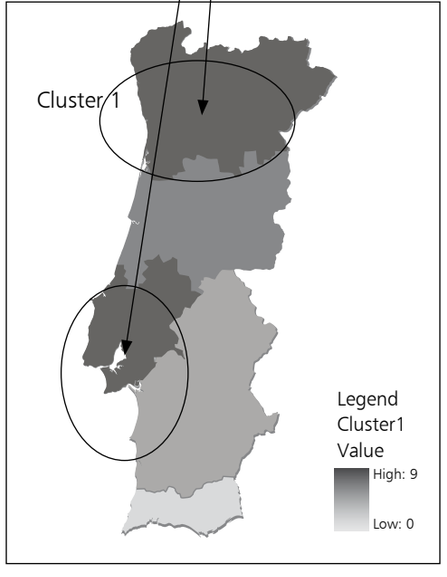


Figure 19: Flow design for internal connexions in Portugal



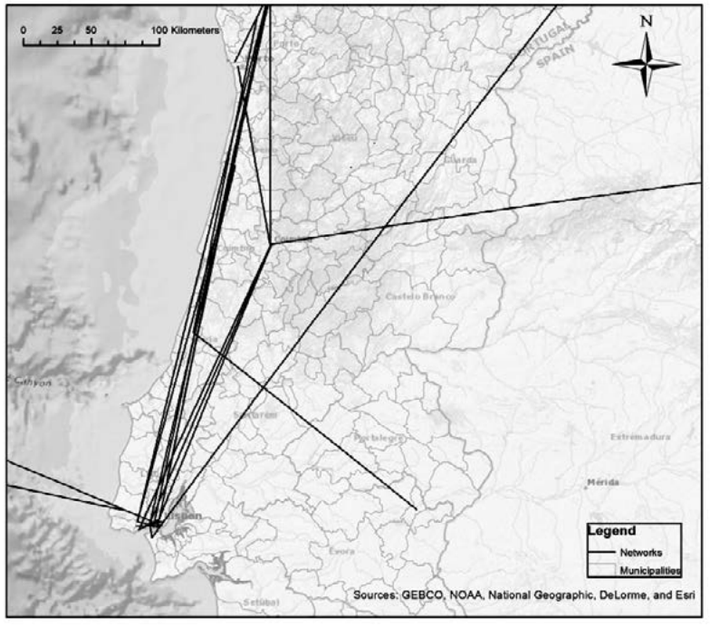
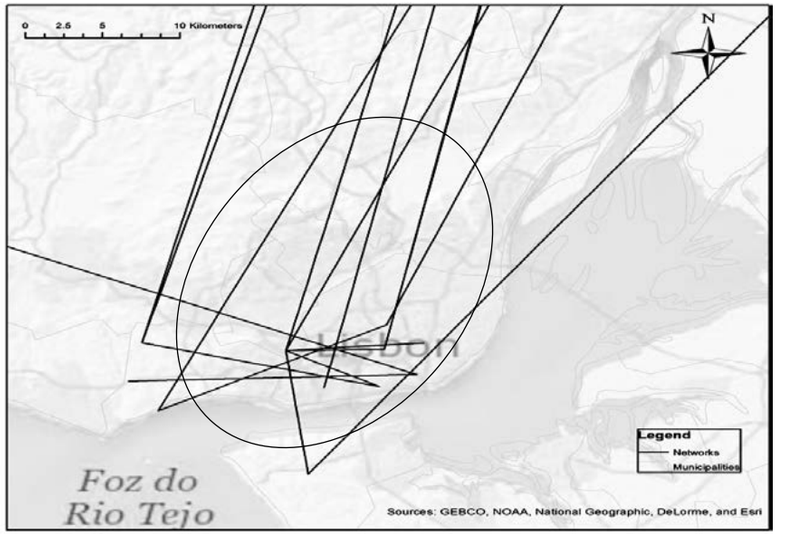


Figure 20: Details of connections in Lisbon area



FIBE Model Results

By detecting the types of patterns of structures of innovation in Portugal, many advantages and fragilities may be identified and clearly interpreted from a mesoeconomic perspective:

- FIBE delivers a combined method able to evaluate the kind of connections underlining the innovation taking place at a certain region or country;
- In our particular case – the application for Portugal - we can confirm the asymmetric flow distribution resulting from the connections from the most innovative institutions, which have based their innovation above all on the study of processes (SP), on the use of external technologies (AET); and on new product development (NPD);
- The asymmetric distribution shows predominant flows concentrated in Lisbon area and Oporto (in this case much less intensively) that occasionally extend across Europe or to the USA. When observing the connections at country level, we may find two hubs and a small focal point in Centro Region. The method permits to pick up the individual institution responsible for this flow, searching for its innovative prospects.
- Contrarily to what was expected, not many connections start in the same point in the Lisbon region. This indicates that different institutions are able to sustain their own innovation paths in a structure that although still not very complex or elaborated defines inter-connexions at an elaborated level.

Conclusion

The addressed model is able to offer multiple advantages to access the performance of companies by its leaders and policy makers.

Leaders of companies or other institutions can compare their individual profiles, reproduced in a geometrical location, with that of the system average by using a simple tool, concluding whether or not they should reinforce specific measures to improve their relative positioning – this may be done by looking for a more rigorous use of the missing attributes, for example.

Also for policy makers and planners FIBE could become a powerful tool. As pointed out, this study confirms the need to implement *tailor made policies* to endorse innovation at regional level. Such is only possible when identifying the specific choice of attributes used by the set of companies and others institutions. The pattern they define to innovate may suggest those specific measures required to act directly on each described attribute contributing to a new concept of intervention – the *regional cluster-architecture,* to help focus policies for regional development.

The examination of flow designs recommends that the emergence of innovation is also a result of the flow intensity which submits the innovation processes as a spatial determinant. Therefore, major general policies to promote it will not be able to be entirely efficient if flows design is not considered. Resulting paths should be able to create some sort of path dependency; in this case, the efficiency of promoting policies in such environments should tend to increase. The contrary is to expect when no flow design emerges in the regions.

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Innovation inputs and processes: The reality out of the box in the Portuguese rural areas

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Introduction

Research in the innovation field has recently exposed the hidden innovation and need for further research within this topic. Identifying and understanding the hidden innovation entail new conceptual and methodological approaches. These will be discussed later in this section. The chapter starts by describing what is meant by the term hidden innovation. The available literature discloses four types of hidden innovation. The first type refers to the commonly called non-technological types of innovation, such as marketing and organisational, which are often highlighted in the low-tech sectors, such as the services. A second type of hidden innovation is product and process innovation not (mainly) based on the R&D inputs. These two situations of hidden innovation have been addressed by a number of studies and authors, for different sectors and firms types, as well as using different methodological approaches (e.g., Jensen *et al.* 2007; Arundel *et al.* 2008; Miles and Green, 2008; Kirner *et al.* 2009; Hervas-Oliver *et al.*, 2011; Trigo, 2013). The later type of hidden innovation, product and process (known as tech innovation) not (mainly) based on R&D (tech inputs) discloses a third type of hidden innovation, recently acknowledged by OECD (2010), which is the result of mixed-modes of innovation developed by organisations in different sectors. A good example of this is the (improvement) product-driven combined with marketing and/or organisational innovations. A fourth type of hidden innovation noticed by the literature, is again derived from the complex nature of innovation processes, and reports to the non-technological innovation mingled in the technological innovation (e.g. Boer and During, 2001; Baranano, 2003; Schmidt and Rammer, 2007).

Knowing what it is, the second question is why hidden innovation matters? It does, because the hidden innovation is mainly developed by firms in the low-tech sectors, and in particular, by the small-sized firms and these (firms and sectors) are roughly neglected by the mainstream innovation framework, which is focused on the technological innovation. As a consequence, public policies, agendas and incentives to promote innovation have been tailored to address the development and implementation of technological innovation. The fact, that at least at the EU level, there are parallel initiatives to promote social innovation and innovation in the services highlights that there is institutional awareness of the gap in the promotion of non-tech types and modes of innovation (e.g. CEC 2009, 2010 and 2013; UE, 2012).

The major limitation of focusing the schemes and mechanisms to stimulate innovation in

the technological and new-to the market innovation is that it neglects a significant part of the actual economy, the small-scale and low-tech firms, sectors and regions. Hence, given the importance of SME in EU (and in Portugal) for local and national economies (namely in terms of employment), they need to be fully included in the EU, national and regional agendas and policies for innovation. In particular, given that is demonstrated the importance of innovation for the performance of the SME firms (e.g. Rosenbusch *et al.*, 2011).

Thereafter, a third question is how to adjust the current innovation theoretical and methodological framework in order to make it more inclusive. This referential framework is based on the third version of the 2005 Oslo Manual (OECD, 2005). This guide establishes the methodological guidelines for the Community Innovation Survey (CIS). The CIS has been implemented systematically in EU since 1997/98 (CIS2)[2] and gathers large data sets on innovation at firm level. It surveys both, innovative and not-innovative firms, allowing for comparative studies. Large samples of firms from industry and some sectors of the services, with 10 or more employees, are surveyed in the EU member-states with the CIS under the EUROSTAT umbrella.

The OECD (2005) employs a fairly broad definition of innovation, including marketing and organisational innovation, and accounting for new-to the firm as well as to new-to the market innovation. Nonetheless, the measurement of innovation is based on the product and processes innovation, which are generally acknowledged as technological innovation, while the marketing and organisational innovation are known as non-technological innovation. Basically, these latter types of innovation are treated by the CIS as complementary sources of innovation.

Nevertheless, the third version of the Oslo Manual (OECD, 2005) configures a greater improvement on the definition and measurement of innovation in respect to the former versions of the Manual (1992 and 1997), which accounted only for technological product and technological process innovation, the TPP innovation. The broadening of the innovation concept across the successive versions of the Oslo Manual reflects the OECD, and other international organisations, effort to build an operational concept able of capturing the multiple dimensions of innovation.

In fact, the OECD (2010) acknowledges the limitations of splitting the innovation concept into two types: technological and non-technological innovation, given the increasingly trends for mixed modes of innovation. Based on a large study conducted by the OECD (OECD, 2009) a diversity of innovation patterns were founded, comprising product innovation mixed with marketing/value chain innovation, mix of marketing and organisational innovation and network-based innovation involving collaborative approaches. The OECD worldwide dataset analysis demonstrates that, in fact, innovation has a broad scope and comprises a large diversity of players, alongside with an increasingly trend for collaborative partnerships and network strategies. Therefore, the results of OECD (2009) show that the current models and policies to promote innovation, focused on the technological innovation paradigm, in accordance with the innovation framework that has been developed during the past 20 years (OECD, 1992, 1997 and 2005), are now clearly limited to promote innovation in the economy, namely in the low-tech sectors and small-firms, as well as to incentivize innovative business models built on collaborative action and networking. Therefore, knowledge is needed on the innovation patterns and dynamics of different sectors and organisations, namely of the small-firms. Hence, broad concepts and adjusted tools for data collecting are needed.

This chapter aims to contribute to the development of broad concepts for innovation and flexible tools for data collection. It presents the results of a survey conducted to innovative organisations (firms and non-firms) operating in the Portuguese rural areas, through interviews, buid on a questionnaire designed to cope with CIS limitations regarding the gathering of data on the innovation processes.

The goals of the chapter are threefold, (1) to present empirical evidence on the innovations being undertook by firms and other type of organisations in the Portuguese rural areas, which are neglected by the current innovation framework; (2) building on these data, to show the importance of hidden innovation in the Portuguese rural areas; and, (3) discuss the need to adjust concepts and data collecting tools in the innovation field in order to gather data that inform better the agendas and policies for innovation.

The chapter is organised as follows. Next, section 2 introduces the methodological approach, including the presentation of the sample and the design and implementation of the survey. Empirical results are presented in the section 3. Finally, section 4 discusses empirical findings and offers some suggestions on how to improve current innovation framework to allow it to support the design of more inclusive agendas and policies for innovation.

Methodology and Data Collection

The main challenges faced by the research project underpinning this chapter (the RUR@L INOV project), aiming to identify and to characterise the innovation taking place in the Portuguese rural areas, were twofold. The first derived from the ignorance about the universe of innovative organizations in these areas; the second was the outline of a methodological approach able to identify and survey a diversity of innovators and innovations.

The project benefited from previous research, conducted by some of the authors, on the innovation in rural areas, which provided a basis for the identification of the innovative initiatives, and an overall picture of innovation in EU rural areas (Costa *et al.*, 2009; Madureira and Costa, 2009, 2009a, 2010; Marques *et al.*, 2009; RAPIDO 2007, 2008 and 2009). This research provided interesting insights on what is innovation and who are the innovators in the EU rural areas. In addition it evidenced a knowledge gap in respect to small-scale and mixed innovation developed by a diversity of innovators (players).

Research to overcome that knowledge gap, applied to the Portuguese case, has been initiated in 2009 with an exploratory survey that was designed and implemented through in-depth interviews to a small sample of innovative organisations in the Portuguese rural areas (Madureira *et al.*, 2012). Its main purpose was to develop a data collection tool, a survey questionnaire-based, able to cope with diversity of players, and to capture innovation processes.

The previous research and findings allowed developing a large-scale survey to be implemented at the innovative organisations operating in the Portuguese rural areas. This survey stems from a two steps methodological approach. First step was the development of procedures to identify the innovative organisations based on a broad scope concept of innovation. The second step

2 A pilot version has been conducted in 1993 (CIS Light)

was the design and testing of the questionnaire to survey the innovative organisations.

To identify the population of the innovative organisations an on-line survey was delivered, in 2012, to a broad set of entities and actors, asking them to identify and describe very briefly the innovation cases in Portuguese rural areas they knew whatever the information source (they knew directly or indirectly through media, contacts or other sources). In parallel, a snowball procedure was used to complement the identification of the population. Different sources were used, including media notices, contacts with experts and projects, as well as literature review (namely grey literature). Built on these two procedures for information collection, a database of innovative cases in rural areas was created.

The design of the questionnaire relied, on one hand, on the CIS questionnaire and, on the other hand, on the exploratory survey conducted in 2009/10 previously reported. The questionnaire design benefited as well from two national level focus groups, carried out in the two Portuguese main cities (Lisbon and Porto) with innovation managers and other innovation stakeholders (focus groups took place in March 2012). The main goals of these focus groups were to understand the innovation concepts, innovation key aspects, accelerators and barriers, as perceived by the innovators and other innovation stakeholders.

The questionnaire was organised in four main sections. The first identified the organisation, including its location, legal nature an economic dimension. In the second section the organisation was characterised in respect to its activities, products and services, markets, value chain position and resources (human, financial and other). The next section was devoted to collect data on the innovation inputs, processes and outputs. This was the innovative component of the questionnaire, given it has been designed to provide qualitative information able to be converted in quantitative data regarding the innovation patterns and dynamics. Alternatively to the CIS approach, the innovations were not categorised *apriori* and the respondents were asked to describe the innovations developed and implemented by the organisation, including the time needed for its implementation and the year the process was initiated. The final section addressed the profile of the leader/manager of the innovation and his/her understanding of both the competitive advantages and disadvantages of the organisation rural location.

The questionnaire was administrated by members of the RUR@L INOV project team to the head/leader/chief responsibles for the innovation management in the organisations (often the responsibles for all the management). The survey was administrated by personnel-interviews to a 120 cases sample, between September 2012 and January 2013. The sample was selected from the abovementioned database, according to the respective proportions regarding the location by NUTS2 and the legal nature of the organisations (private, State and non-governmental organisations).

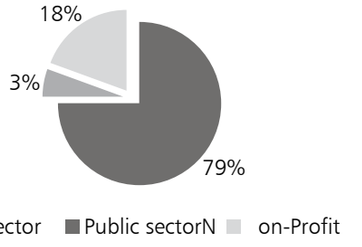
Results

The results are presented in two subsections. The first provides a description of the sample in respect to a set of variables considered relevant for giving the reader a snapshot of the main characteristics of the surveyed organisations, namely of the group of innovative firms. The second subsection presents the results of a cluster analysis (K-clusters) that allowed for grouping the innovative firms according to their innovation inputs and processes, providing evidence of significant hidden innovation.

Description of the Innovative Firms Profile

As shown by Figure 21, the total 120 surveyed organisations include 94 firms, 22 non-profit organisations and 4 organisations from the public sector.

Figure 21: Organisations surveyed according to their legal nature status



The data regarding the firm size show that SME are the dominant group, representing 97.9% of the total. This figure is in line with the weight of SME in the Portuguese economy. In addition, more than half of the total companies (53.2%) are micro-firms, meaning that they employ less than 10 workers (see Table 17).

Table 17: Economic dimension of firms (number of workers)

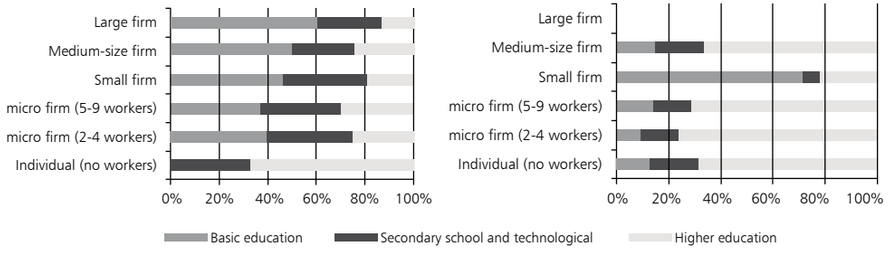
Firm size		**Nº**	**%**	**Nº**	**%**
	Micro firm (2-4 workers)	26	27.5		
	Micro firm (5-9 workers)	13	17.5		
	Individual (no workers)	11	10.0		
Micro firms	Sub-total			50	53.2
	Small firm (10-49 workers)	27	26.7		
	Medium firm (50-249)	15	15.0		
Small and medium-sized	Sub-total			42	44.7
	Large firm (250 or more workers)	2	3.3	2	
Large firm	Sub-total	2		2	2.1
Total				94	100

Another important feature is the multi-activity/multi-sector character of the majority of the surveyed firms: 86% are involved in, at least, two economic activities. This is often a result of coherently integrated production chains, e.g. agriculture combined with food-industry (e.g. in wine, olive oil sectors), or food-industry and trade in the case of the cooperatives. But in other cases it derives from a diversification strategy (e.g. combining agriculture and tourism). This multiple-sector pattern has been previously identified as a trait of the innovative rural organisations, namely the rural firms (Madureira and Costa, 2009, 2009a, 2010; RAPIDO, 2009). Regarding the firms resources, there are three aspects deserving to be highlighted. First, the majority of the firms rely mainly on their own financial resources; That is, in general, both the public support and the bank loans are secondary sources of funding. Second, while scarce in "very-small" firms, the human resources are highly qualified in terms of education level (see Table 18 and Figure 22). And, third aspect, the fact of the main source of knowledge for innovation being the firm own human resources, namely the promoter/manager together with internet-based tools (see Figure 23).

Table 18: Education level of human resources: (a) Employees; (b) Leaders/managers

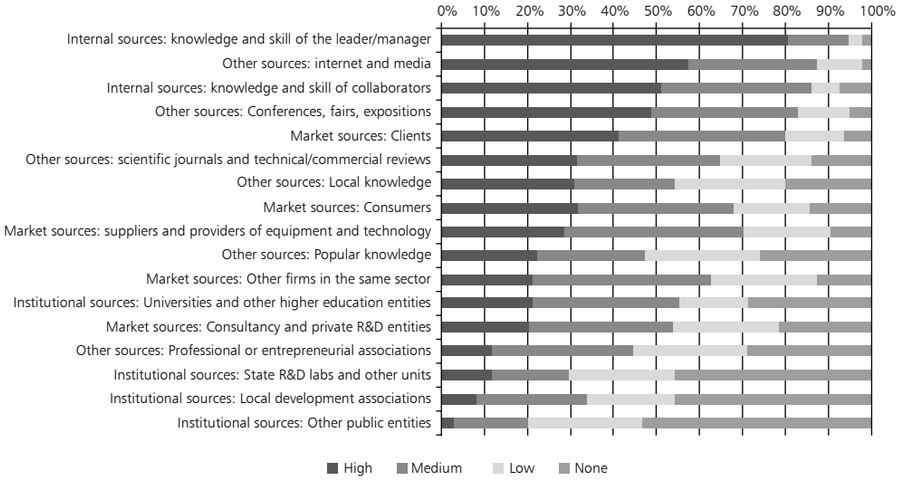
	Employees						
	Individual (no workers)	Micro-firm (2-4 workers)	Micro-firm (5-9 workers)	Small-firm	Medium-sized firm	Large firm	Total
Basic education	0	28	26	260	722	1506	2542
Secondary school and technological	3	25	23	190	376	681	1298
Higher education	6	18	19	99	360	351	853
	Leaders/ Managers						
Basic education	1	4	4	86	5	0	100
Secondary school and technological	3	6	4	8	8	0	29
Higher education	11	24	18	25	22	0	100

Figure 22: Education level of human resources: (a) Employees; (b) Leaders/managers



The main sources of knowledge for innovation reported by the respondents are the in-house ones: the leader/manager and the collaborators, together with ICT tools, namely internet. This is certainly a result of the high education level of firms, in particular the smallest ones. Internet-based resources are also placed in the group of top sources of knowledge for innovation. The top knowledge sources combined with the resort to a multiplicity of sources evidence that the innovative firms have a self-demanding pattern regarding this innovation key input (see Figure 23).

Figure 23: Sources of information for innovation according their relative importance



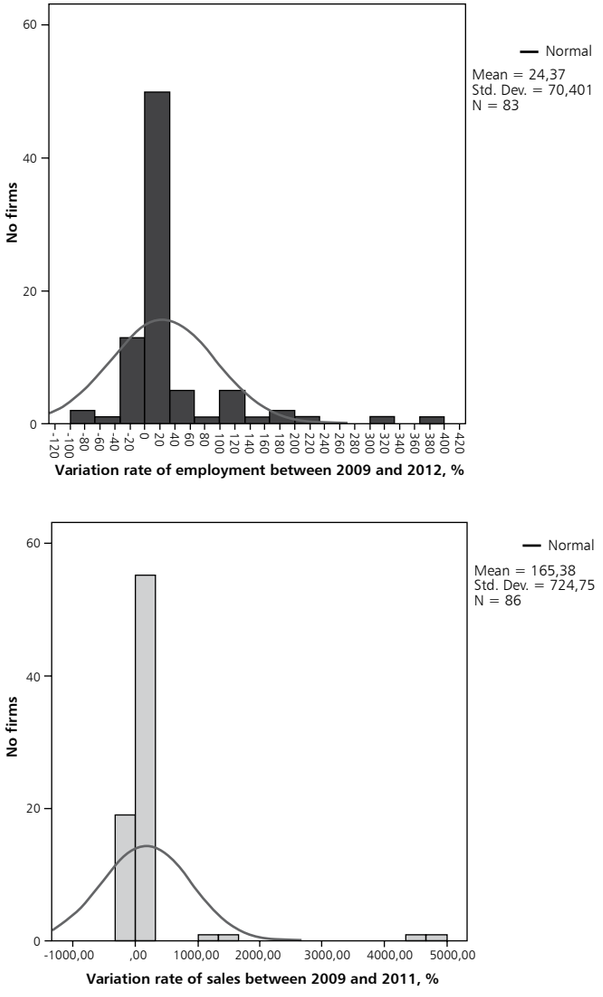
The mobilisation of local knowledge stated by the respondents (see Figure 23) is also very evident on the products and services differentiation. This seems to be another characteristic of innovative rural firms, confirming their ability to mobilise the latent resources of rural areas, such as the local agro-climatic conditions, local knowledge, cultural resources, environment and biodiversity.

The innovation processes highlight the mixed modes, combinations of different types of innovation. Product and process, as well as organisational and process, are strongly correlated innovation types (Pearson correlation coefficient significant at ≥ 0.05 significance level). On the other hand, marketing innovation comes out associated with product innovation for new products, related with broadening the set of products and the entrance in specific markets (Chi-Squared test significant at ≥ 0.05 significance level).

Incremental innovation is the dominant pattern, whereas still around a third of the total firms develops radical innovation, in general alongside with incremental. The maximum time needed to fully develop the innovation can be divided into three groups: (a) 1 year at maximum (in 17.1% of the firms); (b) between 1 and 3 years (in 54.9% of the cases); and, (c) more than 3 years (in 28.1% of the firms).

The empirical data confirm also the resilient economic performance of innovative firms, in particular if we keep in mind that the figures for employment and turnover were collected for a crisis period (2009 to 2011), ended by one year of severe recession in the Portuguese economy. The Figure 24 shows both the distribution of the variation rate for employment and sales, in the surveyed firms, between 2009 and 2012 (2011 for turnover).

Figure 24: Variation in total employment and total sales between 2009 and 2012 (2011 for sales)



These figures highlight the importance of bringing to the scene these backstage firms in respect to the promotion of innovation, given their resilience pattern and their role for the sustainable development of the rural areas, by maintaining and creating qualified jobs.

Clustering Innovative Firms to Make Evident Hidden Innovation

This subsection presents the results of a cluster analysis conducted with k-means clustering, which is a cluster analysis that splits the observations by a pre-defined number of clusters, k. The observations are grouped according to their proximity to the mean of the variables used to define the clusters.

Build on the variables relevant to describe the innovation inputs, processes and outputs different clustering were tested for different set of dummy variables and number of clusters. The finally selected clustering has 4 clusters and it is described in Table 19.

Table 19: Selected clusters

Final Cluster Centers				
	Cluster			
	1	**2**	**3**	**4**
Patents	0	0	0	0
Collaborates with R&D units	0	1	1	0
Received EU financial support	0	1	1	1
States a figure for expenditures with internal R&D	0	1	0	0
States a figure for expenditures with external R&D	0	1	1	0
States a figure with acquisition of machinery and/or equipment	1	1	0	1
Develops product innovation for new-to the market products	0	0	0	0
Develops process innovation for efficiency gains	0	0	0	1
Develops new-to the market innovation	0	1	0	0
Develops innovation continuously and sequentially	1	1	0	1
Innovation takes one year or less to be developed	1	1	0	0
Develops product innovation	1	1	1	0
Develops process innovation	0	1	0	1
Develops marketing innovation	1	0	0	1
Develops organisational innovation	0	0	0	1
Develops networking innovation	0	0	0	0
States to develop internal R&D activities	1	1	1	0
States the acquisition of external R&D	0	1	1	0

Table 20 shows the variables used to describe the clusters to be significant, the exception being the existence of patents.

Table 20: ANOVA analysis

ANOVA						
	Cluster		Error			
	Mean Square	df	Mean Square	df	F	Sig
Patents	0.134	3	0.086	90	1.561	0.204
Collaborates with R&D units	3.110	3	0.157	90	19.770	0.000
Received EU financial support	1.692	3	0.202	90	9,385	0.000
States a figure for expenditures with internal R&D	3.380	3	0.131	90	25.717	0.000
States a figure for expenditures with external R&D	1.629	3	0.169	90	9.666	0.000
States a figure with acquisition of machinery and/or equipment	0.937	3	0.173	90	5.427	0.002
Develops product innovation for new-to the market products	0.410	3	0.179	90	2.284	0.084
Develops process innovation for efficiency gains	2.741	3	0.127	90	21.566	0.000
Develops new-to the market innovation	0.752	3	0.198	90	3.805	0.013
Develops innovation continuously and sequentially	1.061	3	0.163	90	6.499	0.000
Innovation takes one year or less to be developed	0.704	3	0.230	90	3.059	0.032
Develops product innovation	1.547	3	0.136	90	11.400	0.000
Develops process innovation	2.240	3	0.186	90	12.045	0.000
Develops marketing innovation	0.538	3	0.242	90	2.222	0.091
Develops organisational innovation	1.662	3	0.158	90	10.490	0.000
Develops networking innovation	0.298	3	0.106	90	2.799	0.045
States to develop internal R&D activities	1.682	3	0.182	90	9.251	0.000
States the acquisition of external R&D	3.506	3	0.140	90	25.041	0.000

The clustering presented distinguishes four groups regarding the innovation inputs, processes and outputs.

Cluster 1, which will be labeled as "Invisible innovators", includes 34 firms (36.2% of total firms). In this group the R&D inputs are less noticeable and the majority of the firms combines product and marketing innovation and prevails an incremental pattern of innovation related to product innovation.

Cluster 2 includes 27 cases (28.7% of the firms), and is the one where innovation is more visible. Thus, it will be named as the group of the "Standard innovators". Firms within this group state expenditures on both, internal and external R&D inputs, collaborate with R&D units, benefit from public funds for innovation, and present an innovation pattern dominated by mixing product and process innovation.

The cluster 3 (with 16 firms, 17% of total firms) can be envisaged both as a downgrading of cluster 2 or a upgrading of cluster 1. Cluster 3 is R&D less intensive in comparison to cluster 2, and more focused on product innovation. A possible designation for cluster 3 is "Basic innovators", since they use R&D inputs, but invest less on it, and, on the other hand, their focus on product innovation reveals a more incremental innovation pattern in comparison to the cluster of the "Standard innovators".

Finally, the cluster 4 is a group of "Discrete innovators" configuring another type of hidden innovation. This group combines product and process innovation to attain efficiency gains and cost reductions. It benefits from public funding and collaborates with R&D units, but R&D inputs do not show to be as relevant as they are in the clusters 2 and 3.

A set of variables was tested regarding its ability to characterize the four clusters of innovators. Table 21 presents the variables that show statistically significant to describe the clusters.

Table 21: Variables tested for their ability to characterise the clusters

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Firm dimension	25.124	3	8.375	5.111	.003
Turnover 2011 (€)	9764305612884.000	3	3254768537628.000	1,405	.247
Main activity	8.889	3	2.963	1.201	.314
Multi-sectorial organisations	.064	3	.021	.095	.963
Exports	.934	3	.311	1.823	.149
Patents	.402	3	.134	1.561	.204
Expenditures with internal R&D (€)	98665522830.1	3	32888507610.0	2.441	.069
Expenditures with external R&D (€)	4308730492.83	3	1436243497.61	1.899	.135
EU public funds	5.075	3	1.692	8.385	.000
Innovation leader has higher education	.582	3	.194	.897	.446
No of innovations	129.656	3	43.219	7.356	.000
No of product innovations	97.955	3	32.652	6.543	.000
No of process innovations	59.366	3	19.789	7.324	.000
No of marketing innovations	6.472	3	2.157	1.131	.341
No of organisational innovations	10.828	3	3.609	4.360	.006
No of network innovations	1.772	3	.591	2.084	.108
Green dimension on innovations	1.629	3	.543	2.234	.090
New-to the market innovation	2.257	3	.752	3.850	.013
Continuous and sequential innovations	3.182	3	.282	1.147	.000
Collaborates with R& D units	9.331	3	3.110	19.770	.000
Collaborates with firm in the same sector for innovation	.846	3	.282	.1,147	.335
Collaborates with suppliers for innovation	2.263	3	.754	3.545	.018
Collaborates with firms from other sectors for innovation	.603	3	.201	.882	.454

Next tables 22 to 31 present the differences between the four clusters regarding the variables showing significant for their differentiation.

Table 22 takes the economic dimension to explain differences between the groups of innovators. It shows that the large majority of individual businesses (no-employees) are in the group of the "Invisible innovators". This group includes also a relevant percentage of micro and medium-sized firms. "Discrete innovators" are mainly small firms. On the other hand, the medium-large size firms are mostly comprised in the group of "Standard innovators". However, in this latter group one third of the firms are micro sized, indicating that the smallness of firms is compatible with R&D based innovation. "Basic innovators" are mostly micro-sized firms, what might evidence difficulties of smallness in accessing R&D inputs and collaborations.

Table 22: Innovators clusters according to the firms economic dimension

	Valid Percent in each cluster			
	1	2	3	4
Individual	26.5	3.7	6.3	0.0
Micro firm (2-4 workers)	29.4	18.5	43.8	0.0
Micro firm (5 -9 workers)	8.8	14.8	18.8	0.0
Small firm (10- 49 workers)	29.4	25.9	12.5	47.1
Medium-sized firm (50-249 workers)	5.9	29.6	18.8	11.8
Large firm (≥ 250 workers)	0.0	7.4	0.0	0.0
Total	100.0	100.0	100.0	100.0

Table 23 presents the clusters composition according to the firm's main economic activity. It highlights the presence of "Standard innovators" (cluster 2) in the food industry, and, while with lower weight, in the agriculture and forestry activities. The "Basic innovators" include mainly firms operating in the services, including the tourism activities, and on non-food industry. "Discrete innovators" are mainly present in the food industry and gross and retail trade, probably indicating the presence of cooperatives in this group. The "Invisible innovators" seem to be dispersed by a diversity of activities, suggesting again the presence of cooperatives and small businesses in agriculture and tourism.

Table 23: Innovators clusters according to the firms main activity

	Valid Percent in each cluster			
	1	2	3	4
Agriculture and forestry	14.7	25.9	12.5	23.5
Food industry	23.5	40.7	12.5	29.4
Tourism	20.6	3.7	31.3	5.9
Other industry	11.8	11.1	18.8	11.8
Gross and retail trade	26.5	14.8	12.5	23.5
Services	2.9	3.7	12.5	5.9
Total	100.0	100.0	100.0	100.0

The "Standard innovators" have, as expected, a significantly larger expenditure with internal R&D in comparison with all the other groups. Cluster 3, the "Basic innovators", resort to external R&D and that probably explains their low expenditure in internal R&D in comparison with the other groups (see Table 24).

Table 24: Innovators clusters according to expenditure on internal R&D (values are in €)

	Valid Percent in each cluster			
	1	2	3	3
N	34.0	27.0	16.0	17.0
Minimum	0.0	0.0	0.0	0.0
Maximum	50,0000.0	692,038.0	10,000.0	65,000.0
Mean	19,479.9	81,137.6	937.5	4,617.7
Std. Deviation	87,869.3	191,516.4	2,719.5	15,731.7

The collaboration with universities and other R&D units for innovation is 100% in the case of "Basic innovators", which are as already mentioned dependent on external R&D. In the case of the "Standard innovators" two thirds of the firms report this collaboration. The "Invisible innovators" appear to be little involved in this type of collaboration (see Table 25).

Table 25: Collaboration with universities and other R&D units for innovation

	Valid Percent in each cluster			
	1	2	3	4
No	88.9	33.3	0.0	29.4
Yes	11.1	66.7	100.0	70.6
Total	100.0	100.0	100.0	100.0

Cluster 2, the "Standard innovators", is the group stating more use of UE funds to develop innovation. In comparison, the "Invisible innovators" benefit very little from this financial source.

Tables 26 to 30 report on the number and type of innovations and allow comparing the four groups regarding the respective patterns of innovation. "Standard innovators" state a large number of innovations and underline the product and process innovation. As already stated, "Basic innovators" have a product-driven innovation, similarly to the "Invisible innovators". "Discrete innovators" are more committed with process and organizational mix of innovation. The network innovation has relatively little expression, while shows more expressive in the group of the "Discrete innovators".

Table 26: Number of innovations

	Clusters			
	1	2	3	4
N	34	27	16	17
Minimum	2	2	1	2
Maximum	8	17	9	10
Mean	4.7	7.1	3.9	5.4
Std. Deviation	1.7	3.2	1.9	2.6

Table 27: Number of product innovations

	Clusters			
	1	2	3	4
N	36	27	14	17
Minimum	0	0	0	0
Maximum	7	12	9	4
Mean	2.5	3.7	2.4	0.4
Std. Deviation	1.6	3.1	2.2	1.1

Table 28: Number of process innovations

	Clusters			
	1	2	3	4
N	36	27	14	17
Minimum	0	0	0	0
Maximum	4	11	3	5
Mean	0.6	2.0	0.4	1.9
Std. Deviation	0.9	2.7	0.8	1.4

Table 29: Number of organisational innovations

	Clusters			
	1	2	3	4
N	36	27	14	17
Minimum	0	0	0	0
Maximum	2	6	1	4
Mean	0.3	0.5	0.1	1.1
Std. Deviation	0.6	1.3	0.3	1.1

Table 30: Number of networking innovations

	Clusters			
	1	2	3	4
N	36	27	14	17
Minimum	0	0	0	0
Maximum	0	2	1	4
Mean	0.0	0.3	0.2	0.4
Std. Deviation	0.0	0.5	0.4	1.0

As expected, the radical innovation, new-to the market products (or processes), is underlined in the group of "Standard innovators", while and surprisingly shows to be important also for "Basic innovators". The later situation is probably related to the development of new products, built on marketing innovation. Clusters 3 and 4 are dominated by incremental innovation (see Table 31).

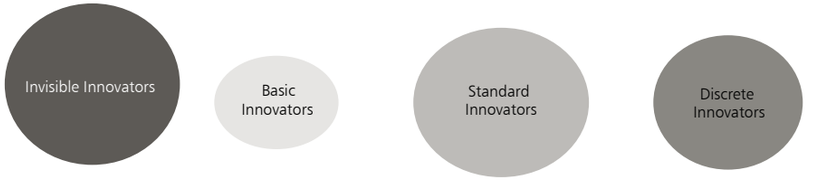
Table 31: Presence of new-to the market innovation

	Valid Percent in each cluster			
	1	2	3	4
Non	61.1	55.6	92.9	88.2
Yes	38.9	44.4	7.1	11.8
Total	100.0	100.0	100.0	100.0

The "Standard innovators" exhibit a more marked profile of continuous and sequential innovation in comparison to the others, followed by "Basic innovators", what is again a kind of surprising outcome.

The Figure 25 presents a summary of the results presented, highlighting the profile of each of the four clusters based on the significant aspects that were described in the sequence of tables presented along this section.

Figure 25: Profile of the selected clusters



	» Expense with external R&D	» Expense with internal R&D	
	» Cooperate with R&D units	» Cooperates with R&D units	» Cooperates with R&D units
» Product innovation	» Product innovation	» Product X Process innovation	» Process x Organisational innovation
		» Radical innovation	
» Little access to fund for innovation	» Moderate access to fund for innovation	» High access to funds to innovation	» Moderate access to fund for innovation
» Food industry, agriculture and whole/retail sales	» Tourism and no-food industry	» Food industry, agriculture	» Food and sales
» Individual firms, micro and small firms	» Micro and small firms	» Small and medium firms	» Small and medium firms

Discussion and Recommendations

The results of the research here presented endorse the hypothesis that the current theoretical and methodological framework, build on the Oslo Manual, presents important limitations in its ability to identify and measure innovation, when the concept is broaden to all type of firms independently of their economic size, activity sectors and to comprise the innovations processes that are not highly R&D input based. It shows clearly insufficient to disclose the actual universe of innovators, as evidenced by the case of the one operating in the Portuguese rural areas.

The research findings highlight two different groups of firms that hardly would be identified as "innovators" based on the use of R&D inputs and outputs. On the other hand, the data show that organizational innovation is often mixed with process innovation (non-technological processes) and that this important innovation pattern is not captured by the CIS data. They show, on other hand, that there is a group of innovators, the "Invisible innovators", that seems to innovate at their own initiative and risk, with little support, both financial and external knowledge. This is a significant group of innovators that deserves further analysis in order to understand what hinders them to access innovation-related resources; and how that access could be ensured? These are key questions for the political agendas and policies meant to promote innovation in the real economy.

In addition, this chapter demonstrates that the identification and measurement of innovation can be significantly improved through better survey methodology and practice. What, has been discussed, is fundamental to adjust the current theoretical and methodological framework to enable it to be inclusive and to cope with huge diversity of types of innovations and innovators that are present in the actual economy.

The chapter highlights the importance of hidden innovation in firms acting in rural areas, but their findings are certainly extensible to urban areas and not-rural related activities, such as the general manufacturing industry. Therefore, more research is needed on the hidden innovation and on how to include it in the innovation research framework.

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PART THREE:
TRENDS FOR THE FUTURE

Measurement of good practices of innovation in rural areas

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Introduction

The Oslo Manual (OECD, 2005a) defines innovation as the implementation of a new or significantly improved product (good or service) or process, a new marketing method or a new organisational method in business practices, workplace organisation or external relations. All innovation must contain a degree of novelty but not necessarily created by the firm: it is enough that the innovation is new to the firm, adding economic or social value. Innovations can also be new to the market, or new to the world, when the firm is the first to introduce the innovation on its market, or on all the markets and industries.

It is also set that innovation goes far beyond R&D, including a wide range of activities like organisational changes, training, testing, marketing and design, and can be influenced by policy. It is accepted that innovation can occur in any sector of the economy but, as the current measurement framework only applies to business innovation, a methodology is needed to capture and measure the "hidden innovation" that exists in rural areas, which potential to promote rural areas competitiveness and sustainability is neglected by rural and innovation policies.

Thus, the project RUR@L INOV seeks to learn about innovation being developed and implemented by different types of organisations and other actors in the Portuguese rural areas. More specifically the project aims to identify and describe the processes of innovation and, simultaneously, to characterise the profile of both innovative organisations and innovators, taking into account their territorial environment. One of the specific objectives of the project is to identify, analyse and disseminate good innovation practices in rural areas, through both the characterisation of what might be considered good practices and the elaboration of a manual (of good practices for rural innovation) that will help to promote their dissemination.

In this chapter we present a contribution for the achievement of the above referred goals: the methodology used for the Measurement of Good Practices of Innovation in Rural Areas that will give shape, in a subsequent stage, to the Good Practices Manual.

Framework / Literature Review

Innovation in Europe

Innovation has been placed at the heart of the Europe 2020 strategy for growth and jobs (EC, 2013): with an ageing population and strong competitive pressures from globalisation, Europe's future economic growth and jobs will increasingly have to come from innovation in products, services and business models.

In 2010, the European Union (EU) formulated a Strategy known as Europe 2020 (EC, 2010). This strategy seeks to help Europe "to come out stronger from the crisis and turn the EU into a smart, sustainable and inclusive economy delivering high levels of employment, productivity and social cohesion". Europe 2020 sets out a vision of Europe's social market economy for the 21st century, where the European countries have to act collectively, as an Union. This Strategy puts forward three mutually reinforcing priorities: Smart growth, Sustainable growth and Inclusive growth. For Smart growth the Commission puts forward the establishment of an "Innovation Union", one of the 7 flagship initiatives to catalyse progress. The Innovation Union, with over thirty action points, "aims to improve conditions and access to finance for research and innovation in Europe, to ensure that innovative ideas can be turned into products and services that create growth and jobs" (EC, 2013).

Innovation in Rural Areas: The New Rural Paradigm

In OECD countries, rural areas account for three-quarters of the land and are home to a quarter of the population. Rapid changes in the international economy clearly have a different effect on these regions, than on cities and towns (OECD, 2006).

The assets of rural regions, such as quality of life and environment, natural heritage and other amenities, combined with improved transport links and infrastructure, internet and increased leisure time are retaining and/or attracting people and businesses for rural areas. These facts are leading governments to rethink their policies (mainly focussed in agricultural subsidies), enlarging their scope to seize new opportunities for rural areas, some linked to agriculture, but most in non-agricultural activities, triggering rural development as a whole (Table 32).

Table 32: The old and new rural paradigms

	Old approach	**New approach**
Objectives	Equalisation, farm income, farm competitiveness	Competitiveness of rural areas, valorisation of local assets, exploitation of unused resources
Key target sector	Agriculture	Various sectors of rural economies (ex. rural tourism, manufacturing, ICT industry, etc.)
Main tools	Subsidies	Investments
Key actors	National governments, farmers	All levels of government (supra-national, national, regional and local), various local stakeholders (public, private, NGOs)

Source: Reinventing Rural Policy (OECD, 2006)

In the same report (OECD, 2006), new opportunities are identified including: an increased demand for rural amenities on the part of urban residents; sources of economic success, such as dynamic SME clusters; development of diversified agro-industries and rural tourism; and, opportunities related to products that project traditions of quality and craftsmanship, connectedness with nature and a sense of place and culture. These new opportunities encountered echo in a new innovation paradigm: in the last few years, it has been agreed that innovation involves much more than only technology, as more and more it regards strategy, marketing, organisation, management, design (OECD, 2005a and Brunori *et al.* 2007).

In the project RAPIDO (Esparcia, 2008), that investigated the processes and role of different actors (public and private) launching, implementing and developing innovative projects in rural areas, it is highlighted the presence of new knowledge and/or different types of innovation: innovation in products (agro-tourism and rural tourism activities related to environmental protection); technological innovations (irrigation, pollution control, waste treatment, treatment of agricultural products, etc.); innovations in processes (cooperation of stakeholders); organisational innovations (structures for cooperation between local actors); innovations in attitudes (the culture of cooperation).

These findings are equivalent to those of the IN-SIGHT project (Brunori *et al.* 2007), in what concerns innovation in rural areas. Farmers, for example, looking for alternatives to industrial agriculture, don't necessarily apply "new" technologies as their novelties emerge as the outcome of "different ways of thinking and different ways of doing things".

These alternative practices and the show up of new policies for the rural areas led to a change in paradigms, where alternative paradigms as, among others, economies of scope, diversification, added value, communication and organisation technologies have showed up and have a growing importance compared to more conventional ones, such as economies of scale, specialisation, productivity of labour or industrial technologies (Brunori *et al.* 2007).

Measuring Innovation

In the 50's Jacob Schmookler started to use patents as an indicator of innovation, although it was understood that patents measured invention, not innovation. In the mid-60's, the start of R&D surveys made possible the use of industrial R&D data to measure innovation. In 1992, a draft manual for the OECD member countries - the Oslo Manual - was adopted, with the purpose to harmonise national methodologies and collect standardised information on the innovation activities of firms: the type of innovations carried out, the sources of technological knowledge, the expenditures on related activities, the firm's objectives, the obstacles to innovation and the impacts of innovation activities. A firm was considered innovative if it produced one or more technologically new or significantly improved products or processes in a three-year period. Since then, the OECD/Eurostat definition of innovation has changed, as services activities were added to the manufacturing activities for the second edition of the Oslo manual, together with a weaker distinction between technological and non-technological activities (Godin, 2002)

According to Rogers (1998), that compares the OECD's innovation definition and measurement systems with the ones from the Australian government and businesses, one method for measuring innovation is to make the distinction between the outputs of innovative activity and the inputs for this activity.

Several variables for measuring the success of the firm (output) are discussed, having into account that indicators as profits, revenue growth, share performance, market capitalisation or productivity can reflect other factors other than the level of innovativeness. A suggested alternative is (from OECD survey) the percentage of sales accounted for new or improved products or processes. Although this indicator relies on the ability of firms to correctly and consistently report such percentages, it can be a good assessment of innovative activities. Another alternative is the creation of variables for measuring the number of new or improved products and/or processes introduced.

Intellectual property data, such as patents, that were at first used to measure firm's innovation outputs, and lately have been considered as indicators of inputs to the innovation process, are not always a commercially exploited innovation and in many cases are not obtained as it involves the full disclosure of the knowledge which may be of indirect use to competitors.

The level of R&D expenditure is frequently used to measure innovation effort (input), and although it doesn't match exactly with innovation, it can be an indicator of innovation activity. Data on the purchases of external technology or on the improvement of equipment or machinery can also be used as an indicator of innovative activity, as well as the expenditure on the marketing of new products and on training that is related to the introduction of new or improved products and processes, as innovation involves the entire resources of a firm in developing and extracting value from new ideas, including the marketing of ideas, and the ability of staff to efficiency implement the ideas.

Rogers (1998) also proposes the use of econometric techniques to quantify the firm's innovativeness, allowing inferences about the value of the different innovation activities, an assessment of the overall value of innovation activities, and to compare it to other firms. The great advantage of these methods is that they can link the innovation inputs, as R&D and patents, to a quantifiable measure of innovative outputs, like market value and productivity.

Recently OECD (2010) identified five key areas of action that could be the basis for a forward-looking, longer-term, international measurement agenda for innovation. These areas include: the development of innovation metrics that can be linked to aggregate measures of economic performance; the investment in a high-quality and comprehensive statistical infrastructure to analyse innovation at the firm-level; the promotion of metrics of innovation in the public sector and for public policy evaluation; the look for new and interdisciplinary approaches to capture knowledge creation and flows; and, the promotion of the measurement of innovation for social goals and of social impacts of innovation. The indicators proposed for the country level are, among others, related with sources of growth, intangible assets, innovation beyond R&D, protection of innovation, complementary innovation, collaboration, multidisciplinary and interdisciplinary research, knowledge clusters and knowledge circulation, skills, entrepreneurial talent, mobilising private funding, policy environment, investments in R&D and in innovation, information and communication technologies.

Methodology

General Description

The methodology developed to identify and measure good practice of innovation in rural areas is based on the analysis of an extensive literature on innovation, good practice and rural development, from which were identified a set of key variables and indicators associated with the development and implementation of rural innovation. From this set were selected the variables that could be adapted to the project RUR@L INOV. The analysis of the literature also revealed that the measurement of innovation practiced either at national level or at organisation level is limited to the measurement of input factors and/or of the results achieved. In the methodology adopted we have considered an added value to include the measurement of factors related with the processes followed by the organisations to achieve innovation.

The model was tested resorting to the data basis obtained through a previous survey, also prepared specifically for the project RUR@L INOV, that gathered information about 120 organisations which are representative of the great diversity of activities, innovations and innovators that can be found in rural areas (defined according to the OECD criteria). Some of the answers obtained through the survey allowed a fine tuning of the definition of variables and of the construction of the indicators associated with good practices for rural innovation.

The literature review, the several analyses carried out and the type of answers that could be obtained from the survey made us decide for a conceptual model that will be used to identify "innovative organisations in rural areas", regardless of their size, activity and legal form. That is, the focus will be given to the organisation, instead of focusing on the innovations themselves.

The structure of the survey was used as a reference to the definition of variables and indicators, as the answers received were the likely information to identify and classify the cases of good practice. We also sought to identify other indicators that could be used in future analyses, although they could not be quantified within the scope of this project.

The methodology that was adopted for the definition of the variables and for the construction of indicators associated with the best practices for rural innovation, as well as the fine tuning of the selected set of variables and indicators to be used, was previously discussed in a Focus Group composed by experts in innovation, rural development and statistical development.

Good Practices of Innovation in Rural Areas

The great amount of references analysed revealed that there are no specific definitions for good practices of innovation in rural areas and that there are several descriptions of what can be "the best practices in innovation". The range of descriptions gets broader, or more imprecise, when the focus is reduced in order to identify what could be best practices of innovation in rural areas and, much more, when the organisation is specifically addressed.

Another challenge related to the fact that best practices criteria were usually applied to the organisation in general, or only focused on the engagement of input factors and/or on the results achieved.

From the various criteria used for identifying good practices, a selection was made to

choose those which seemed to adapt more closely to the Portuguese rural areas. The selected criteria were then allocated to the level of functioning of the organisation for the production of innovation to which they were more fitted: Input, Process or Outputs.

In synthesis, a "best practice" can correspond to an organisation:

Input

- with an approach based on investment instead of subsidy based (OECD, 2006 and Rur@ct, 2012)
- that provides policies and resources to the pursuit of innovation projects and activities (COTEC, 2010)
- involving stakeholders institutions, entities and relevant personalities (Brunori *et al.*, 2007; CSE, 2003 and de Jong *et al.*, 2006)
- with a network that includes partnerships with stakeholders outside academies, involving local people, integrating local and academic knowledge, recognising and building on existing capacities of the various actors (Knickel, 2009)
- including actors with an 'open attitude' or an 'innovative mind-set' towards change, overcoming sectorial and territorial barriers, collaborating between communities, regions, countries and various sectors (Kenyon, 2005 and Knickel, 2009)
- involving leadership and skilled management principles and practices and staff with pride, enthusiasm and involvement (Kenyon, 2005)

Process

- that seeks complementarity and consistency with the priorities of existing policies (CSE, 2003; EC DGARD, 2010; Rur@ct, 2012 and SAE, 2004)
- with a continuous process of innovation management and focused on both quality and differentiation of products/services offered and on an innovative marketing (COTEC, 2010 and Kenyon, 2005)
- involving local knowledge and local actors (producers and consumers) (de Jong *et al.*, 2006 and Kenyon, 2005)
- adapted to local specifics (ARE, 2006)
- with a cross and participatory action (ARE, 2006)

Output

- that has produced positive and tangible results and outputs (ARE, 2006; CSE, 2003; Rur@ct, 2012 and SAE, 2004)
- that can be replicated or adapted to other contexts horizontally (diffusion) and/or vertically (integration into systems and regulations) (ARE, 2006; CSE, 2003; InterAction, 2012; Rur@ct, 2012 and SAE, 2004)
- that has shifted its orientation to regional and international markets (EU SCAR, 2012 and OECD, 2012)
- with a positive impact on the employment and growth development of the area where the investment has taken place, and/or on the socioeconomic situation of the innovator (DATAR, 2010 and EC DGARD, 2010)
- that builds the capacity to deliver services in agriculture and rural livelihoods and newcomers in a sustainable way (DATAR, 2010 and InterAction, 2012)
- that promotes the natural, cultural and tourist resources and contributes to the recovery and management of bio-resources, landscape / heritage preservation, environmental / ecological protection (DATAR, 2010 and de Jong *et al.*, 2006)
- that contributes to a sustainable territorial development (DATAR, 2010)

Indicators

The same rational was used to identify the indicators that would be more suitable for measuring good practices in rural areas. The same drawbacks that we had faced when searching for good practices definitions, were found when trying to identify indicators and metrics for measuring innovation in rural areas. Existing indicators and measuring systems were also broad, or focused either into measuring innovations in large firms - like the Community Innovation Survey (CIS) -, or to compare national levels, like, for example, NESTA and Innovation Union Scoreboard. Most of the indicators were also mainly designed to measure inputs and/or outputs.

The selection of a set of key variables and indicators that would be used to characterise the development and implementation of good practices in the Portuguese rural areas was also split into the levels of functioning of the organisation for the production of innovation: Input, Process and Outputs. One more group of indicators was included to describe the main characteristics of the organisations, essentially based on CIS surveys:

General information

Input indicators

- knowledge and skills: human resources in science and technology, human resources allocated to R&D activities, human resources university graduated, multidisciplinary and interdisciplinary research, inter-disciplinary teams/ co-operative atmosphere (COTEC, 2010; Hervas, 2011; InnovationLabs, 2008; Leskovar-Scapan *et al.*, 2007; OECD, 2005b; OECD, 2010 and TWB, 2008);
- R&D expenditures, R&D expenditure as a percentage of sales (COTEC, 2010; Hervas, 2011; InnovationLabs, 2008; NESTA, 2009; OECD, 2005b; OECD, 2010; OECD, 2012 and TWB, 2008);
- financing through internally generated funds, mobilising private funding, direct and indirect government funding, borrowing, availability of venture capital investment funds (Leskovar-Scapan *et al.*, 2007, OECD, 2005b; OECD, 2010; OECD, 2012 and TWB, 2008);
- mechanisms used to support private investment in R&D: competitive grants, tax provisions; credit guarantees, government R&D financing (OECD, 2005b; OECD, 2010 and OECD, 2012);
- knowledge acquisition through partnerships with external parties (alliances, joint ventures, joint development, etc.), acquiring/selling knowledge (using contract R&D, purchasing, licensing), contact with University, contact with international network, contact with competitors and social network (CEC, 2006; van Hemert *et al.*, 2012, Hervas, 2011; InnovationLabs, 2008; Leskovar-Scapan *et al.*, 2007; NESTA, 2009; Nybakk et al, 2009; OECD, 2005; OECD, 2010; OECD, 2012 and TWB, 2008);
- barriers to entrepreneurship and innovation (OECD, 2010 and TWB, 2008).

Process or throughput indicators:

- number of innovations (by type - product, process, organisational, marketing) during the

last 5 years (Leskovar-Scapan *et al.*, 2007 and Nybakk et al, 2009);
- during the last 5 years (product, process, organisational, marketing) improvements have been mainly incremental or radical (Leskovar-Scapan *et al.*, 2007);
- mixed modes of innovation (complementary innovation strategies in manufacturing or in services) (OECD, 2010);
- value chains (TWB, 2008);
- total factor productivity (TFP) growth or number of changes introduced in firms (OECD, 2012);
- design, organisational improvement, marketing improvement (NESTA, 2012);
- internationalisation (OECD, 2005b).

Innovation outputs
- number of innovations created or introduced (COTEC, 2010; van Hemert *et al.*, 2012; Hervas, 2011; InnovationLabs, 2008 and TWB, 2008);
- percentage of sales of innovative products (CEC, 2006; COTEC, 2010; InnovationLabs, 2008; NESTA, 2009 and OECD, 2010);
- growth rate of the firm (Nybakk et al, 2009; InnovationLabs, 2008 and TWB, 2008);
- number of publications in academic journals, number of mentions in media, number of actions for knowledge dissemination, etc… (COTEC, 2010; OECD, 2005b; OECD, 2012 and TWB, 2008);
- number of patents and trademarks (COTEC, 2010; InnovationLabs, 2008; OECD, 2005b; OECD, 2012 and TWB, 2008);

Focus Group

The above referred analyses and their intersection with the structure of the RUR@L INOV survey, resulted in a proposal for a set of dimensions, indicators and variables that could be used to identify (and measure) good practices in rural innovation.

This proposal was further discussed and refined through the input obtained from researchers, consultants, entrepreneurs and decision-makers, with expertise in innovation, rural development and statistical development, who participated in a Focus Group or were asked to provide written contributions.

Questions on the following substantive issues were asked to the experts:
- How to define "good practices for rural innovation"? How to identify them? Are there alternatives?
- What dimensions, indicators and variables are more suitable for the definition of best practices in rural areas? Changes should be made on the way they were organised (input, process and output)?

Opinions were also asked on detailed issues / chosen criteria:
- About the relevance of an indicator related with the "Intensity of the innovation process", and with different innovation types (continued incremental innovation? regular radical innovation? is radical innovation maximised?) as well as on criteria adopted (or to adopt) for measuring this indicator.
- About the criteria used for the definition and classification of the organisation's skills for innovation.
- About the classification assigned to the sources of funding / financial resources that best reveal the robustness / sustainability of the organisation.
- About the classification criteria for the contribution of the organisation to its value creation.
- On the importance of sources of knowledge, the involvement of local knowledge, the establishment of partnerships, the existence / use of R&D
- About a proposal for a breakdown (and/or aggregation) of the classification of Economic Activities and Products / Services

Results

Indicators for Measuring Good Practices of Innovation in Rural Areas

A set of indicators was defined for measuring good practices of innovation in rural areas (Table 33). For each of these indicators, various classes were defined in order to allow a better understanding of the available information. To several of them, it was not possible to gather information from the survey, therefore further questions have to be included in future surveys.

Table 33: Indicators for measuring good practices of innovation in rural areas

Characterisation of the Organisation	
Type and size	1.1 - Legal form of the organisation
	1.2 - Size of the organisation
Activities and products/services	2.1 - Economic activities
	2.2 - Products and services
Input	
Location	3.1 - Typology of urban areas
	3.2 - Local environment
	3.3 - Competitive advantages
	3.4 - Competitive disadvantages
Skills	4.1 - Leader / manager innovation skills
	4.2 - Human resources qualifications
	4.3 - Internal cooperation
	4.4 - Organisation skills in R&D
	4.5 - Organisation skills in Design
	4.6 - Organisation skills in Marketing
Resources	5.1 - Financial resources
	5.2 - Resources through "merit"
	5.3 - Material resources
Sources of knowledge	6.1 - Internal sources of information
Networking	7.1 - Partnerships for innovation
Barriers to innovation	8.1 - Internal barriers
	8.2 - External barriers
Process	
Innovations	9.1 - Type of innovations created / adapted
	9.2 - Intensity of the innovation process
	9.3 - Activities for innovation
	9.4 - Investment in innovation
	9.5 - Value chain
Internationalisation	10.1 - Exports profile
	10.2 - Geographical scope
	10.3 - Dynamics for internationalisation
Knowledge mobilisation	11.1 - External sources of information
	11.2 - Mobilisation of local knowledge
Networking (Synergies)	12.1 - Synergies for innovation
	12.2 - Motivations for cooperation
Specialisation/diversification	13.1 - Specialisation
	13.2 - Diversification
Behaviour to local specifics	14.1 - Adapting to local specifics
	14.2 - Use of endogenous resources
Outputs	
Innovations	15.1 - Number of innovations created/adapted
	15.2 - Weight of the innovation in the organisation
Socio-Economic	16.1 - Job creation
	16.2 - Internal results
Dissemination of knowledge	17.1 - Dissemination of knowledge
Impacts	18.1 - Certificates
	18.2 - Internal effects
	18.3 - External effects

Some Examples of Results Obtained

Some results obtained from the application of the defined indicators over the RUR@L INOV data base are presented below. The chosen examples try to illustrate some of the main issues found when dealing with organisations in rural areas.

In what concerns the "Size of the organisation" (Figure 26), classes were defined according to the definition of the European Union for SMEs, but with a further breakdown of the existing class "micro enterprise" in order to obtain a better description of the organisations involved.

The "Economic Activities" as well as the "Goods and Services" (Figure 27) were aggregated according to the Statistical classification of economic activities - NACE, and for goods considering also both the common organisation of agriculture markets and the combined nomenclature for the customs.

"Leader/manager innovation skills" were classified considering education and professional and leadership practice. Only 14 leaders had the maximum qualification (graduate, with professional and leadership practice in the business area) but 75 are above the average.

Figure 26: Size of the organisation

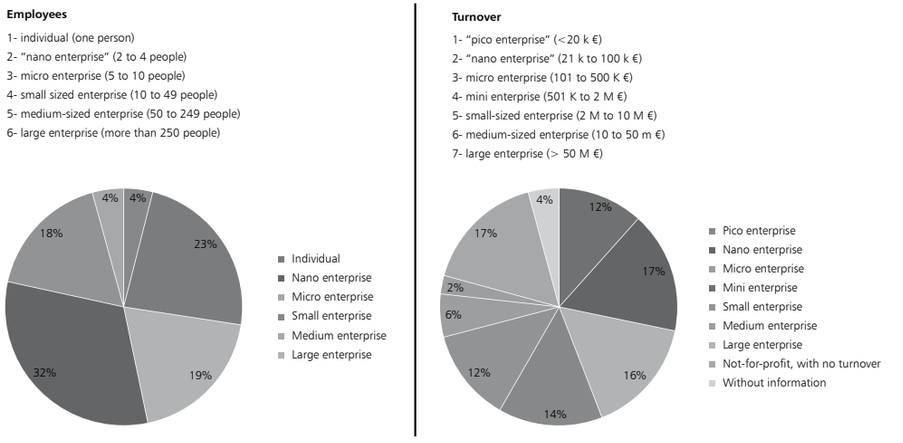


Figure 27: Goods and Services

First variable obtained

1- vegetables and potatoes: 2- fruit; 3- aromatic herbs; 4- cereals and rice; 5- live plants, products of floriculture and grass; 7- products of heliciculture; 11- forestry and forest products

6- apiculture products; 8- meat production; 9- soaps and creams; 12- Fleur de Sel;
13- hams and sausages; 14- canned fruits and vegetables; 15- olive oil and table olives;
16- milk and derivatives; 17- flour. bread and cakes, sweets and jams;
18- coffee. tea. maté and spices; 19- wine spirits

20-clothing and fashion items; 21- articles for home and decoration;
22- coatings and building materials; 23- electrical equipment and lighting

25- wholesale of rice, vegetables, fruits, wine and olive oil;
26- retail trade (regional gourmet products and cosmetics)

10- game; 24- housing; 27- tourist entertainment activities, organization of events;
28- accommodation; 29- restaurants and wine tourism

30- edication, training, environmental awareness; 31- promotion and regional development, technical assistance; 32- health and social support; 33- forest management; 34- environmental management; 35- knowledge and R&D

Recoded variable

1- products from the "farm" (1-5,7,11)

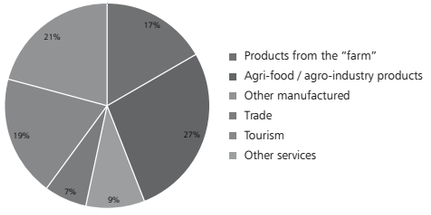
2- agri-food / agro-industry products (6,8,9,12-19)

3- other manufactured (20-23)

4- trade (25-26)

5- tourism (10,24,27,28,29)

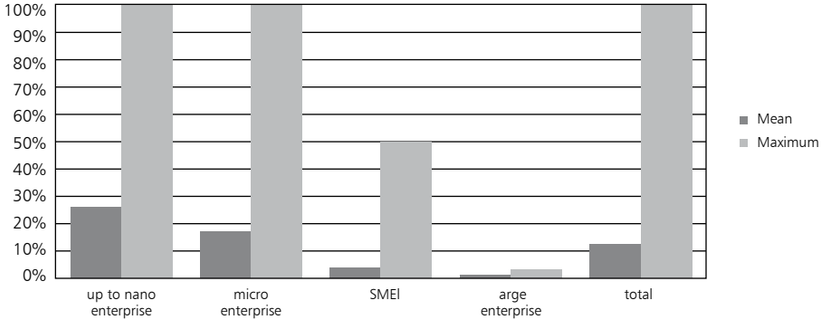
6- other services (30-35)



"Organisation skills in R&D" (Figure 28) were valuated considering the relationship between the number of promoters, family and staff with R&D functions and total staff. For this valuation the sample was divided in 4 classes related to the size of the organisation as larger organisations in rural areas employ a lesser percentage of skilled staff.

"Financial Resources" used by the organisations were evaluated, weighting with a higher value the independence from external funding (11 organisations only used equity and/or family loans) and the use of "merit" resources (23 organisations were supported by contest prizes and trust funds) and with a lower value the use of regional or local public funding. Only 4 organisations maximised the variety of financial resources while 3 only used public funding. 82 organisations used European funds.

Figure 28: Organisation skills in R&D

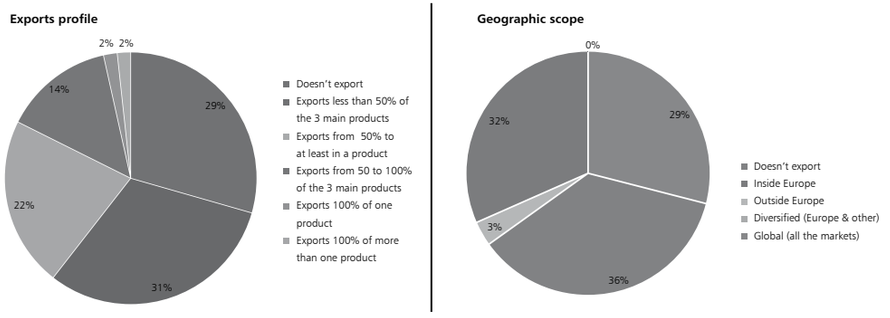


The indicator "Intensity of innovation process" revealed that 94 organisations practice continuous and sequential innovation. The other 26 organisations are divided between punctual, concentrated, launching or not continuous innovation processes.

In what concerns the organisations contribution to the "Value chain" it was possible to determine that only 13 organisations cover more than 70% of all the levels of the value chain. It is noticeable that 21 organisations are not involved on the product/process design but 80 organisations develop more than 70% of the product/process design.

As exports can be representative of the robustness of the organisations, "Internationalisation" was measured through the "Exports Profile" (at what level does the organisation export) and the "Geographical Scope" of exports (Figure 29).

Figure 29: Internationalisation profile



"Knowledge mobilisation" was measured with the help of two indicators: "Sources of information" (internal, from the market, institutional, other) and "Mobilisation of local knowledge" (technical/ construction knowledge, traditional/ handicraft knowledge, historical/ cultural knowledge and ecological knowledge). The four sources of information were used by 103 organisations but in 12 organisations internal sources were more important than all the others. A total of 85 organisations used local knowledge and 16 used the four types of local knowledge.

For the evaluation of "Specialisation/diversification", 3 classes were detected (Figure 30):

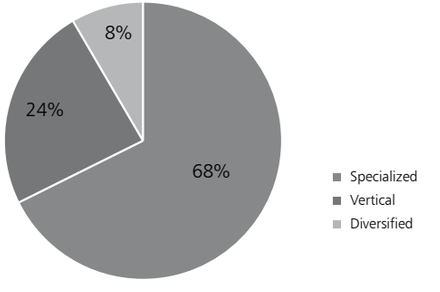
Figure 30: Specialisation / Diversification

Specialization/diversification levels

1- specialized firms: only 1 type of good/service

2- vertical organizations: more than a good/service but complementing or sequencial through th value chain

3- diversified organizations: more than one good/service belonging to different economic activities

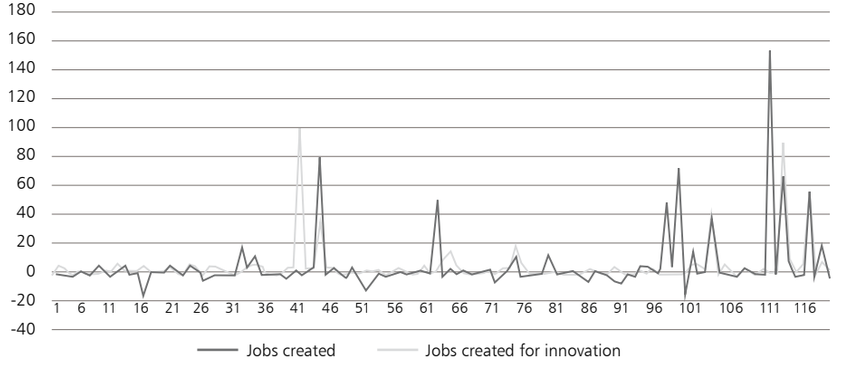


The mean "Number of innovations created/adapted" by an organisation since its establishment is 5.43. One organisation developed 17 innovations and 8 organisations 10 or more. 54 organisations are above the mean.

The "Weight of the innovation in the organisation sales" can be up to 100% (61 organisations), with a mean of 68.9% surpassed by 76 organisations.

Between 2009 and 2011, the "Job creation" (Figure 31) was weak with only 26 organisations growing 20% or more and 25 organisations reducing staff. But, in what concerns job creation for innovation, a mean of five jobs were created, value surpassed by 26 organisations.

Figure 31: Job creation

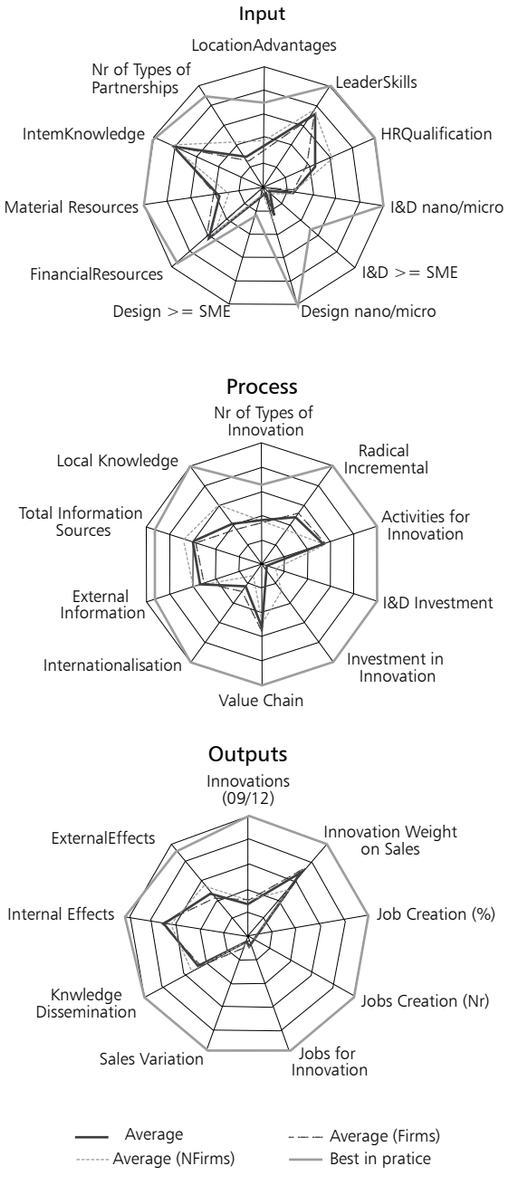


Discussion

The research is still under process for the preparation of the Manual of Good Practices for Innovation in Rural Areas. But the application of the indicators to the RUR@L INOV data base reveals some interesting results. As it was referred, some of the indicators defined for measuring good practices (Table 33) were not chosen for the identification of good practices. That is the case of "Internal Cooperation", "Organisation skills in Marketing" and "Certificates", for which it was not possible to obtain information from the survey. Further questions are being prepared be included in future surveys.

The radar graphs (Figure 32) illustrate the distance between the mean and the maximum values (best in practice) obtained for several indicators, meaning that there is room to improve on innovation practices in rural areas (for some indicators the maximum value was not attained).

Figure 32: RUR@L INOV data base: organisations gap



None of the organisations is above average for the global set of indicators, neither when considering separately each level of functioning of the organisation for the production of innovation (Input, Process and Output). Input indicators show a better performance, which reveals a concern about "using well" the available resources.

The organisations that are "best in practice" for each of the listed indicators are already known. Next steps are to understand why they perform better than the others, namely through the comparison, for each of these organisations, of its different practices in order to find out if and where are internal synergies or external environments that lead to their best performances. Some of these will be chosen to illustrate the Manual of Good Practices for Rural Innovation.

Acknowledgments

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A differentiation framework for maritime clusters in Europe

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Teresa de Noronha
Paulo Neto

Introduction

Around the world in recent decades, awareness has emerged that the management and governance of the ocean, coastal zones and human activities associated with it, should be addressed at an ecosystem approach, of sustainable development, based on a comprehensive view, not sectorial but integrated (EMAM, 2007: 13).

As expressed by SaeR (2009), among the scientific community it's almost unanimous the advantage for the use of a cluster approach, embodied through the concept of the "Hypercluster of the Sea", which encompasses a complex of activities ranging from Tourism and Leisure to Logistics and Maritime Transport, Fisheries and Aquaculture, Naval Construction and Repair, Related and Supporting Services, to Research and Development. This way of approaching the issues from the sea, being systemic, requires a global vision and a holistic and interactive performance in the search for strategic solutions to increase the efficient use and value added generated by the exploitation of resources of the Sea.

An endeavor to make some differentiation of a maritime cluster, as opposed to a "cluster of economic activities mainly based on land", may reside in the maritime cluster definition provided under the project "Europe of the Sea", sponsored by the Conference of Peripheral Maritime Regions of Europe (CPMR): *"…a network of firms, research, development and innovation (RDI) units and training organisations (universities, specialized schools, etc.), sometimes supported by national or local authorities, which co-operate with the aim of technology innovation and of increasing maritime industry's performance…".* Although rarely addressed among the various authors considered in the literature review, our intention is to find out what are the distinctive factors to consider in a targeted cluster approach for the maritime economy. We want to focus on what are the critical factors that influence the creation, sustainable development and resilience of successful maritime clusters, and how their respective competitiveness factors are greatly enhanced by multisectoral clustering processes.

Conflicts over the use of marine and coastal space tend to fall into two broad categories (Sørensen *et al.*, 2003). The first category concerns to areas with existing regulated, restricted or prohibited access such as: major shipping routes, military exercise grounds, major structures, sub-sea cables or pipelines, and marine protected areas for fisheries management or marine conservation. The second one refers to areas with conflicting uses exist such as: commercial and recreational fishing grounds, resource extraction areas, tourism and non-consumptive recreational areas, archaeological sites such shipwrecks, and those with cultural significance.

This situation has highlighted the need for sufficient planning and regulations to optimize the management of the resources within a multiuse context.

Management of ocean resources in a global, sustained and integrated fashion has remained elusive, despite several international agreements and initiatives. In the debate over the economic scarcity of natural resources, one significant change in recent years has been a greater focus on the ecosystem services and the resource amenities yielded by natural environments. The general conclusion extracted from Krautkraemer (2005) is that technological progress has ameliorated the scarcity of natural resource commodities; but resource amenities have become scarcer and it is unlikely that technology alone can remedy that. This configures the absolute need for a long-term strategy to support sustainable growth in the maritime sector as a whole, in what has been recently designated for instance by the EU as "Blue growth" strategy.

The European maritime cluster has a strong position in the maritime world. The following examples substantiate this claim (Policy Research Corporation, 2008):

– European ports handle almost 25% of world seaborne trade, its ship owners control almost 40% of the world fleet, and Europe has been the region with the highest global shipbuilding turnover for most of the last decade;

– Europe is world's number one tourist destination with coastal tourism being one of its main attraction pools;

– European yacht builders produce 60% of the mega yachts;

– European dredging companies have 80% market share of the open market;

– 40 % of the oil and 60 % of the gas consumed in Europe is drilled offshore;

– Europeans dominate the market for renewable offshore energy;

– European services, maritime research, inland shipping, fisheries and Navy are world leading sectors.

Around Europe, the sea provides a range of energy transport routes, via shipping, submarine pipeline networks, and electricity interconnectors. Offshore wind, ocean currents, waves and tidal movements carry a vast amount of renewable energy. Another emerging area, besides the exploitation of metallic resources from the ocean floor, is related to methane hydrates (projections estimate around 10,000 Gt carbon equivalent, which amounts to as much as all other fossil fuel resources combined), a form of energy which could help diversifying sources of supply and releases less CO_2 into the atmosphere than oil or coal per unit of energy obtained. The sea biosphere (particularly from the deep sea) and its correlation with "Blue biotechnology" offer a great deal of long-term potential to many industrial sectors from aquaculture to healthcare and from cosmetics to food products.

The goal of this study is to point out some of the main characteristics and critical factors for success that can substantiate the proposal of a differentiation framework for maritime clusters. We conduct a benchmarking analysis intended to distinguish the most relevant aspects which can or should be observed in these types of clusters, applied to the following countries: Spain (Basque Country), Germany (Lander of Schleswig-Holstein), the Netherlands and Norway. The differentiation factors are considered to be essential regarding the success and long term resilience of maritime clusters, involving agglomeration economies and endogenous conditions derived from geographic proximity, essential for lowering transaction costs, strengthening the leverage of public/private cooperation through centres of maritime excellence, at the same time providing an adequate local environment that favours positive interactions between the different maritime industries and actors. The main results arising from this chapter are presented through a reconceptualisation of Porter's Diamond framework for diagnosing the competitiveness of maritime clusters.

The chapter is organized as follows: the next section 2 elaborates on the objectives pursued and the methodology chosen to conduct the data collection and treatment; Section 3 presents the current literature review related to the concept and nature of clusters, while section 4 talks about their relation with innovation and knowledge networking; Section 5 discusses the data collected through benchmarking and summarises the observations made using a matrix built over the seven cluster key dimensions proposed in Andersson *et al.* (2004); finally, section 6 reports the main results and supervening discussion arising from this chapter in terms of the distinctive factors that influence the creation, sustainable development and resilience of successful maritime clusters. Those conclusions underlie the proposal for a re-adaption of Porter´s Diamond model of national/regional competitiveness for the case of maritime clusters.

Objectives and Methodology

Along this chapter, we will assume our solid conviction that innovation and networking processes are the primordial corner stone of successful long-term maritime cluster policies, i.e., the ability to innovate and the collective production and appropriation of knowledge are the most important factors for the survival, competitiveness and economic growth in maritime clusters. From a more evolutionist perspective, we will therefore attempt in this chapter to stress the following idea:

> A complex phenomenon such as innovative performance needs explaining in terms of a multifarious set of factors. The level and character of competition within maritime clusters is highly dependent upon the existence of formal networks of economic, social and environmental actors that constitute an aggregation of interactive, mutually interdependent economic actors connected to the sea, as expressed in Salvador (2010).

To do so and subsequently to a literature review focused on the cluster nature and on the relation of clusters with innovation and networking processes, we will conduct an exercise intended to distinguish what are the main features and critical factors for success behind successful European maritime clusters. As a reference framework for this benchmarking, we will use the seven key dimensions proposed in Andersson *et al.* (2004), namely: i) Geographical concentration; ii) Specialisation; iii) Multiple actors; iv) Competition and co-operation; v) Critical mass; vi) The cluster life cycle; and vii) Innovation, to measure their maturity and development level. This set of observations then will allow us to reconceptualise Porter's Diamond framework for diagnosing the competitiveness of maritime clusters.

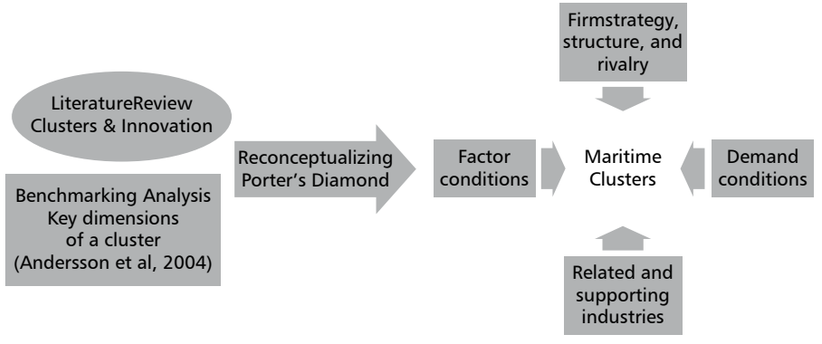
To understand the dynamics of maritime clusters, a conceptual model is proposed, which highlights the main forces driving a maritime cluster as well as its underlying mechanism. This chapter describes new methodology techniques for analyzing the competitiveness of maritime clusters, using a modification of the Porter Diamond Model (see Figure 33). Porter's Competitive

Advantage of Nations (1990) introduces his diamond model of competitiveness through four broad drivers that shape the environment in which firms and regions compete for business:

- factor conditions, which include the skills, resources, technology, and infrastructure necessary to create competition in a given industry or cluster;
- demand conditions, which include the nature of local and overseas demand for industry products and services;
- related and supporting industries, where the presence or absence of suppliers and distributors in support of industry sectors or clusters will determine competitiveness;
- firm strategy, structure, and rivalry, which relate to conditions in a nation governing how companies are created, organized, and managed and the nature of domestic rivalry.

Porter identified two other important factors that affect competitive advantage of firms: chance and the role of government. Chance relates to events or occurrences that have little to do with a country's circumstances, but can be influenced by individuals. Governments can have significant role in aiding competitive advantage, especially through public policies which are favorable to investment and profit performance.

Figure 33: Objectives and methodology adopted for the chapter



Source: Authors.

The Evolutive Concept of Clusters

Porter (1998: 197) gives the following definition for clusters: *"Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (for example, universities, standard agencies, and trade associations) in particular fields that compete but also cooperate."*

Clusters are characterized by the following commonalities (Altenburg and Meyer-Stamer, 1999; Carpinetti, 2007):

– Forward and backward linkages between firms
– Information exchange between firms and other cluster members
– Institutional infrastructure supporting the activities of the cluster
– A social cultural identity with common values
– Shared focus
– Entrepreneurship attitude, aiming at value-creation and innovation
– Most important is agglomeration, being, either, geographic, economic, cultural or sectorial.

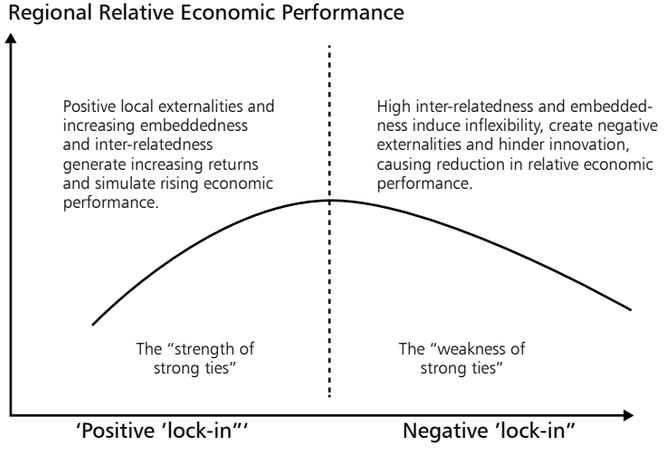
When clusters are defined as groups of firms interconnected through trade and other kinds of interaction and interdependencies, it becomes important to recognize that they contain both horizontal and vertical linkages (Maskell apud Sornn-Friese, 2003). Horizontal linkages are relationships between competing and sporadically cooperating rival firms operating at the same stage of the value chain, while vertical, or user-producer, linkages are relationships between complementary firms at different stages of the value chain (Gemser apud Sornn-Friese, 2003). Malecki and Poehling (1999) have given a very valuable review of the literature on this issue. They observe a variety of network configurations, such as suppliers or customer networks, local networks of neighbouring firms, professional networks and knowledge networks, which all may contribute to a better entrepreneurial performance.

In growing functional regions, the location of households and firms form a self reinforcing dynamic process, i.e. a process with positive feedbacks. Over time, the (slow) formation of regional infrastructure affects the process by gradually building up the basic conditions for the household milieu and the economic milieu of firms (Karlsson, 2008). Neto (1999) suggests that network strategies and the affirmation of the functional territories modify the organization and the spatial and economic interrelationships of sectors and their organizations, as well as the economic specialization of the territories, by this means reshaping the comparative and competitive inter-territorial advantages. Porter's theory states that a cluster is the manifestation of the "diamond" model at work, in which proximity (understood as the placement of companies, customers and suppliers) amplifies all the existing pressures to innovate and improve economic performance. Porter (1990) also discusses the role of opportunity and of the state within the diamond's vertices (competitiveness factors). Inside the cluster and its supporting forces, the resulting benefits (e.g. information and innovation) flow in several directions (Porter, 1990), allowing, thus, boosting growth, encouraging competition and innovation in related support companies. Successful clusters have also significantly increased their global reach, attracting people, technology and investments, serving global markets, and connecting with other regional clusters that provide complementary activities in global value chains (Ketels *et al.*, 2008).

A growing literature looks at the life cycle of clusters (Bergmann apud Ketels, 2008). Clusters often seem to follow an s-shaped development path. After an (often long) phase of slow gestation a cluster reaches a size where cluster effects set in and growth accelerates. This growth than becomes self-reinforcing; cluster effects reach their full scale and growth explodes. Eventually, growth moderates as the cluster reaches its market potential and congestion effects become more relevant. Some clusters then manage to reinvent themselves, finding a new market or technology to ignite a next phase of cluster dynamisms. Others, however, get locked into existing technology and eventually shrink, as their markets disappear or other locations develop more dynamism (Audretsch *et al.* apud Ketels, 2008). Martin and Sunley apud Holte and

Moen (2010) describe how the positive factors turn into a negative lock-in with inflexibility and reduced innovation ability as illustrated in Figure 34.

Figure 34: Illustrating development paths



Source: From Holte and Moen (2010).

Clusters as Motors of the Dynamic System of Innovation

Hakanson (2005) posits a model of cluster dynamics emphasizing two mutually interdependent processes: the concentration of specialized and complementary epistemic communities, and entrepreneurship and a high rate of new firm formation, which in particular stresses the role of knowledge in industry clusters.

Clusters are argued to have a positive impact on innovation due, among others, to knowledge spillovers, labour market pooling and competitive pressure. When comparing the general survey on innovative firms presented in the Innobarometer 2004 with the 2006 Innobarometer dedicated to "Cluster's role in facilitating innovation in Europe", both published by the European Commission, there are evidences pointing to the fact that clustering may foster more efficiently firm-level innovation. The data collected show that firms within clusters did more market research than firms located outside clusters (53% vs. 33%) and are twice more likely to cooperate with universities, research institutes or other firms in innovative activities (41% vs. 20%). They also registered more patents (29% vs. 12%), introduced more innovative products (78% vs. 74%) and introduced new or significantly improved production technology (63% vs. 56%).

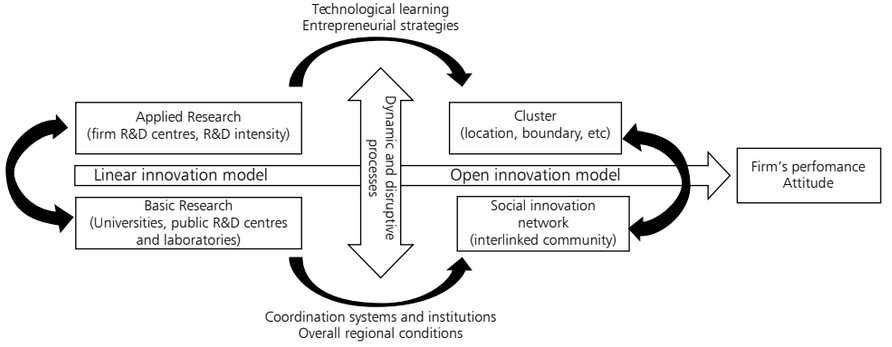
The role of geographical proximity has been discussed in the literature concerning regional innovation systems, as well as the related with knowledge spillovers. The proponents of the view that proximity offers innovation advantages in itself, begins in relatively recent times with Jaffe *et al.* (1993). The argument here was that RDI in particular constitutes a public good in locations where it concentrates and that this is sufficient to cause firms to concentrate in proximity to such knowledge spillover opportunities to access them as free goods in advance of competitors. Innovation and entrepreneurial behaviour are as consequence, heavily impacted or influenced by proximity conditions. If the entrepreneurial character of an individual agent is defined by the nexus between himself and an opportunity, then, what defines this nexus is how the individual appropriates the opportunity gain he aims at (Giménez-Roche, 2011). Also Hindle (2010) refers that from the perspective of the practicing entrepreneur, the notion of evaluation culminates in the design of what needs to be done to convert a possible opportunity into some kind of blueprint for action. Additionally, market forces tend to concentrate investments in prosperous areas which offer better access to infrastructure and human capital, lower risks and better access to markets (Krugman and Venables, 1990).

In this process, clusters have become increasingly specialised and increasingly connected with other clusters providing complementary activities. Successful clusters have also significantly increased their global reach – attracting people, technology and investments, serving global markets, and connecting with other regional clusters that provide complementary activities in global value chains (Ketels *et al.*, 2008).

Economic development results from discontinuous internal changes by economic innovations that originate from within the economic system, pinpointing major industrial disruptions which fuel business cycle fluctuations (Schumpeter apud Backhaus, 2003). A useful concept in this regard is the 'triple helix' (Leydesdorff and Etzkowitz, 2001; Etzkowitz, 2002; Leydesdorff and Etzkowitz, 2003; Goktepe, 2003), which holds that innovation networks in clusters depends upon academic and research institutions (Academia); companies, capital and entrepreneurship (Private Sector); as well as favourable framework conditions (Government). Arguing that the triple helix model is not enough to sustain long-term innovative processes, several authors defend the introduction of a fourth helix (Civil Society) to stress its importance in the knowledge creation process (Liljemark, 2004). Cluster organizations and forums that facilitate the networked collaborations are also frequently highlighted as instrumental in clusters. However, at the basis of clustering is the interaction that occurs among businesses and people as part of regular work life. It is the creation of linked relations, which create cluster benefits. On the perspective presented at DG Enterprise and Industry (2007), innovation is increasingly characterised as an open process, in which many different actors - companies, customers, investors, universities, and other organisations - cooperate in a complex ways. Ideas move across institutional boundaries more frequently. From a policy perspective the innovation system approach draws attention to the behavior of local actors with respect to three key elements in the innovation process: learning, linkage and investment (Mytelka, 2000:18). The subsequent demanding endeavour to combine, in the production chain, innovation with the coordination capacity of organizations, presents much more than a theoretical challenge, and rather a social reshaping (Noronha Vaz and Nijkamp, 2009). Additionally, Noronha Vaz *et al.* (2006) stressed that the transition from a closed regional environment to an open interregional system demands an evolution of economic activity from simple forms of activity branches into complex technological regimes. In such a dynamic system, technological learning, entrepreneurial strategies, coordination systems and institutions and overall regional conditions, are factors that determine firm attitudes to

innovation. The traditional linear model of innovation with clearly assigned roles for basic research at the university, and applied research in a company RDI centre, is no longer relevant. Consequently, it is no longer so much the co-location of innovation stakeholders that counts as the nature and intensity of their "connectivity" and the fact of belonging to the same social innovation network or "interlinked community" (Amin and Cohendet, 2005).

Figure 35: The changing paradigm



Source: Authors, based on Amin and Cohendet (2005) and Noronha Vaz *et al.* (2006).

Benchmarking Analysis

For the purpose of conducting a strategic benchmarking analysis taken as relevant for the context of the present chapter, we present the following four successful examples of European maritime clusters: two regional clusters (the Basque Country and the Lander of Schleswig-Holstein) and two national clusters resulting from initiative bottom-up and top-down (the Netherlands and Norway).

This benchmarking analysis had three objectives: firstly, to measure and compare the performance of four different European maritime cluster organisations; secondly, to show the main characteristics and differentiation aspects between them; and finally to increase our level of knowledge through the use of a data measurement tool with both strategic and operational relevance for the purpose of the current chapter.

These four cases were selected among several other possibilities, because they constitute different approaches towards a successful maritime cluster strategy in terms of: top-down vs. bottom-up cluster initiatives, national vs. regional amplitude, degrees of specialization and the cluster enablers.

Basque Country (Spain)

In the early nineties of the past century, the Basque Country was in the process of economic decline. Until then, the main competitive advantage of its industry relied on low prices, a strategy that began to fail. The political response from the autonomic government to address these serious structural problems was to adopt the Porterian model of clusters that focuses on inter-industry linkages, as a way to encourage the development of new sustainable and specialized advantages. The primary objective of the Basque cluster policy is to improve the competitiveness of enterprises and of the region through cooperation on strategic projects related to three main areas: technology, quality management and internationalization. This desideratum was operationalized by the Department of Industry, Trade and Tourism of the Basque Government, through the establishment of associations of clusters (e.g.: aerospace, mobility and logistics, audiovisual, paper industry, manufacturing of machine tools, environment, energy, electronics and information, automobile). These associations have as main task to promote the competitiveness of each of the respective clusters, by facilitating and supporting cooperation / collaboration among its members (firms, R & D centres, universities, government institutions, among others). In the field of sea economy, there are two clusters associations: the Uniport Bilbao (ports) and the Foro Maritimo Vasco (shipbuilding).

The whole Basque maritime sector has an important presence in the economy of this Spanish autonomous community, representing approximately 2.5% of its GDP. The companies that comprise invoiced in the year 2008, 1,470 million euros in activities directly related to the sector and € 2,535 million as a whole. The Basque maritime sector closed the year 2008 with 17,900 associated jobs, of which 9,300 are direct jobs. The maritime cluster of the Basque Country comprises two anchor areas: ports and shipbuilding.

The main shipping facility located in the Basque Country is the Port of Bilbao in Biscay, which represents a direct communication gateway between Spain and the rest of Europe. It is a modern and flexible infrastructure, able to receive any type of ship and cargo. The movement of containers in 2007 exceeded half a million TEUs, which puts it in 4th place of the busiest ports in Spain, after Algeciras, Barcelona and Valencia.

The Foro Maritimo Vasco (FMV) is a non-profit organization created in 1993, and since 1999 is recognized as a priority cluster by the Basque Government. The FMV's mission is to represent, defend, consolidate, enhance and improve the competitiveness of Basque companies from the maritime industry through the services it provides, in its different strategic axes (Internationalization, Technology, Excellence in Management, Finance, Audit, Training and Resources Human and Communication, Information and Representation). This association, which also worked actively in the creation of the Spanish Maritime Cluster, is seen in Spain as a pioneering organization in adopting the cluster approach, integrating approximately thirty entities, among companies, associations and public institutions, which includes government departments and universities. The current strategic challenges embraced by the FMV, while cluster association representative of the shipbuilding sector which has been strongly affected by the economic downturn originated from 2008 and suffering from a severe competition promoted by shipyards from Korea and South China, due to their extremely low prices, includes the promotion among its members of a culture for continuous innovation effort in products and organizational, business and marketing processes.

Lander of Schleswig-Holstein (Germany)

Schleswig-Holstein, covering a total area of 15,763 km2, is the most northern and most "maritime" of Germany's "Länder". It is located just south of Denmark's Jutland peninsula between two seas: the North Sea, on the west coast, and, on the east coast, the Baltic Sea. The total coastline along both seas is 1,190km.

Schleswig-Holstein is a composite maritime cluster, comprehending several networks within it, differing in intensity. Various maritime activities are well established in Schleswig-Holstein. Some are associated with the metropolitan region of Hamburg which represents both a major maritime cluster given Hamburg's status as one of the most important ports in Europe and the third largest for container traffic after Antwerp and Rotherham and also a significant maritime financial centre offering many insurance services.

The cluster components include: port industry, maritime logistic, shipping companies, shipbuilding and engineering services, marine equipment suppliers, maritime services, offshore technology (specially offshore wind), oceanography and university marine science laboratories, marine and coast protection, blue (marine) biotechnology, fishing, aquaculture, maritime tourism (aquatic sports, cruises). Shipping, marine equipment, shipbuilding and marine tourism together accounted for a turnover of € 7.5 billion in 2006, representing the most important components of the Schleswig-Holstein maritime sector.

This cluster has two important characteristics: a high intensity of RDI by firms, especially by those belonging to the suppliers of equipment and components for shipbuilding sectors, especially in the areas of energy efficiency, environment, maritime safety and offshore energy, participation in international networks and relationships with clusters from other countries (Baltic Sea, United Kingdom, Denmark, Norway, Holland, France and Poland). There are several cooperation networks operating in the Schleswig-Holstein area ("Maritime Cluster Schleswig-Holstein", "German Hydrographic Consultancy Pool", "German Gashydrate Organization", "Marina Networks") and since July 2008 was formally constituted a management entity for the *maritime cluster*, which includes as partners, besides the Lander government, the Trade and Industry Chamber of the Lander e o Business Development and Technology Transfer Corporation of Schleswig-Holstein (WTSH), among others.

The Netherlands

The Dutch history is inseparable from the sea. Small country with 300 km long and 200 km wide, is strategically located in the heart of Europe, with which communicates via two major arteries: the Black Sea and the Rhine, elements that largely shape the cultural and maritime past of the Netherlands. The first area of specialization of its economy occurred in the activities of fisheries, ports, shipping, trade and maritime works. Some of its cities participated in the formation of the Hanseatic League (or Hansa), a kind of market economic alliance that developed in the Baltic Sea area. The strength of this set of maritime activities has enabled the Netherlands to become the most powerful maritime European nation then. In 1602, with the merger of several companies who were engaged in international maritime trade, was born what was to become the first multinational company with shares listed on the stock exchange market : the Dutch East India Company.

The vocation and importance of activities related to the sea economy in the Netherlands remained until the present day. According to data from Policy Research for 2001, the aggregate of the Dutch maritime sectors represented up to 10% of the value added generated by all the maritime industries in the EU, and their share in the Dutch GDP is twice the European average. In 2002, the Dutch maritime cluster has generated 190,000 jobs, 135,000 of which were direct jobs and represented 5.4% of the Dutch national exports. The high export quote of more than 60% illustrates the international competitiveness and international orientation.

When the Dutch Maritime Network was born in 1997 it had a cluster structure still very limited. For example, marine equipment were not yet perceived to date as an independent sector, but part of the shipbuilding sector, while the maritime services sector was so fragmented that it was very difficult interact with it as such. The first task of the working group to whom have been tasked the project of creating the Dutch maritime cluster was thus: define / delineate the various sectors suitable for integrating the cluster; determine its degree of relevance to the Dutch economy; assess and strengthen the inter-relationships among the various sectors, and, finally, design and implement policies that strengthen the dynamics of entrepreneurship within the cluster. The Dutch Maritime Network is an independent foundation established to strengthen and promote the Dutch Maritime Cluster, and to increase the cohesion and visibility of its eleven maritime sectors constituents (Logistics / Freight Shipping, Shipbuilding, Marine Equipment Suppliers, Offshore Resource Exploration, River Transport, Dredging, Ports, Marine

Services, Fisheries, Navy, Royal Dutch War and Yacht Construction Industry). The companies in the maritime cluster are grouped in trade organizations, which are funded by member contributions and who perform business activities on behalf of their members. Its main function is to lobby for its members at various levels of government: local, regional, national and European level, either directly or as members of European and global associations. The Dutch Maritime Network was formed to act as a platform for contact and networking of these trade organizations (which are part of it), working actively with them to improve the image of the maritime policy and maritime cluster in the Netherlands, developing an intense activity in areas of communication, business internationalization, innovation and job market / education in the maritime sectors. The administration of the Dutch Maritime Network is composed of prominent personalities from various marine and industrial sectors in the Netherlands. The central government has an observer on this board, but no formal power for direct intervention in the management of the funds available to the foundation.

Norway

The maritime tradition in Norway is ancestral. Archaeologists have found traces of vessels dating from the Paleolithic and there is evidence of the practice of maritime trade since the early Bronze Age. The Vikings were skilled navigators and builders of fast warships, which reached the remote corners of the planet. Along the first centuries of the first millennium, trade and naval transport grew rapidly, with the Hanseatic city of Bergen playing a central role in that process. During the industrial revolution in the nineteenth century, the Norwegian shipbuilding industry would assume a global scale. In the post-oil crisis of 1973, the Norwegian merchant fleet went through a process of profound transition. The aggressive competition conducted by Asian countries with lower costs, imposed a great strain on the Norwegian merchant fleet. The global market for naval expedition came to be characterized, from the early eighties of past century, by an excess of installed capacity. To respond to growing global competition and pressure to reduce their operating costs, many ship owners abandoned the Norwegian flag and the crews of their ships were replaced by seamen from those foreign countries earning lower wages. The turnaround began in 1987 with the introduction of the Norwegian International Ship Register (NIS) which allowed the ship owners to employ foreign seamen with wages equivalent to those practised on their countries of origin, associated with the change in taxation for companies and seafarers.

Norway has 10% of the world merchant fleet, placing it in the top 3 world ranking, and carries out 15% of the global oil exploration activities in the nearshore. The sea-related activities in Norway are the third largest industry in the country, surpassed only by the financial sector and the offshore oil and natural gas (that Norway is Europe's largest producer). In 2007, the activities of the maritime cluster originated revenues of €12 billion (11% of the value generated in the economy), employing 97,000 people (29% in shipping, 26% in equipment suppliers and marine machinery, 24% in marine services and 21% in shipbuilding and repair).

The main components of the Norwegian cluster are: Maritime Shipping, Marine Equipment Suppliers (mainly for the offshore oil and natural gas); Maritime Services (finance, insurance, brokering, maritime law, classification and certification of ships, port services) ; Shipbuilding (specialized vessels for oil prospecting and exploration, highly sophisticated cruise ships, factory ships and fishing vessels, including equipment for propulsion and navigation, patrol boats, specialized vessels for the transportation of chemicals and liquefied natural gas, icebreaker vessels), and Fisheries. All these sectors, especially those related to shipbuilding and equipment / marine machinery, are characterized by a strong RDI intensity, involving companies, universities and public RDI centres.

There is an organization that serves as a network platform, linking the various sectors and their respective actors at various levels (the Maritime Forum), founded in 1990, which aims to strengthen cooperation mechanisms within the cluster, as well as to influence policies for the marine industry and defend their interests in international affairs. The maritime cluster in Norway is divided into nine regions and in each one of them there is a regional Maritime Forum (Oslo region, Buskerud, Vestfold and Telemark, Agder; Stavanger region; Haugaland / Sunnhordland; Bergen region, Northwest, Mid-Norway, Northern Norway). In 2007, the Stavanger region recorded the highest turnover, followed closely by the Oslo region.

A further particular feature of this cluster is related to the great importance given to the evaluation and strategic planning, either in whole or in terms of the regional components, to the needs and requirements of demand, competition assessment, processes, needs and opportunities innovation networks, cooperation, and certification requirements of the quality of production, training and qualification of manpower highly specialized, among other aspects.

Following the presentation of the main characteristics and drivers underlying each one of the maritime clusters cases selected for this benchmarking analysis, in Table 34 bellow is presented an evaluation of their current status on relation to the seven cluster enablers proposed in the work of Andersson *et al.* (2004). As stated by Andersson *et al.* (2004), those main elements of clusters, commonly found in the literature, are driving forces and determinants of success. That is not to say that all these elements need to be present, or should be pushed for, in specific cluster initiatives and policy measures.

- Geographical concentration - has been central to the cluster idea from the outset. Firms may experience that their belonging to a set of inter-related actors which - in a given region - can serve to enhance efficiency, underpins productivity growth and raises innovativeness, especially due to better access to knowledge, ideas and skills.
- Specialisation - a cluster is traditionally viewed as specialised in the sense that the participating actors are linked together via a core activity, which provides direction towards emphasis on the same markets or processes.
- The cluster actors - firms form the natural and obvious components or building blocks of clusters. However, clustering is also about pluralism, not about single firms. In the absence of such pluralism, an observed agglomeration is likely to consist of an enlarged enterprise, where the other companies or units may merely serve as sub-contractors or clients in regard to the main entity.
- Cluster dynamics and linkages: competition and cooperation - the fourth cluster element relates to the connections and interrelations between the actors. Typically, as firms and individuals compete with each other, pressures for improvement are generated. Depending on market characteristics, actors may strive to gain advantage by reducing costs or prices, raising quality, acquiring new customers, or entering new markets. At the

same time, the actors in a cluster may cooperate around a core activity, using their key competencies to complement each other. By operating in tandem, firms may also be able to attract resources and services that would not have been available to them isolated.

- Critical mass- in order for a cluster to achieve inner dynamics, it needs to engage numerous actors and reach some sort of critical mass. Critical mass may serve as a "buffer" and make a cluster resistant to exogenous shocks or other kinds of pressures, including "losses" of companies, even when they might be regarded as "key companies", as long as a critical threshold of remaining players is not exceeded.
- The cluster lifecycle- clusters and cluster initiatives do not represent temporary solutions to acute problems. They have a sense of direction and inner stability over time. Any cluster will pass through a number of stages. These may not be identical, and the pace of their evolution may vary. Still, there is an inherent logic to the way that clusters develop, which makes it possible to discern certain characteristic patterns.
- Innovation – here understood in a broad sense, incorporating technical, commercial and/ or organisational change.

Table 34: Benchmarking observations vs. Cluster key dimensions

Cluster key dimensions (according to Andersson et al., 2004):	I) Basque Country (Spain)	II) Lander of Schleswig-Holstein (Germany)	III) The Netherlands	IV) Norway
i) *Geographical concentration*: firms locate in geographic proximity due to hard factors, such as external economies of scale, as well as soft factors such as social capital and learning processes;	+	+	0	0
ii) *Specialisation*: clusters are centred around a core activity to which all actors are related;	+	+	+	+
iii) *Multiple actors*: clusters and cluster initiatives do not only consist of firms, but also involve public authorities, academia, members of the financial sector, and institutions for collaboration;	0	+	+	+
iv) *Competition and co-operation*: this combination characterises the relations between these interlinked actors;	+	+	+	0
v) *Critical mass*: is required to achieve inner dynamics;	-	+	+	+
vi) *The cluster life cycle*: clusters and cluster initiatives are not temporary short-term phenomena, but are ongoing with long-term perspectives, and finally;	0	0	+	+
vii) *Innovation*: firms in clusters are involved in processes of technological, commercial and/or organisational change.	-	+	0	+

Legend: (+) strong; (0) neutral; (-) weak.
Source: Authors.

Subsequently to the observations made so far, we can notice that the evolution of maritime clusters emanates from both deterministic (legacy, culture, history, availability of specific natural resources) and proactive forces (e.g. Lowering transaction costs especially in accessing and transferring knowledge; Economies of scale and scope; Specialisation of supply from factor markets with respect to labour, capital, or technology sources; Accessing and sharing information on market and technology change; Triggering learning processes and more sophisticated demand; Strengthening the leverage of public/private cooperation through centres of maritime excellence). Clusters are not ex nihilo creations, very often they are based on skills existing locally since long ago. Most of the cluster initiatives described above represent organised efforts to enhance the competitiveness of a certain cluster within a particular region, involving private business, public bodies and/or academic institutions. To accomplish this, a satisfactory coupling between government, capital and knowledge is needed for entrepreneurial ventures to succeed in an international maritime market increasingly competitive. These initiatives can be based on a "bottom-up" / "top-down" or "hybrid" (by combining the latter) approach, and very often they are managed by specialised institutions, such as cluster associations, which have tight connections with RDI entities. Among their various achievements, knowledge dissemination (although varying in intensity from case to case) is common to all clusters, once the development of maritime clusters critically depends on interconnecting firms and RDI bodies through shared knowledge. Also, crosswise to all four European maritime clusters described above there's: a conscious efforts to improve the microeconomic business environment and towards the upgrading of human resources; the expansion of the cluster by stimulating new entrepreneurship and attracting outside firms to the cluster; commercial collaboration such as joint export initiatives or coordinated purchasing to increase purchasing power and generate scale economies; and the permanent upgrading of technology and the establishment of close ties with other international maritime clusters.

The observations made above are consistent with the results (drivers/constraints) out coming from the report on results of the study 'The role of Maritime Clusters to enhance the strength and development in maritime sectors' (Policy Research Corporation, 2008), where maritime sectors are divided into clusters (or Areas) in order to focus on developing a European cross-cutting policy approach for the sea-related sectors (combining offshore and coastal activities):

- Area 1: Traditional maritime sectors;
- Area 2: Coastal (and marine) tourism and recreation;
- Area 3: Fisheries.

The main cross-sector trends which have been analysed in this study based upon literature and field research are the following:

- Increase in Research, Development and Innovation (RDI-activities);
- Difficulties with regard to recruitment;
- Limited public awareness of the importance of maritime sectors;
- Sustainable development.

First maritime trend: there´s an increase of innovation, research and development activities, especially in marine equipment manufacturing and shipbuilding. European maritime (and non-maritime) manufacturing sectors face tough challenges in competing with low-cost and subsidising countries, mainly in Asia. European Intellectual Property Rights (IPR) have a

limited effect on the production volumes in these third countries of copied European-designed equipment. To maintain their competitive advantage European companies specialise in know-how and expertise and focus on niches through RDI.

Second maritime trend: problems regarding recruitment. It´s difficult to attract potential employees and young people to the maritime sectors (particularly to the offshore professions). Moreover, attracting people to offshore activities is not only important for the shipping and offshore sectors, but also for the onshore maritime sectors when in a later stage of their career offshore staff are of great use because of their valuable experiences and competences (e.g. port and service related). Maritime clusters have a large labour mobility within their sectors.

Third maritime trend: the limited public awareness of the importance of maritime sectors. Because ports and their related manufacturing and services, and consequently ships, have for practical and safety reasons been moving away from cities, the public awareness of the importance of maritime transport seems to have been fading. Maritime sector and cluster organisations often indicate that this limited public awareness of the importance of their activities leads (or could lead) to the aforementioned recruitment difficulties and a shortage of government initiatives and policy.

Fourth maritime trend: because of increasing know-how and awareness of negative external effects on the environment and because of increasing fuel prices in combination with further measures to reduce operational costs, investments and initiatives are made in order to (further) sustainably develop the maritime sectors.

Figure 36 combines the different approaches in terms of good practices based upon the main cross-sector trends listed above with the findings arising from the benchmarking analysis done previously for the four European maritime clusters selected for this chapter.

Figure 36: Good practices of European maritime cluster organisations based upon main cross-sector trends

Cluster benefit	Approach	Main initiatives	Sector involvement	Cluster observed
1 **Promotion** of the maritime cluster	Mainly project-based approach	- Promotion campaigns throught websites, videos and presentations - Report on economic importance of the cluster - Organising promotion events	Almost all sectors are involved in these initiatives	The Netherlands Basque Country (Spain)
2 Focus in maritime cluster organisation on **education, training and the labour market**	Project-based and structural approach	- Promotion in coorperation with universities and professors - Recruitment campaigns and fairs - Plaforms to exchange best practices	Almost all sectors are involved in these initiatives with leading roles for shipping and shipbuilding industry	No way
3 Focus in maritime clusters on **RDI**	Project-based approach based upon (high budget) govermment support programs and strutural approach	- On (govermmental) project basis - Strutural cooperation with RDI-institutes and universities - Platforms to exchange best practices	Almost all sectors are involved in these initiatives wich leading roles for shipbuilding, marine equipment, offshore supply and shipping	Schleswig-Holstein (Germany)

Source: Authors, based on Policy Research Corporation (2008).

Discussion and Conclusions

The birth of maritime clusters may often be traced to specific location factors and historical circumstances and upon the country's culture. Some of the maritime industries and connected activities have been part of the global economy since long ago. Although they had to face ups and downs, the arrival of new and low cost competitors from time to time, they have shown strong resilience in sustaining their competitive position, due, in a large extent, to technological innovation and to a continuous capacity for reinventing themselves.

The cluster concept has been successfully applied in various regions, countries and sectors linked to the sea, and some aspects can be assumed as crosscutting to these types of clusters. Although many clusters are concentrated in coastal areas, very often maritime economy has impacts beyond those coastal regions and because of so it is also necessary to establish relationships with stakeholders from such remote areas. Many times, the challenges faced go widely beyond the simple sharing and collaboration *inter pares* within a specific sector. Very often, the main issues at the basis of the establishment of a maritime cluster organisation are to increase competitiveness, to promote maritime sectors, and to improve coordination within the cluster.

Also important is the relevance frequently assumed in these types of clusters concerning the exploitation (extraction) of natural resources (normally used as raw materials or inputs to production systems) over time and the need for its optimization, both in environmental and economical terms, and the marine and maritime spatial planning, in order to regulate potential conflicts between different uses and users and preserve environmental conditions. Finally, there are certain key factors with high accuracy to the topic at hand: Agglomeration economies that attract firms and resources into a particular geographical area, namely a joint labour pool, a broad supplier and customer base, knowledge spillovers and low transaction costs; Endogenous factors that are inherent to a particular cluster, including not only deterministic conditions such as legacy, culture and history, but also those who have a positive impact on innovation, like the presence of multiple actors deeply interconnected (e.g.: firms, business associations, public authorities, universities and RDI centres, financial services, etc.), a solid education and training infrastructure, the collective production, management and transfer of knowledge and the carry out of joint RDI activities.

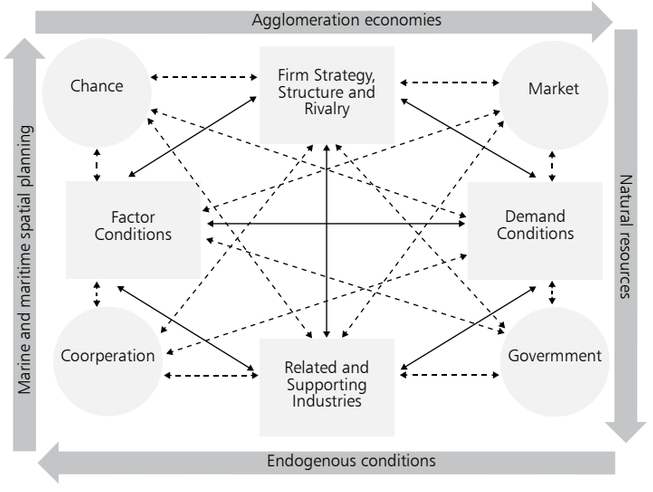
Through the present chapter, we highlighted those aspects considered of most relevance towards the establishment of a distinctive set of critical factors and key dimensions, understood as essential to attend the singularities and emphasize the idiosyncratic nature of maritime clusters; therefore, whose manifestation is considered crucial to their creation and sustainable development.

Is thus clear if some differentiation exists between "terrestrial" and maritime clusters that is related to the absolute critical role that innovation and knowledge networking hold in the latter. The increasingly demanding international contexts where maritime clusters evolve and the permanent source of use conflicts for space allocation and resource depletion, induce a competitive pressure to innovate, because maritime firms are highly dependent upon the introduction of new products, new production processes and new organizational practices, as a way to sustain competitive advantage. Therefore, the consolidation of a critical mass of private

and public actors, the existence of adequate conditions for the emergence and sustenance of labour market pooling, based on an appropriate system of education and training, the presence of solid interdependence relations between these multiple and sophisticated actors, are decisive for the genesis and success of those inner dynamics.

From the findings presented so far, a reconceptualised model for the case of maritime clusters, inspired by the Porter Diamond, is shown in Figure 37.

Figure 37: An Adaptation of Porter's Diamond Model of National Competitive Advantage: the case of Maritime Clusters



Source: Authors, based on Porter (1990).

Within this framework, the geographic concentration of activities, the intersectoral and intrasectoral linkages and the assembling of local innovation networks, based upon strong cooperation ties between public and private actors, function as strong cluster enablers, allowing maritime firms to benefit from the technological externalities of agglomeration (v.g. better access to strategic information via knowledge sharing, risk sharing, lower transaction costs, scale economies, etc.) and proximity effects (pre-emptive access to knowledge, specialised technical, legal and organizational skills, human and financial resources and strategic technologies; knowledge spillovers and localized collective learning effects; physical infrastructures, access to new markets, etc.). Due to the increasingly demanding international contexts where European maritime clusters evolve and their high exposure to tradable sectors, we also emphasise the important role played by the market (access, strategic positioning, etc.).

Based upon the observations made of the four European maritime clusters chosen in this study and their relation with the different dimensions presented in Figure 37, we are able to establish for the case of European maritime clusters the follow differentiation framework.

Factor Conditions:

- Important role often played by historical circumstances, cultural factors and/or the abundance of natural resources (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- A high quality and multidisciplinary maritime educational infrastructure (the Netherlands, Norway and Schleswig-Holstein);
- Advanced research and development and knowledge transfer infrastructure and policies that stimulate entrepreneurs to innovate, exchange information and take risks together (the Netherlands, Norway and Schleswig-Holstein);
- Sophisticated local labour market with sufficient career prospects (the Netherlands, Norway and Schleswig-Holstein).

Demand Conditions:

- Strong intersectoral exchanges: innovation-dependent highly specialized demand sectors using capital equipment and services produced in other sectors inside the cluster (Norway);
- Presence of strong and internationally oriented demand sectors, such as shipping, nautical tourism and recreational boating, water transport, offshore industries, fishing, Navy and dredging (Basque Country, the Netherlands, Norway and Schleswig-Holstein).

Firm Strategy, Structure and Rivalry:

- Permanent upgrade of products and services, production processes and organizational practices (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- Presence of leader firms that are able to set demanding standards, trigger innovation and organize a number of companies (from the supply sectors) to address the innovation challenges (the Netherlands, Norway and Schleswig-Holstein);
- High level of intrasectoral relations: locally-based competitors involved in co-opetition processes, which makes it easier for companies to specialise on a narrow part of the value chain due to reduced transaction costs (the Netherlands and Schleswig-Holstein).

Related and Supporting Industries:

- Capable locally-based specialized supply sectors, like naval repair and shipbuilding, marine equipment and maritime services are increasingly exposed to foreign competition (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- High level of interdependency with the remaining sectors of economic activity (the Netherlands, Norway and Schleswig-Holstein).

Government:

- Focus on the importance of the maritime cluster evolving educational and research institutions, trade and labour associations, financial institutions and other private and government institutions, labour force, entrepreneurs and the general public (Netherlands and Norway);

- Acknowledge the maritime cluster as an important building block of the economy (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- Create the right conditions for the maritime sector to adapt to a competitive environment that is changing continuously (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- Existence of an overall industrial policy for the maritime sector (Basque Country, Norway and Schleswig-Holstein);
- Networking / alliances / close contacts with other international maritime clusters (the Netherlands and Schleswig-Holstein).

Cooperation:

- Strengthening the leverage of public/private cooperation through centres of maritime excellence (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- Accessing and sharing information on technology change (the Netherlands, Schleswig-Holstein and Norway);
- Risk sharing on the development of R&D activities and accessing new markets (the Netherlands, Norway and Schleswig-Holstein);

Market:

- Crucial need for the internationalization of the cluster economic activities (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- Strong lobby activities on facilitating the access to new markets (Basque Country, the Netherlands, Norway and Schleswig-Holstein);
- Accessing information on new market opportunities and legal access conditions (Basque Country, the Netherlands, Norway and Schleswig-Holstein).

Functioning at the center of the model above are maritime clusters, understood as integrated ecosystems where innovation-dependent highly specialized producers and capable locally-based specialized suppliers of goods and services, educational and research institutions, financial institutions and other private and government bodies, related through solid forward and backward linkages, evolve in competitive and demanding contexts, which increase the importance of science-based clustering and favours the creation of a "fertile" environment much suitable for the promotion of excellence RDI networks, as well as strong interdependence relations not only with other sectors of economic activity, but also with other international maritime clusters, thereby improving the structural conditions and the competitiveness factors either of the sea related sectors and of the nations/regions involved.

To conclude, with the current chapter we presented a set of critical factors and determinants which may embody the proposal of a differentiation framework for the case of European maritime clusters: not all of them must be present at the same time in a particular cluster, but they all are positive structural dimensions towards the creation, resilience and sustainable competitiveness of successful maritime clusters.

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Knowledge spillovers within the Algarve tourism region evidence to identify a regional innovation system

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Introduction

In the last two decades, an extensive body of theoretical literature and research related to regional innovation systems (RIS) has been developed, demonstrating how evolved economic and cultural processes may support the generation of innovations in leading and high-technology core regions. RIS have commonly been considered as an open social and economic system with institutional behavioral support in which innovations result from interactions between organizations and the systematic use of accumulated local knowledge and learning (Isaksen, 2001; Evangelista, et al, 2002; Cooke, 2003; Cooke, et al, 2007; Asheim & Coenen, 2004; Asheim, et al, 2011; Bracayk, et al, 2004; Doloreux & Parto, 2005).

However, the operation of RIS in peripheral and small and medium-sized regions, with low technology innovation systems, requires more empirical evidence (Wiig, 1996: Andersson & Karlsson, 2004). Current research shows that RIS in peripheral regions are characterized by a less developed cultural and economic environment for innovation. They also lack a critical mass of activity supporting institutions and organizations, including networking among regional agents and interactions with external innovative hotspots. Industrial patterns are dominated by less developed low-technology clusters, mostly comprising small and medium enterprises (SMEs) with low capacities. Innovations are more related to incremental and process innovations, since firms are more inclined to adopt and receive technical knowledge than to act as a diffuser of novel knowledge. In this context, learning-by-doing and learning-by-using are more commong processes in generating new local knowledge (Tödtling & Trippl, 2005; Doloreux & Dionne, 2008; Asheim & Isaksen, 2000).

In accordance with the characteristics of peripheral or non-core regions identified by Lagendijk and Lorentzen (2007), the Algarve region is therefore still dependent on a low-technology tourism industry that commonly generates only incremental and process innovations. It is also quite isolated in relation to Portuguese and European metropolitan areas, knowledge sources, R&D expenditures and high technology agglomerations. In this context, it offers a timely case study of a peripheral region in rural surroundings, with low population and education levels, focusing especially on the development and effects of regional, national and international linkages among the key regional agents (Huggins & Johnston, 2009). In this same context, the region also offers the possibility of considering whether tourism firms may act as knowledge intensive services (KIS) (Sundbo, 2010). Although more detailed information may be needed,

as a first step, it may be of interest to understand the different mechanisms used by tourism firms to absorb, utilize and generate new knowledge at a regional level in order to increase competitive advantages and maintain and capture new markets.

Many industries involving tourism, some more than others, have had to move further toward a more intensive utilization of knowledge while at the same time providing and diffusing knowledge to other organizations and customers in order to solve specific problems, deliver high quality products and have a wide range of competitive services around the world and in Algarve specifically, has experienced an increasing demand and growth. Tourism is the main economic income in Algarve featuring a well developed, productive net of firms around all sub-sectors that participate in this economic activity.

The main objective of this study is therefore to determine the importance of local knowledge spillovers among regional organizations and tourism firms in the Algarve region, and the role played by the regional innovation platform as in increasing competitiveness. The main sources of knowledge are identified, highlighting the capabilities and capacities of firms, as a basis for moving toward a KIS-based tourism industry seeking to improve business opportunities.

Tourism Innovation, KIS and Knowledge Spillovers

"Services" have become fundamental to modern economies, providing an important source of employment, productivity and economic development, while also acting as an interconnector and facilitator for the development of other economic activities. The specific subgroup of KIS has been studied from different perspectives (Odec, 2007; Müller and Doloreux, 2007; Miles, 2008a; Rubalca, *et al*, 2010), giving rise to different conceptual approaches and definitions depending upon the focus and type of service firms. Important inputs from the analysis of KIS may be used to understand the tourism Industry.

Merino and Rubalcaba (2006) maintain that the primary causes of the increasing importance of KIS are linked to the consolidation of a knowledge based society. Adopting a knowledge perspective to understand patterns of innovation in services, as suggested by Miles (2008a, 2008b), the tourism industry is increasingly characterized by KIBS features. This is especially noticeable through the dependence of tourism on human qualities, with employees focused on problem-solving/client-firm interactions, professional and specialized knowledge in relation to the use of information and communications technologies (ICTs) and reliance on tacit knowledge, including "experience". Miles (2008b) has classified tourism as a KIS, even though the main economic activities generally linked to tourism, including hotels, restaurants, catering, transport services and travel agencies, are usually associated with "less knowledge intensive" market services.

In a RIS context, it is recognised that KIBS play an important role as intermediary players, promoting innovations through outsourcing and collaboration activities (Howells, 2006). They may act as node functions in the creation, diffusion and implementation of knowledge, essentially through face to face communication and the diffusion of tacit and localized knowledge among regional agents supporting learning by interaction (Doloreux, *et al*, 2008; Thorsten & Böhn, 2003; Koch & Stahlecker, 2006). Rubalcaba, et al (2010), emphasises that innovations in the service sector should be assessed in the context of the interactions and interdependencies of innovation systems. The characteristics of KIBS are important in understanding the dynamics and evolution of RIS, acting as suppliers of expertise to other firms, promoting and helping them in the innovation process (dos Santos Ferreira, 2010).

Hjalager (2002) argues that, although the tourism industry displays various obstacles to knowledge transfer hampering innovation processes, including low-skilled employees, four main sources can be identified that identify channels of knowledge transfer: a) Trade systems, cof knowledge embedded in associations or tourism organizations and transferred in conferences, forums, sector surveys, etc; b) Technological systems: knowledge embedded in technologies, c) Infrastructural systems: knowledge embedded in free goods and, d) Regulation systems, knowledge embedded in regulations or mandatory actions promoting innovation.

Although some have portrayed tourism as a sector with a low capacity to develop innovation systems, others have identified tourism innovation systems, including institutional innovation based on collaboration and spin-offs between highly interrelated agents. In this, each may take different roles, some acting as drivers of the process and others assuming more peripheral functions, creating synergy and mutual benefits. In this process, firms take advantage of externalities and other innovation system outputs (Hjalager, 2010b). Prats, *et al,* (2008) have focused on the evolution of tourism destinations using a model approach based on tourism innovation systems, adding evidence on the generation of social networks and the distribution of benefits among firms.

Sources and Vehicles of Knowledge Spillovers

The last few years have stressed the importance of adopting a cluster approach to the study of the tourism industry to analyse issues of regional specialization through innovation and knowledge management by tourism firms (a complete bibliography revision can be found in (Hall & Page, 2008; Hjalager, 2010a). However, only incipient research initiatives have tried to understand tourism from a RIS approach, emphasising the need for new evidence (Sundbo, *et al*, 2007; Hjalager, 2010b).

Many of the new, marketable ideas about products or services offer a mixture of tacit and explicit knowledge (Shaw & Williams, 2009). Since innovation by firms is crucial tin gaining new markets and more competiveness. It is important to support their capabilities to generate, absorb and use knowledge in producing more and better products and services (Cohen & Levinthal, 1990; Noronha Vaz & Nijkamp, 2009). Although some authors having noted the low capacity of small firms to absorb knowledge and information, because of their low proportions of skilled workers and high labour mobility (Sundbo, *et al*, 2007), other studies have stressed the capacity of some tourism firms to gain knowledge both from tourism and other economic sectors (Plaza, *et al*, 2010).

The main models of innovation in tourism and services (Decelle, 2004; Cooper, 2006; Hertog, den, et al, 2006), including variable reflecting knowledge spillovers, categorise different dynamics separately as vehicles and sources, depending on their direct or indirect capacity to influence innovation in firms. Regional variables have a major impact in these processes because they are used by firms as free externalities produced by high regional specialization in tourism. Consider-

ing processes of knowledge transfer in peripheral tourism regions, the Shaw and Williams model (2009) examines indirect diffusion and the direct transfer of knowledge in tourism, as well as the knowledge spillovers studied by Hjalager (2002) and Sundbo, et al (2007), and variables utilized in studies of other economic sectors such as labour mobility and formal-informal networks (Kesidou & Romijn, 2008; Boshuizen, et al, 2009). The central idea of this categorization is that firms take advantage of accumulated knowledge as a result of regional concentration and specialization in tourism activity and that these processes could be further developed, directly or indirectly.

This chapter focuses on the role, linkages and knowledge spillovers currently shaping the "regional innovation platform" in the Algarve. A regional innovation platform consists of innovation patterns supporting low levels of evolution of an "emerging RIS" (Chaminade & Vang, 2006, pp. 11), *"where some of the building blocks of the RIS are in place but where the interactions among the elements of the RIS are still in formation and thus appear fragmented"*. On the other hand, knowledge spillovers are seen as the prime source of agglomeration economies and innovation systems (Caniëls & Verspagen, 2001). They support the diffusion of knowledge from where it is created or from one agent to another. This is how it becomes useful and acquires societal value (Stough & Nijkamp, 2009*).* In this context, we examine how specialized tourism knowledge is diffused in the Algarve region and the extent to which these processes may contribute to the evolution of an Algarve RIS.

Methodology

In this work we seek to obtain preliminary perspectives about KIS and knowledge transfer processes in building a RIS in a peripheral region based on tourism. The Algarve region of Portugal was selected as a suitable case study. It is located in the southern part of the country and occupies approximately 5% of continental Portugal, with a total area of approximately 5.000 km^2. In the 1960s, the Algarve became popular as a tourism destination for North European countries, and a good place for retirement and second or vacation homes. Although beginning as an up-market destination, it progressively lost this characteristic, mainly as a result of inefficient tourism planning. In the 1980s the number of arrivals grew rapidly, but in the 1990s, there was a marked slowdown due mostly to high prices, making the region less competitive for its particular types of tourist compared with Spain.

Over a long period policy-makers recognized tourism as the best base to ensure continued growth in the region. Indeed, in spite of its extreme dependence on tourism, regional GDP has shown continued growth, with a significant impact on urban growth and a steep rise in real estate prices. In 2008, around 200 km^2 of land was urbanized from which about 50 km^2 for tourism activities (CCDR Algarve, 2007).

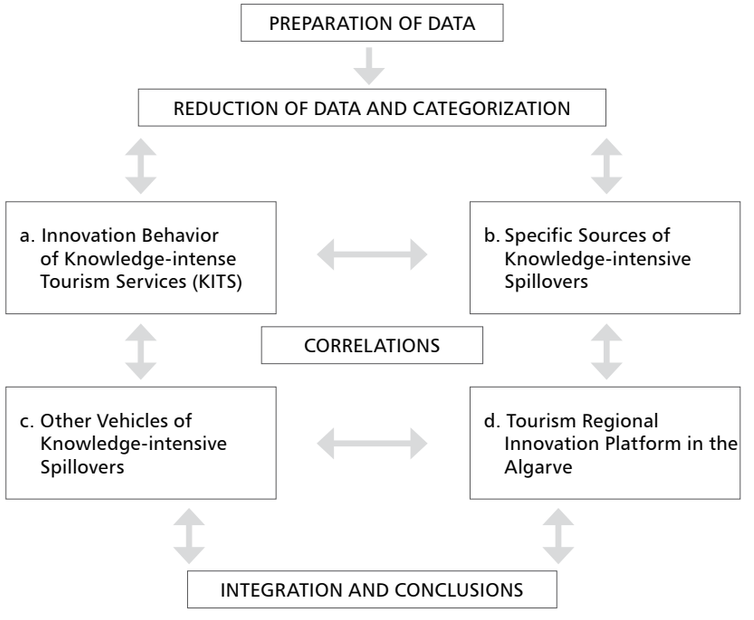
In 2007-8, tourism generated 10.5% of the total GDP of Portugal and contributed 8 per cent of employment (OECD, 2010). In the Algarve, tourism contributed 47 per cent of the regional GDP and 35.4 per cent of the total national overnight stays (INE, 2008a). The population employed in the service sector reached approximately 72% of total employment, highlighting the structural importance of tourism activity in the region (INE, 2008b).

This research applied a case study approach to the Algarve, and a qualitative methodology of analysis (Yin, 2003; Clark & Fast, 2008; Phillimore & Goodson, 2004):

- Information was collected from 20 semi-structured and extensive interviews with major regional stakeholders between February and April 2011. A flexible interview guide with open questions was used to gain depth in the responses.
- Regional dynamics and innovation behaviour in tourism firms were first categorized into specific research topics and then integrated. This procedure was designed to develop preliminary conclusions about tourism dynamics in this peripheral region, in the absence of fuller data evidence.

The use of open interviews therefore sought the formal views of regional stakeholders, usually shaped by their legal and organizational perspectives. The method nevertheless shed light onto how institutional-social systems have developed in the Algarve region, and how far key regional players are linked. The twenty interviews included representatives of five regional business associations, one regional non-governmental organisation, five public organizations supporting innovation, four tourism organizations, two municipalities and three educational organizations, of which two were universities. The results provided insights into regional tourism strategies and innovation practices at the micro level.

Figure 38: Organization of a content analysis method



The interviewees were chosen because of their direct access to relevant information and specific knowledge, but a regional perspective was encouraged to stress links among different

topics, including knowledge transfer, the roles of business associations, interactions between large and small tourism firms, and specific innovation efforts.

The resulting primary information was studied through content analysis using the ATLAS.TI software tool. The resulting texts were analysed through the classification and categorization of specific topics and sub-topics, allowing direct correlations to be found relating to research goals, patterns of common expression and key differences about key points. The information was analysed according to the methodological model set out in Figure 38, integrating 20 different perspectives around the four topics. These were finally combined with secondary information to support the main research findings and conclusions.

Discussion and Evidences

Innovation Behaviour of Knowledge Intense Tourism Services (KITS)

There is an important lack of statistical information about innovation activities among tourism firms in the Algarve. However, according with a common vision collected with the interviews, public tourism organizations and regional business associations stress the important differences between the large, international tourism companies and the greater number of Micro and Small Tourism Firms (MSTF) in the region, especially when considering innovative behaviour, regional business networks, market share, inter-firm linkages and territorial impacts:

- The MSTF are commonly based on obligatory or necessity entrepreneurship and familiar subsistence related to entertainment, tourism accommodation, travel agencies, restaurants, natural and cultural tourism business, etc.
- The large companies, however, belong to international hotel chains and tour operators, linked to the region through local travel agencies. The large hotel chains have investments in the country and around the world, supporting systematic innovation activities, modern business structures and innovative processes of marketing. They incorporate advanced technologies, employing skilled human resources with knowledge of hotel management in vertically organized operations.

The Algarve region and tourism are both characterised by these co-existent forms of business: According to the Portuguese National Institute of Statistics (INE) (2008b), in 2007, around 96 per cent of the regional firms had fewer than 10 employees, 3.7 per cent 10 – 49, and only 0.3 per cent had between 50 and 250 employees.

In this context, large companies benefit from the region mostly through the exploitation of geographical conditions and low cost labour compared to the rest of Europe. When introducing innovations, they display low levels of interaction and knowledge diffusion with other regional firms and institutions. In addition, returns created by these companies in the region are not systematically reinvested there, since productive cooperation and commercial linkages are fragile, and better opportunities are commonly available elsewhere. Because of the significant presence of Mstf, Korres (2007) has suggested that it should be possible to gain competitiveness through scope economies. This argument is complemented by geographical qualities based on social and geographical proximity in a spatial context in which tourism activity may be developed on the basis of rivalry and competition.

At the same time, networking and cooperative behaviour between institutions, allowing knowledge transfer, may support a cluster, with repercussions on the capacity to innovate by tourism firms. Tourism products are experience services, based in specific tourism destinations, where a set of complex, interlinked elements may be involved in a specific location (Decelle, 2004; Hjalager, 2010b). In the Algarve several projects support such an interpretation. Two examples are:

- Plano Estratégico da Bacia do Arade – a development plan for the restricted area of Arade river by Portimão resulting from the cooperation of cross border municipalities, the Universidade do Algarve, the Institute of Employment and Training (IEFP), the regional office of the Ministry of Economy, Innovation and Development (DRE) and the Coordination Commission for Regional development (CCDR).
- A Rota da Cortiça – the so-called "Cork Route", through the Serra do Caldeirão showing the production of cork, cork extraction and industrial processing. The programme, one of the most integrative in joining institution such as DRE, the Algarve Regional Tourism Office (ERTA), the Association of Municipalities of Algarve (AMAL), the Business Association of Algarve, NERA, CCDR and several enterprises, is also contributing to protect and promote the only product in which Portugal is the world leader.

From the perspective of any emergent innovation system, the tourism industry needs to generate new knowledge through partnerships, collaboration and networking among MSTF, large firms and other regional players. A capacity to create value and competitive advantage in specific destinations must involve many firms. A systemic approach is therefore needed rather than the promotion of innovation in individual firms (Plaza, *et al*, 2010). Tourism is therefore still an open field for analysis (Hjatlager, 2010b).

Currently, among the important features of tourism are interactivity, based on client-tourism firm contacts, and intangibility, through the intensive use of new technologies and data. Tourism innovations are therefore mostly based on incremental processes, through "Project management and on-the-job innovations" (Miles, 2008a, pp. 115). In our survey, most of the key players cited examples of innovations in tourism firms incorporating new technological innovations such as the ICTs:

- Improving the generation of new client interfaces and new service delivery systems. The utilization of internet Web pages and internet and computerized booking systems have reduced the costs of transactions and direct relationships with customers. Additionally, computerized communication and internal task and cost software have improved the internal efficiency of firms – Visualforma is one such company, awarded a prize as one of Portugal's most innovative SMEs.
- Sometimes, such programmes have required organizational, back-office improvements and more skilled employees. Frequently, however, these tasks have been subcontracted to emerging small firms specialized in supplying such services to hotels and restaurants (e.g. Algardata has expanded as a result of the use of such skills).
- Some innovations, such as lower internet prices and the promotion of tourism packages (especially in low seasons), co-branding initiatives, the intensive use of internet and mobile phone tools for promotion via social media channels, and multi-lingual interfaces have been developed by both large firms and MSTF. This supports the need to incorporate increasingly specialized knowledge capabilities, especially in the use of these technology tools.

- Private and public Algarve tourism agencies have built regional internet interfaces including all tourism firms in the Algarve, where it is possible to identify the activities of firms and their regional location, providing efficient communication channels among suppliers and client-tourism firms. An example is the Algarve digital portal. Such new marketing techniques and new communications channels have provided opportunities for many small firms, in particular in relation to property sales and rental markets.

As well as developing knowledge and information networks for tourism destinations, it is more important on a daily basis to develop regional tourism products themselves. Tourist regions may build a RIS by developing systematic knowledge spillovers and absorption capabilities, based on linkages among regional, national and international agents, reinforcing learning behaviour through regional private and public partnerships. Sundbo (2010) considers such a case including tourism as a KIS (featuring the development of destinations and new tourism systems) focusing on public-private network collaboration to promote cities and regions. In the Algarve many public private partnerships now shape the institutional framework of tourism activities. The strongest such case relates to sporting activities (e.g. Estádio do Algarve for EURO 2004) or the construction of infrastructure for environmental improvement (e.g. management and recycling of water and waste products and the construction of industrial parks in the various municipalities).

Specific Sources of Knowledge-intensive Spillovers

The presence of knowledge spillovers influencing innovative performances in KIBS depends on the nature of the activities (De Jong *et al.*, 2003). Doloreux (2010) confirms that KIBS behaviour is quite distinct in peripheral areas. While most of the literature shows that innovation in peripheral regions suffers from a lack of critical mass and low densities of actors and relationships, strategic choices may be able to overcome such bottlenecks.

Most of our stakeholder respondents agreed that the promotion of education and information regarding R&D were two important tasks of regional policy targeting potential bottlenecks. In the Algarve, the success rate in secondary education only reaches 76.1 per cent, compared with 79.7 per cent in Portugal. Around 70 per cent of the population has schooling for fewer than 12 years and the educational attainment rate in higher education reaches only 19.9 per cent, compared with a national rate of 29.7 per cent (INE, 2008).

As well as complex challenges such as improving educational levels, market necessities must also be addressed to promote and improve tourism professionalism. This includes adopting new tourism business models, mostly based on e-tourism, e-commerce and ICT as the principal agents of change in the structure of the industry (Hjalager, 2002). Requirements for more skilled human resources are reflected in recent public and private initiatives in tourism training. This may become an important source of knowledge for innovation, encouraging the rise of more technology-based firms or KITS. Recent initiatives include:

- Tourism in Portugal (RTA and EHTA), the Ministry of Labour and Social Solidarity (through IEFP), and the Ministry of Education have developed regional programmes in secondary level education and vocational training in tourism to support tourism firms. The Escola de Hotelaria do Algarve provides excellent conditions for implementing many such programmes.
- Respondents to our survey drew attention to many schemes through which project leaders gain access to specific knowledge through more advanced training in tourism. For example, CCDR, the University of Algarve, NERA, AMAL and the Association of Hotels and Tourist Enterprises of Algarve (AHETA) are major knowledge providers in the region. Formally or informally, they incorporate knowledge management tools in their training, supporting MSTF in being competitive enterprises by assisting them in gaining access to new technologies, organise business plans, acquire new partners and respond to marketing trends.
- In contrast, owners or founders of tourism firms who are not able to access suitable knowledge, especially by increasing or incorporating new skills, they find it difficult to be competitive and invest in their companies. In turn, they fail to generate access to financial backers willing to support improvements in firm performance. Respondents confirmed that this may be the most common behaviour of small tourism firms.

Interaction and the sharing of a common business language related to tourism are important in a small territory such as the Algarve, where geographic proximity is important role in facilitating new business and innovative activities.

As a stakeholder representing a European agency at the CCDR pointed out, there have been some regional projects in which firms cooperated to structure a specific product or create an external marketing platform to improve the promotion and dales of their products. Without this, the region's size and investment capacity would not have allowed them to fund such a project.

Spinoffs from the Universidade do Algarve can also be considered, both as isolated sources of knowledge at the regional level and when they include cooperation with the private sector. Currently, only a few tourism companies have generated cooperative relationships linking universities and commercial knowledge from specific projects.One of this is the planned IIEAT (International Institute for Advanced Studies in Tourism).

Key players have shown concern about the fact that firm-university relationships in the region that might have helped commercialize particular expertise have not had the needed impact, not just in the tourism sector The Algarve Region Innovation Centre (CRIA) is putting significant effort into promoting possible partnerships at this level, including joint R&D projects and other actions in areas of marine sciences and new technologies.

In the Algarve, there are also MSTF that participate in regional development bodies. Business Associations are important, in which formal and informal networks are used by firms to gain tourism knowledge, including AHETA. Tacit knowledge is shared and absorbed by the owners of hotels and tourist enterprises and transferred to other tourism firms. Business Associations are also involved with regional tourism bodies (ERTA) which commonly discuss and propose guidelines regarding the specific role that tourism has to play in regional development. These instances provide all regional players with a significant role in the development of the region. They promote increased interaction among public, private and Non Governmental Organizations (NGOs) such as Globalgarve, a regional agency, responsible for a number of initiatives to promote regional growth and firm competitiveness.

Regional business associations, such as NERA, including micro, small and medium tourism firms, also act as a source of knowledge for innovation and entrepreneurship by promoting

the diffusion of ideas, projecting opportunities, and issues of financing, business plans, etc. Although there are only a few such forums, sector meetings or seminars coordinated by business associations also allow the exchange of ideas and business experiences among private enterprises and with other regional or international players.

Generally, there are still no permanent structured relationships in the region to spread good practices to small businesses, for example by following those implemented by large tourism companies. Only a few large companies offer such knowledge openly in forums or seminars where information about the company may help smaller firms by spreading knowledge about innovative activities, adapted to their fields of action and development.

Other Vehicles of Knowledge-intensive Spillovers

Public initiatives to promote and regulate tourism and innovation in the Algarve, designed to improve processes of knowledge-intensive spillover, are contained in the National Strategic Reference Framework, 2007 – 2013. This is focused around guidelines provided by the European Union. In this national context, the main regional private and public actions are elaborated in the "Algarve Development Strategy 2007 – 2013", which also considers lines of action contained in the Regional Land Plan of the Algarve. Headed by the Regional Coordination and Development Committee of Algarve (CCDR), this document emphasizes the need to increase regional competitiveness and skilled employment. In turn, the "Operational Program of the Algarve Region", based on the three lines of structural investment (innovation and knowledge, environmental qualifications, and territory) has become an important regional public policy (PO ALGARVE 21). On the other hand, specific suggestions for national tourism activity are contained in the Strategic Plan for Tourism Development (PENT, 2007). As part of the national structural policy programme promoting knowledge creation and diffusion across Portuguese regions, the "Regional Plan for Innovation" was also elaborated by the Universidade do Algarve in 2007. This initiative aimed to generate a technical and productive redefinition of the region and create conditions supporting a RIS to promote Algarve strategically as a competitive region, in particular in through tourism.

The many small companies involved in the regional tourist system in the Algarve face many difficulties and lack the technical and operational resources needed to carry out innovation activities. The most innovative tourism firms are generally belong to large, vertically integrated economic groups, in which the use of knowledge is organized within their own companies or groups. These operate globally and, through their organizations, are able to gain scale econmomies, helping to reduce final prices.

Hjalager (2002) and Sundbo, *et al*, (2007) have questioned the capacity of tourism workers as sources of innovation because of low levels of training. One of the reasons for this is the seasonality of the sector. This applies in the Algarve, even though many efforts have been made to reduce uneven activity through the year by offering a more diversified set of regional tourist products and services. Examples include eco-tourism initiatives, aquatic entertainment, golf facilities, activities and recreation for seniors and intensification of international sport contests. External factors have also influenced the capacity to attract larger numbers of tourists, including the economic crisis and the devaluation of the Pound against the Euro, reducing the numbers of British tourists, the main source of international visitors.

High seasonality and the low-skill levels of tourism jobs are the main reasons for strong labour mobility between jobs and places within the region. However, the high employment offered by large companies in the busy season acts as a source of specialist knowledge, including efficient organizational and business practices that can be acquired by workers. Labour mobility therefore spreads the organizational models of these companies across the tourist area as the technical and operational profile of human resources is internalized, diffused and reproduced in different firms as workers are contracted around the region .

Conclusion: A Tourism Regional Innovation Platform in the Algarve

The primary and secondary information collected through our series of interviews with regional stakeholders included all the actors reported in Figure 39. This is one of the major conclusions of this work, drawing links between all the implicated actors and confirming the existence of an extensive Regional Innovation Platform for tourism in the Algarve. This platform has the following characteristics:

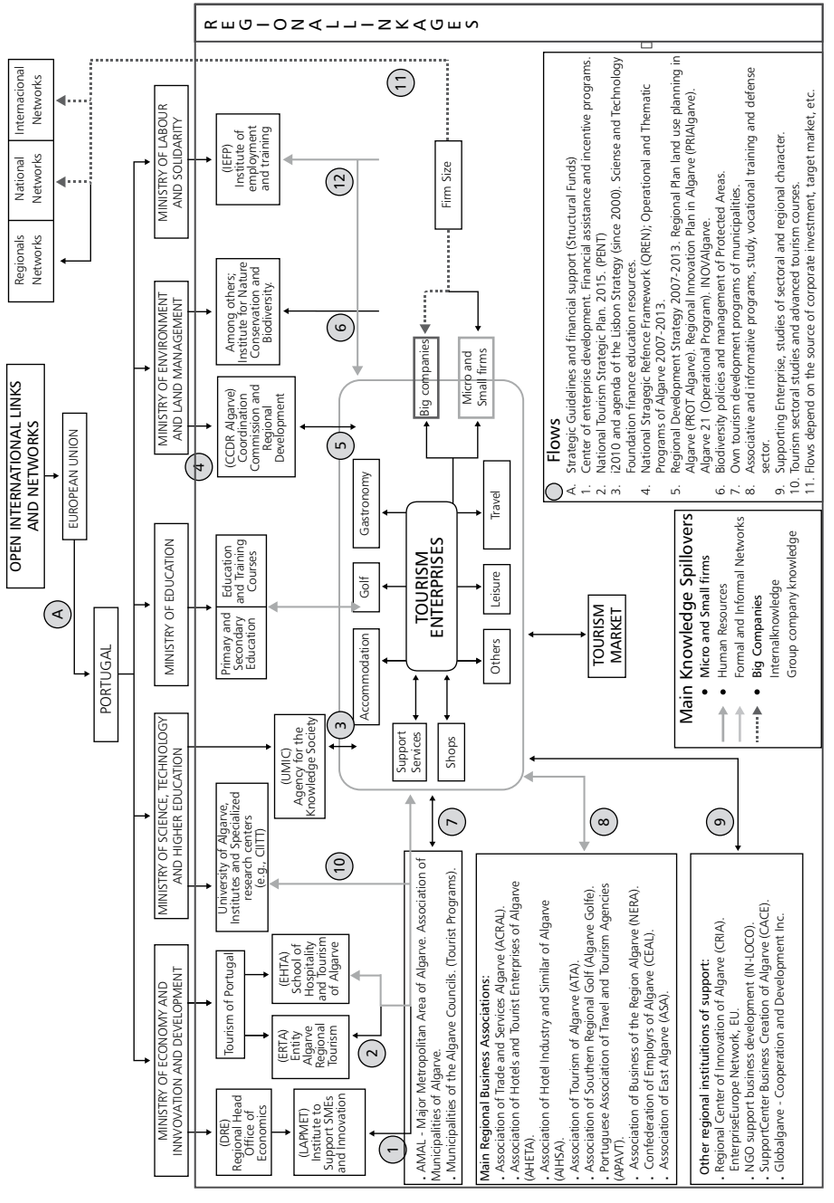
- It is composed of international, national and regional public and private agents, which are still unable to build an interconnected innovative system because of the fragility of regional interaction and coordinated initiatives so far.
- Institutional routines to generate innovation are still emerging, despite their active promotion, since they reach remain quite isolated from each other.
- Private initiatives in the region have made advances, generating interesting results through informal and formal networks supporting regional sources of knowledge about innovation in tourism firms.
- The most important effects of public policies in relation to innovation has been through the regional training support used mainly by small tourism firms to increase skilled human resources.

The competitiveness achieved by tourism in the Algarve has stimulated the need for public sector support, for example, through the promotion of tourism studies in the Universidade do Algarve, and also to focus regional growth on the exploitation of tourism activities (for example, as part of specific programmes from the Social Cohesion Fund). Furthermore, many other international programmes, mainly from the European Union, have sought to favour improvements of competitiveness in more peripheral regions through specific regional programs (e.g. LEADER, MED). These are led by public institutions supporting private projects to shape economic resources and humans skills in support of regional tourism development.

From the governance point of view, it is also important to generate a clear regional leadership for the emerging RIS, a role that should be taken up by the regional tourism agency, ERTA. Although regional strategies can assert key policy areas, operational application need to be improved through efficient instruments and policies towards greater participation and communication among regional players.

Figure 39: Linkages and Flows of Knowledge in Tourism

Innovation Platform Algarve Region



Source: Own elaboration, 2011

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The links behind the nodes: The role of individual ties in innovation networks[1]

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Introduction

The current worldwide economic and financial crisis is posing unparalleled challenges to organizations and nations. Two of the most common strategies that both organizations and nations have been adopting to overcome these turbulent times are internationalization and innovation. In the first case, local markets stagnation and/or sharp decline are the triggers behind the search for new (mostly external) markets. This can be observed in many forms, from high emigration levels, to rising exports and geographical relocations. The second strategy is a strong emphasis on innovation and entrepreneurship, as a way to reinvent products, services, and even organizations. Innovation has thus become a topic not only important for organizational growth, but also survival (Fagerberg, 2003).

Schumpeter (1934) laid down much of the modern thinking about innovation and entrepreneurship, and his works have triggered interest in many scientific disciplines and practitioner areas. Although his ideas still live on, more recent accounts have been adding important knowledge to understand modern innovation processes. One such example is that of innovation networks (Westlund & Bolton, 2003), which is helpful to comprehend the influence of linkages between distinct organizations on creativity and innovation. The concept has been analysed mainly from an economic and technological point of view, which is paramount to describe and characterize such symbiotic associations. Less work has been done, however, in regard to *how* such bonds are created, developed, and contribute to entities' overall innovation outputs.

The main goal of the current work is to investigate the human and social foundations of innovation networks, as a contribution to understanding the dynamics underlying the construction and development of these networks. The study is organized into five sections. In the next section, a brief literature review is presented; the third section describes the research design, after which the results are shown. The final section sets forth the main theoretical and practical contributions of this research.

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Literature Review

The Strategic and the Organizational Behaviour Views

The idea of joining efforts in innovation processes is not new in the strategic management literature. Perhaps the most popular concept addressing the importance of collaboration in innovation is that of cluster (Porter, 1998). Porter states that countries are hardly successful if they strive in isolated industries; however, if nations are able to develop industrial poles, then the chances of becoming competitive are much higher. Accordingly, he defines a cluster as a group of entities whose interrelations strengthen competitive advantage. These entities include the competitive firms, their competitors, supplier industries, customers, and other related entities - see also Porter (1990) and Enright (1998). On top of economic and other tangible advantages, clusters have intangible advantages. For example, Porter and Sölvell (1998: 444) explain that the local cluster "offers an environment for the evolution of a common language, social bonds, norms, values and institutions, i.e. a social capital." Although this points to a number of human and social factors involved in organizational and industrial clustering, the authors did not develop further their ideas.

Commonalities and social phenomena are also central topics in the organizational behaviour literature. The specific field of social cognition, for instance, intents to comprehend how people operate and act in social contexts, and specifically how they process and share information (Augoustinos *et al.*, 2006). It is assumed that human cognitive processing is a fundamental ingredient to understanding the dynamics inherent in the collective process (Nickerson *et al.*, 2007; Hurmelinna-Laukkanen & Heiman, 2012). Collective cognitions are structured into mental models that are more or less shared and which consist of concepts and relations that are used to understand situations. Mental models originate from a process of learning from situations, systems and people. In other words, they develop from the contact established with the environment, and they are dynamic since they will reorganize, restructure and update according to the interactions that take place (DeChurch & Mesmer-Magnus, 2010). In sum, these and other works have started to highlight the fact that behind organizational bonds there are a number of human and social factors that need to be understood and explained. The more recent literature on collaborative innovation also stresses this fact, as shall be seen in the next subsection.

Innovation Networks and Individuals in Networks

In more recent years, authors have called attention to the notion of innovation networks. The dispersed nature of modern business dictates that geographical colocation is no longer a *sine-qua-non* reason for organizations to establish symbiotic relationships. Rather, entities embark in joint innovation processes due to a common interest in particular aspects of innovation. Hence, innovation is the result of the dynamics taking place in networks (Pyka & Scharnhorst, 2009). Organizations in innovation networks are highly exposed to different ideas and have a closer contact with knowledge resources and knowledge transfer (Powell & Grodal, 2006).

In a similar trend, the concept of Regional Innovation Systems describes networks of organizations within which the creation, dissemination and exploitation of new knowledge and innovation occur (Cooke *et al.*, 2004). This concept is useful to describe how industrial and institutional structures of a national or regional economy are related to technological and industrial development. Clusters, as put forward by Porter (1998), are therefore smaller components of a Regional System; besides clusters' core elements, an innovation system also includes academic and research organizations, policy institutions, government authorities and financial actors (Teigland & Schenkel, 2006).

Advantages of participating in innovation networks are many. The control of transaction costs is amongst the most important of these, since organizations may have more cost-efficient access to resources and knowledge. Other benefits include technological relationships and a richer and wider decision-making basis (Goerzen, 2007). In fact, as the same author explains, an organization in a network will probably have many distinct connections to distinct entities, thus enhancing its access to a variety of ideas and a wide-base knowledge platform. The variety of entities in a network is high, since it may include governmental agencies, associations, technological parks and science centres, R&D organizations, entrepreneurship support entities, technological schools, university interfaces, and other private and public institutions (such as venture capitalists) (Galindo *et al.*, 2011). Other authors also include selected suppliers, distributors and customers, thus creating what is called an "open innovation ecosystem" (Adner & Kapoor, 2010).

Galindo *et al.* (2011) used a novel methodology to identify the main innovation networks in Portugal, using a set of criteria and web-based information related to several entities and organizations in various regions in the country - see also Noronha Vaz *et al.* (2013). Each of these networks is composed of several innovation clusters, which at times cross the country's frontiers, and are also characterized by different structures of interaction and different innovation pathways - see also Davis (2008).

Research Aim

All the previous works have looked at innovation networks from a structural, economic or technological perspective. Similar to the innovation cluster literature, less attention has been paid, however, to how such networks start, and how they are developed and sustained. Amongst the exceptions, Gomes and Hurmelinna-Laukkanen (2013) have used a case-study strategy to explain the human and social elements that form the basis of an innovation cluster. Their research is limited, however, to a cluster, since they observed three companies involved in competitive dynamics. The current study expands the aim of Gomes and Hurmelinna-Laukkanen (2013), to investigate individual and social relationships underlying innovation networks, especially those identified and characterized in the works of Galindo *et al.* (2011) and Noronha Vaz *et al.* (2013). In sum, the goal of the current study was to explore the micro dimensions (individual and social dynamics) behind macro structures (innovation networks).

Method

In line with its exploratory character, the research adopted as main data collection strategy semi-structured qualitative interviews. These were targeted at executives from entities involved in innovation processes in the Centre, Lisbon and North regions of Portugal - more precisely in the areas of influence around each of the cities of Coimbra, Lisbon and Porto. While the metropolitan areas of Lisbon and Porto represent the country's two traditional engines of development, the city of Coimbra is one of the economic and knowledge poles of what is considered to be an emerging region: located between the capital region and the North, the Centre region achieved the second best innovation performance in the country in 2011, according to the European Commission's Regional Innovation Scoreboard (2012), a position which has been continuously improving ever since the first similar comparative assessments were carried out in 2007.

An interview protocol was designed to enhance consistency in the interviewers' work, including the formulation of a guide with an indicative set of key open-ended questions. These covered three main topics: a) characterization of the participating entity and interviewee (academic and professional backgrounds); b) innovation processes in which the entity is involved; and c) positioning vis-à-vis innovation networks (actual participation and opinions). Initial identification and selection of interviewees involved a continuous desk review (encompassing, *inter alia*, scientific papers[2], academic works[3], reports[4], publications[5] and databases[6]), as well as the attendance of specialized events (such as conferences on themes related to innovation and entrepreneurship), during which contacts with potential informants were established. The main selection criterion adopted was the involvement of target entities in innovation processes; consistent with the study's subject and objectives, priority was given, whenever relevant and possible, to snowball sampling.

All in all, more than 300 entities (and their respective key executives) were screened, 90 of which were selected and contacted. Out of these 90 entities, 45 eventually showed interest in collaborating with the study and were available for an interview (25 in the Centre, 10 in Lisbon and 10 in the North). Participating entities consisted of 34 (mostly private) enterprises (both start-ups and longer-established firms, mainly from the ICT, health, engineering, aerospace, materials and agro-food sectors), and 11 innovation support organizations (such as R&D institutions, universities, science and technology parks, and business associations). The group of informants was mainly composed of CEOs, CTOs, R&D/innovation managers and entity founders. Interviews were carried out at the premises of participating entities, between April 2012 and April 2013, and had an average length of 41 minutes.

Qualitative content analysis (Bardin, 1977; Huberman & Miles, 1994; Schilling, 2006) of transcribed interviews was carried out with the support of the *MAXQDA* software (VERBI, 2012). It involved a continuous and iterative coding process, whereby an initial list of categories was generated and recurrently updated as data was being collected. After several rounds of coding and data processing, a parallel 'layer' of new categories was devised to help with the reconstruction and interpretation of data, and the structuring of findings.

2 Notably Galindo *et al.* (2011).

3 Such as ISCTE-IUL (2010) and Barata (2012).

4 Such as CiencInvest (2010) and DGEEC/MEC (2012).

5 Such as Catarino *et al.* (2007), COMPETE (2009), COTEC (2010) and Saraiva (2011).

6 Such as COTEC (2012) and ShareBiotech (2012).

Preliminary Results

In generic terms, the interviewees showed a highly positive attitude towards innovation networks, which is well in tune with the wider European and global economic contexts: under current international competition conditions (reinforced by the recessive economic climate presently experienced in the country), either knowledge-based entities embark in effort-sharing processes, or it will be, sooner or later, harder for them to compete and survive. Among the more immediate benefits of innovation networks, participants mainly alluded to access to knowledge and pools of competences, information exchange, creativity and inspiration, visibility and reputation, and critical mass build-up.

At the same time, accessible networking opportunities seem to exceed the proper demand for innovation networks, which is (especially in the case of smaller entities) limited by the availability of internal resources (mainly in terms of time and staff). Yet, this excess in supply is not accompanied by a loss in value. The level of enthusiasm is evidently not the same among all participants, and a number of them recognize that some networks can have disappointing outcomes, but, for instance, none of the interviewees made use of pejorative terms while referring to available innovation networks, although an external observer can easily get puzzled, at first encounter, in a labyrinth involving numerous different types of innovation oriented inter-organization collaboration schemes (which participants do not hesitate to dub as *"innovation ecosystems"*). Be them of local, national or international scopes, rather formal or more informal, rather tight or loose, these innovation networks include indeed schemes as diverse as simple webs of personal relationships or entity stakeholders, and the more elaborate consortia, joint initiatives, platforms, business incubators, living labs, poles of competitiveness, clusters etc.

A key issue, therefore, is not as much whether or not to participate in innovation networks, but rather what is the intended or most advantageous type of network (and how to identify and select adequate collaboration schemes), or what is the optimum intensity of participation in networks (bearing in mind, among others, the entities' limited resources). In order to help exploring these emerging issues from the micro point of view, of prime importance is to capture the attitudes, opinions and insights of entities involved in innovation processes, regarding their direct experiences on the ground.

The systematic and iterative computer-assisted content analysis of interview transcripts allowed, in a first stage, to inductively list, define and connect key concepts related to the individual and social factors behind innovation networks. These key themes were subsequently refined and grouped according to their nature: basic prerequisites (referring to pre-existing conditions inherent to the socioeconomic context in which participating entities and informants have evolved) on the one hand, and strategies and means used (related to participants' positioning and interactions) on the other. Thus, 'common background', 'personal relationships',

'trust', 'closeness' ('geographical proximity' and 'like-mindedness'), and 'culture' are all basic prerequisite concepts that emerged from the interviews, while strategies and means used include such relevant concepts as 'recognition', 'empathy', 'networking', 'professionalism', 'formalization', 'synergy', 'serendipity', 'knowledge flows', or 'inspiration'.

After several rounds of coding interview transcripts with the iterative list of concepts, a second stage of content analysis consisted in overlaying data processing by means of a parallel list of new categories[7]. In contrast with the previous concepts, this new layer of categories did not intend to code each and every occurrence in the interview transcripts under analysis, but to spot the most significant ones (a selective hierarchization process allowed by the prolonged immersion in the collected data). It was thus possible to identify professionalism, like-mindedness and trust as three themes which stand out, in the perception of participants, as main critical success factors of innovation networks from the micro point of view. These are presented in the next subsections.

Professionalism Mind-set

Composed of two interrelated qualities (competence and commitment), professionalism, as an existing or aimed-for attitude, is perceived by participants as a main critical success factor for several reasons. To start with, professionalism is closely linked to the ultimate goal of business innovations and innovation networks: to reach society with marketable products or services. Therefore, a successful business innovation network is a network which is entered and dealt with through a common results-oriented mind-set, thus requiring both competence and commitment. Having the market as a goal and a final judge, the collaboration between different entities (and particularly the participation of private enterprises, by nature closer to end customers) can also lead to more adapted products and services and be seen as a quality seal. But professionalism emerges clearly as a theme in which the tensions between idealized and real-world innovation networks are quite noticeable.

The importance of commitment for an innovation network is illustrated in the fact of its being tantamount, in the minds of interviewees, to dynamism and to an assurance of continuity. Innovation processes are long-term ventures, typically requiring several challenging phases of trial and error before the hypothetical first signs of success; therefore, as stressed by one of the participants, under these conditions, *"without commitment, it's very easy for an innovation partner to let go"* (and for related innovation processes to lose momentum). Commitment can be stimulated by the fact of liking one's own activities and area of work (and in taking pride in its successes); hence dedication does not necessarily erode with age or with the loss of ownership and control. It is thus common to find senior researchers and experienced executives as enthusiastic as young eager-to-discover entrepreneurs, or start-up founding partners remaining in-house as administrators after the company's formal integration into a wider structure (often owing to the success of its own innovative products). At the same time, it goes without saying that innovation processes require competences in the form of specialized skills and knowledge, and that the seeking and acquisition of these competences can be facilitated by commitment.

In addition to acquired skills and knowledge, competences relevant for innovation processes also include more innate qualities. Prominent among these is a trait inherent to the Portuguese culture, related to the nationals' aptitude to articulate and integrate diverse specialized languages and technologies, a capacity considered to be both a precious potential source of innovation and a facilitating feature for interpersonal collaborations. Although widely recognized, this cultural trait is not always capitalized upon, some detachment being often necessary to build self-confidence and put this awareness into practice. According to the collected data, such detachment commonly takes the form of academic and work experiences abroad (notably in the United States and the United Kingdom), during which gained soft skills and cultural influences end up being at least as valued as the initially sought technical knowledge.

Also, professionalism's philosophy is generally recognized to be more infused in some specific cases or at the level of intentions than in existing innovation networks as a whole. This deficit is identifiable both by the fact of professionalism being so vehemently put by interviewees as a critical success factor (in a way a testimony of its scarcity) and in the form of overt criticisms. Thus, in the words of a participant, Portugal "*is a country full of excellent ideas, filled with excellent resources, with fantastic talents, but then we all fail at the execution stage*", alluding to the suboptimum work methods and lack of discipline which prevail amid professional interactions (admittedly a more general cultural burden, yet mirrored in innovation networks).

Other criticisms are more specific to innovation networks themselves, and are similarly not as much related to the competence component as they are to commitment. At least in the studied regions, competences seem to be much easier to find than commitment (it is no wonder that Coimbra, for example, is dubbed 'City of knowledge'). In spite of universities being widely recognized as valuable sources of scientific knowledge and technical validation, a certain technological *"amateurism"* can sometimes be found in the academic realm, according to both academics and business executives. In fact, some innovation processes demand high levels of commitment and client orientation from all participants, but these are not always fulfilled by those academics simultaneously involved in different other day-to-day activities and not conditioned by the same market pressures as their business counterparts. Competence itself has also its darker side, which is more likely to materialize as a barrier to innovation networks as of a certain level. According to some participants, the fact of reaching a high level of technical knowledge and skills seems to be accompanied by a reduction in accessibility and the erosion of such soft skills as openness, listening capacity and humility, so essential for the quality and effectiveness of interpersonal collaborations (and the success of innovation networks). In order to pursue specific parts of intended R&D activities, instead of turning to innovation networks, some business executives thus end up looking inwards or formally contracting outside entities against a fee (the remuneration being in that case perceived as a better assurance of commitment).

Although in practice not always easily found in combination, professionalism's two components are indeed closely interrelated. The idealized more optimistic interrelationship can be formulated in the shape of a virtuous circle also involving other key concepts, whereby the existence of competence, when properly recognized (for example, by means of the obtainment

7 The main categories considered in the second analysis stage were: 'envisioned situation' (including aspired positioning), 'expected gains', 'real situation' (including actual positioning), 'actual gains', 'means of network identification/selection', 'critical success factors', and 'barriers'.

of an award, or the captivation of a new major client or strategic partner), leads to higher motivation and to a sense of reputation nurturing, two straightforward sources of commitment; in its turn, commitment facilitates the acquisition of new competences.

In any case, the professionalization of innovation networks is a visible trend in the interviewees' accounts. With the maturation of networks, intuition and reaction in dealing with innovation processes seem to give way to more organized and systematized practices. Substantial amounts of money have been spent at various levels during the last decade to back joint innovation structures[8]; business executives start to recognize the benefits of keeping track of their innovation ventures, of benchmarking, and of implementing best practices[9]; and managers of innovation support institutions do not hesitate to use words such as *"obligation"* when referring to their own interface tasks, which they endeavour to bind to clearly defined and publicized strategic plans. This transformation is still in its early stages and involves the instillation of new mind-sets (including in old institutions, such as the regions' most prominent universities). Of prime importance in this respect is to enhance communication and organized dissemination (and avoid duplication of resources and scattering of results) and to ensure focus and continuity (in other words, commitment), by means of giving innovation processes a human face. While, within entities, the recent appointment of a corporate innovation manager is a common example, when it comes to innovation networks as a whole, the need is still felt for interface pivots: individuals *"with a clearly defined mission"* and *"paid to do the job"*, in the words of a participant.

Although the rise of professionalization potentially creates tensions with such innovation pillars as creativity and serendipity, which ought not to be stifled, professionalization is not to be confused with formalization. Professionalization, as a mind-set, contrasts with formalization (as the introduction of more rigid structures and explicit rules), whose excesses, as identified in the participants' experiences, can come in the shape of *"mere formality"* (whereby to have one's entity name officially listed as a member of a network is not in itself an assurance of positive results), red tape (still prevalent in the subculture of public sector entities, including the regions' main universities), or hierarchy (self-conceit and inaccessibility). The current professionalization trend is actually even simultaneous with the perceptible growing importance of informal structures governing innovation-oriented collaborations. As stated by one of the informants (from an innovation support entity), *"people are shunning formal networks (...), they are less and less willing to pay a share to be part of an association, for they think they can find what they're looking for elsewhere. So I would say we are living in the era of informal networks."*

Like-Mindedness

The analyses above have shown the importance for innovation networks participants to embrace the same results-oriented vision. Yet, in addition to the adoption of common mind-set, language and *modus operandi*, which enhances dialogue and cooperation between diverse professionals from different entities, like-mindedness as an identified critical success factor is also linked, upstream, to more basic prerequisites. These include the sharing of personal traits (notably creativity and openness - to contribute with and to receive ideas), professional preferences or areas of interest. Subjectivity here plays a definite role, as illustrated in the importance given by interviewees to aspects that are rather difficult to characterize and measure (such as the attraction for the atmosphere prevailing within an association, or, inversely, the potential hindering of professional ties and collaborations by matters of temper and sensitivity). It is thus not always easy to express oneself regarding like-mindedness, yet the following interview excerpt (in which one of the participants refers to one of his personal sources of influence regarding innovation and entrepreneurship) is a meaningful attempt of doing so:

> *"(...) it's a person with whom I speak very often, someone with whom, within five seconds, I'm converging towards an idea, towards an attitude, towards anything else. He's a physicist, hence not at all related to my academic background, but he's a person who very quickly speaks the same language as I do; we have the same patterns of reasoning."*

Like-mindedness brings people together and promotes solidarity, and in that sense, is an important cohesion factor for innovation oriented collaborations, standing behind the edification of joint initiatives, thematic networks (virtual or real) or sectorial clusters. In the words and experiences of many interviewees, the inclination is high to partner with individuals who share similar interests and mind-sets (especially after a first successful common venture), whatever their location. Like-mindedness indeed seems to achieve stronger social bonds than geographical proximity, regardless of the existence of a reciprocal relationship between the two concepts.

Geographical proximity certainly acts as an enabler, on a case-by-case basis, for like-mindedness to be potentially discovered and capitalized upon, as shown, for example, by the emerging of a singular culture (not to mention collaborative ideas and even innovation projects) among enterprises jointly located within one of the regions' business incubators[10]. In its turn, like-mindedness sometimes leads to geographical proximity, be it in the form of sporadic gatherings (thematic events targeted at people with a specific academic or professional profile), or in the form of more lasting settings (as in the case of the deliberate sharing of physical premises - co-working structures - by start-up managers and nascent entrepreneurs with similar hopes and needs). These virtuous interactions between like-mindedness and geographical proximity can be said to be among the essential ingredients for the materialization of thriving *"innovation ecosystems"* - see, for example, the flourishing ICT and health sectors orbiting around the University of Coimbra since the 1990s. In addition to being sources of knowledge and validation, higher education institutions, in both their training and research dimensions, are in fact privileged arenas for the detection of common interests, visions and values (notably as regards the entrepreneurial spirit). Most of the studied start-ups, for instance, were thus founded by former classmates or former research colleagues, being subsequently often supplied with new staff originating from the same establishment.

As regards established innovation networks, whereas the ideal is perceived as a synergetic

8 For example, Inov C, a four-year 48 million euro strategic programme targeted at the Centre region, initiated in 2010 and led by the University of Coimbra (Inov C, 2011).

9 Notably inspired by the Portuguese innovation management standard NP 4457 (IPQ, 2007).

10 For example, IPN in Coimbra, Madan Parque in Lisbon and UPTEC in Porto.

agglomeration of entities sharing goals, commitment, risks and results (in case of success, in the shape of innovative products or services), many informants alerted to the lack of a shared vision as an important barrier to effective interpersonal relationships. In the identified cases, this lack of a shared vision is caused by such features as isolation, short-term vision or status, and is commonly mirrored, at the entities' level, in a lack of strategic alignment. Thus, according to one of the interviewees (the CTO of a firm that plays a coordination role within one of the Portuguese poles of competitiveness), *"many partners perceive innovation networks as a mere means of seeking funding. When this happens, the ensuing result comes in the shape of individualized goals, not of a shared aim."* While referring to available financing opportunities (notably in the framework of the European structural funds) and to how his firm has usually been approached in this regard by research institutions, another participant complements by complaining that *"it's not always really positive (...), for moves are made because money is available, whereas it should be the other way round: first we have some ideas, then we look for ways how to materialize them."*

The lack of a shared vision can likewise originate in the cultural divide between the business and the academic realms, reflected in their marked differences in terms of adopted productivity indicators (sold products *vs.* published scientific papers) and deadlines (tight *vs.* loose), but also in terms of risk tolerance degrees (high *vs.* low). While these differences can admittedly be more universally related to professional esprit de corps than specific to the Portuguese case, they tend to be considered by some informants as more patent in Portugal (and other southern European countries) in comparison with northern Europe and especially northern America. Reacting to Portuguese academics' excessive risk aversion and fear of putting their reputation at stake, one of the interviewees thus caricatures: *"What they really prefer to do is technology push, and to say: 'I have developed this; won't you find a market for it?'"*

Yet, one should beware not to associate too narrowly innovation networks' results to marketable innovative products and services. Participants themselves usually stress that innovation is not an easy undertaking, but a funnel-like process, with uncertain outcomes, requiring significant amounts of time and efforts. While referring to the various joint initiatives in which his firm participates at the European level, one of them also explicitly recognizes that the fact of not promptly achieving tangible innovations does not mean that other common gains are not obtained, even if indirect in nature (notably, as in his particular case, the fact of getting in touch with other realities, perceived as a potential source of inspiration and a contribution to enhance mutual understanding and strengthen economic integration). Also, much like in the case of the possible tensions related to the rise of professionalism (shown in the previous subsection), the general consensus on the power of alignment within innovation networks should not overshadow the latent richness that can originate from dissimilarities, and how to conciliate these poles is certainly an issue that deserves further attention.

Trust Mind-set

As a sense of confidence and faith governing interpersonal relationships, trust is considered by many informants as a critical asset of any innovation network. When properly consolidated among a network's entities and professionals, trust (together with the mutual recognition of competences) can bring about significant efficiency gains (in particular, savings of time and resources), to the common benefit of all participants. Trust building is based on both information and experience, and thus can be stimulated by such important aspects as common background, personal relationships, closeness or professionalism. Recurrently meeting one's commitments and demonstrating competences, for example, help to create and gradually consolidate the reputation of individuals (and whole entities), allowing relationships to perpetuate and networks to gain in cohesion.

However, the participation of professionals and their entities in innovation networks and, ultimately, the end-results of these have, in some cases, been hampered by lack of trust or lack of trust-based relationships. Trust's commonly referred-to foes are the disregard for established common objectives (the pursuing of parallel or *"hidden"* agendas), the breach of the confidentiality commitment and the violation of intellectual property rights (the *"theft"* of ideas). But lack of trust is also attributable to more indirect issues, such as the perpetuation of mutual prejudices between rival entities (for instance, higher education establishments competing for a better position in national rankings) or between distinct communities (notably academics *vs.* business executives); another indirect issue is the repercussion at the micro and meso levels of image deficits at the macro level (as is the case of particular local industries not recognized to have any relative weight as seen from abroad, or even the case of Portugal as a whole amidst the country's current economic downturn).

Important to mention is that each of these barriers to trust can be either real (rooted in identifiable events) or merely feared (based on more or less objective conceptualizations). Yet, the (potentially significant) consequences ought to be similar in both cases, as expressively exemplified by one of the informants: *"we are always fearful of something being, let's say, stolen from us; and time and again, this doesn't happen, this fear is not necessarily justified. So we sometimes end up shunning gains because of our fear of losing something."* Although this equation is certainly not an easy one to solve (as it shows how tenuous the borderline is between cooperation and competition), recognizing it in such a clear way is likely to represent an important step for the changing of attitude (which, according to this particular informant, has already been initiated in the case of his firm).

Many mechanisms for the reduction of uncertainties (and hence the enhancement of trust) within innovation networks were, explicitly or implicitly, referred to by informants. Much more than being formalized around intellectual property rights and non-disclosure agreements (except, perhaps, in the case of sensitive sectors, such as health or aerospace engineering), these mechanisms usually put emphasis on soft measures, for which the need for a stronger interface role of innovation support entities is still felt. Examples include the creation and maintenance of arenas for the dialogue among participating entities and professionals, the identification and highlighting of complementarities among partners and potential partners (helping to deter rivalries), or the monitoring of the networks' activities and results (against participants' expectations).

Yet, trust does not always have to be rationally constructed (founded on tangible justifications), for risk is also a central ingredient of innovation processes and of the rewarding businesses that potentially stem from these, a fact that informants seem to be well aware of. Openness and new 'untested' professional relationships are indeed also latent sources of creativity and richness. As put by one of the interviewees (the CEO of a firm) regarding relationships within innovation

networks, of utmost importance is *"generosity, in the sense of taking some risks, of jointly investing some money and some efforts, even without having a clear idea about end results"*; or, as noted by another one (the head of an innovation support entity), the key issue in dealing with innovation networks *"is to have a positive attitude."* Innovation being hardly possible without taking risks, *network innovation* thus also stands out as a way of sharing and hence reducing risks.

Conclusion

The current work sought to understand the softer dimensions which constitute the building blocks of innovation networks. In particular, it addressed the individual and social aspects that bond organizations in such networks. Based on interview data collected from 45 entities involved in various innovation networks in three regions in Portugal, the findings revealed that there are three key dimensions at the micro level of analysis which contribute to understand how organization networks emerge and develop. These dimensions constitute the main theoretical contributions of the current research to the emerging field of innovation networks.

The first dimension, professionalism, encompasses two aspects: competence and commitment. Professionalism as a mind-set reflects a strong wish to become more market-oriented and an effort to become successful in delivering products or services which add value to customers. The competence aspect is something which partners truly involved in networks expect one from each other, and something that at the same time serves as a unifying spirit. This spirit allows partners to focus their efforts on the marketable products and services. The commitment aspect is critical to continuously invest in innovation activity, which is recognizably a medium- to long-term endeavour. Without commitment and perseverance in the network itself and in its ongoing innovation flows, collaboration between partners would be harder to achieve, negatively affecting the network's structure, functioning and, ultimately, performance.

The second critical dimension of individual and social linkages in innovation networks, like-mindedness, quite powerfully helps explain, for example, why people collaborate in a network whose entities are geographically distant from each other. Geographical proximity, a key factor in the traditional cluster literature, seems to be less relevant in the presence of like-mindedness. In fact, as the current research has shown, like-mindedness can act as a triggering element for geographical proximity; in other words, owing to a constructive like-mindedness state, partners reinforce their physical contacts, thus turning the virtual into the real.

The third dimension, trust, refers to both a result of collaboration efforts and a powerful facilitating factor for new partnerships within an innovation network. If properly built and maintained, it allows network participants to embark in joint business ventures aimed at longer-term horizons, fraught with higher uncertainties but also heralding higher outcome prospects. Formalized partnerships may still play a role in such common ventures, but the more informal and less tangible trust mind-set seems to play a central role in networks and networking in the country.

The findings in this study corroborate other works which investigated relationships within innovation networks. Noteworthy amongst these rare works is that of Rampersad *et al.* (2010). Based on an empirical research in R&D networks, these authors found that trust has a positive influence on network coordination and harmony, while no effect was found with regard to commitment. Yet, commitment and trust in their study were measured with relatively simple scales (composed of four items and seven items, respectively), whereas in the current research, the studied concepts were firmly rooted in the interview data and thus constitute much more complex constructs. This calls attention to the importance of qualitative approaches, like the one followed in the present research, to enhance and develop theory in such a novel topic in innovation. These can be coupled with quantitative approaches such as the one used by Rampersad *et al.* (2010), or even with other more specific techniques - such as, for example, social network analysis (Zaheer *et al.*, 2010).

Practical implications are of utmost importance. Collaboration seems to be an essential constituent for innovation networks and regional innovation systems alike (Powell & Grodal, 2006; Nickerson *et al.*, 2007; Adner & Kapoor, 2010; Noronha Vaz *et al.*, 2013). How such collaboration is created and developed is, nevertheless, a relatively unknown matter in the literature, dominated by technical and economic disciplines. The current research has pinpointed some of the psychological, sociological and cultural foundations that embody collaboration. While highlighting how innovation networks are already part of the business landscape in the three studied Portuguese regions, it also extended the knowledge in the field by showing that, behind such complex innovation webs, there are individual and social phenomena which are vital for their emergence and success. Future research should expand on the dimensions and subdimensions identified and described in this chapter, in order to further develop them both in theoretical and practical terms.

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Conclusion

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A first striking characteristic of this book is the sheer variety of angles and lenses about innovation, adopted in the various texts shown in the previous pages. One reason for this variety is certainly related with the diverse authors' backgrounds, which range from Economics to Psychology, from Management to Geography, and from Sociology to Information and Technology Sciences. These distinct backgrounds bring a rich and important contribution to the understanding of a phenomenon which, as pinpointed by several scholars and policy makers alike, is key to economic and social development and progress.

But the diversity of approaches is also due to the complexity inherent to innovation. In fact, innovation has been the subject of much research since Schumpeter's earlier formulation, and one key element that stands out after all these decades is that innovation is a phenomenon which crosses several levels of analysis, and therefore, if one wants to understand and manage it, then one needs to try to take such levels into account.

Following this line, in the introductory chapter of this book, Noronha called attention to one of the most recent perspectives through which innovation can be addressed: the regional level of analysis, and in particular the networks in which knowledge, creativity, and innovation activities unfold. Noronha traces the origins of such perspective to the works of Fischer and Johansson, Geenhuizen and Nijkamp, and Cooke and colleagues, amongst others, all published in the 1990s.

This book mostly addressed the regional level in innovation research, in which case a key question is distance and proximity across all actors involved in creative and innovation activities. One of the current leading authorities in this matter, Nijkamp, establishes in chapter 1 a parallel between Newton's gravitational principle and Tobler's First Law in Geography, which states that *everything is related to everything else, but near things are more related than distant things*. Nijkamp takes a closer look at the debate over whether or not, in the new digital economy, distance matters in innovation networks. The author concludes that, despite the fact that technology knocks down barriers due to distance, proximity is still paramount in regional innovation systems, thus confirming Tobler's law. The discussion is much centred around whether there is or there is not a case for taking proximity as a factor in modern electronic economies, but as briefly put in the text, a complex system such as a regional innovation network is the result both of individual-level action, and of exogenous physical forces. In other words, physical distance might impose specific conditions with regards to networks' initial stages and development, but it also triggers individuals to take action to deal with such conditions.

The next chapter, by Pinto, compares levels of efficiency in knowledge production across innovation systems in Europe, and concludes that the emergent Portuguese system is still some long way to go to reach the realms of its European counterparts. However, some important behavioural changes have been taking place in the last recent years, which are identified by Pinto: university-industry linkages, numbers of academic patenting, cooperative R&D projects or the creation of spin-offs. The author further elaborates on each of these components, which are likely to stimulate research in the forthcoming years.

Chapter 3, written by Xavier and Noronha, goes a step further, to show a comprehensive account of the most important Portuguese regional innovation trends. The methodological approach used in this empirical chapter identifies key regional spatial innovation patterns, and it therefore makes a contribution to our common understanding of the national innovation case.

Chapters 2 and 3 address regional innovation systems from *above*, in the sense that they look at innovation from a descriptive point of view, thus allowing the reader to map out the country's current positioning as far as innovation networks are concerned. The next chapter, by Pinto, Noronha, and Faustino, addressed the same topic from *within*, since it delves into the very core of innovation networks. The authors analyse the determinants of innovation networks, and found in their empirical work that advanced firms and universities are the actors more prone to embark in innovation activities. Likewise, actors using external technologies and promoting knowledge are also more keen to innovate.

These dynamical forces operating in networks certainly help explaining the centrality of knowledge creation and dissemination across networks, which is the topic of interest in chapter 5, by Vaz, Noronha and Nijkamp. Similar to some of the previous chapters, Vaz and colleagues use empirical data at a more aggregated level of analysis, to identify and establish how strong the links for innovation in Portugal are. Moreover, this work uncovers the level of concentration and dispersion of network linkages, both internally and with external entities, thus showing that regional innovation exists in a wider frame, which encompasses national and supranational systems.

Chapter 6 offers yet another view of the topic. Most methodological (and theoretical!) approaches studying innovation are usually centred on medium and large organizations, and on high-technology and knowledge-intensive companies. But what about rural and non-technological companies? Is innovation taking place in these settings? How is it taking place? Are these entities also embarking in networks of innovation? These were some of the questions addressed by Madureira, Gamito, Ferreira and Oliveira in chapter 6. The authors used questionnaire data collected in several sectors, such as the agriculture and agro-industry, and found interesting patterns, such as the importance of non-technological innovation and the merging of different categories of innovation (product, marketing and organizational). Some other results include the identification of four groups of innovative firms, of which only one fits existing research frameworks.

The same team presents in chapter 7 a methodology to identify and measure good innovation practices in rural areas. Gamito and colleagues have been carrying out research in this field, and their project is due to produce a manual of good practices which can help innovation activities in rural areas. What is perhaps more significant in these authors' research is the fact that innovation is neither an elitist activity, nor it is limited to high-technological economic sectors. In fact, it is a widespread human activity, that can be found both in a high-tech firm and in a fisherman vessel. These distinct realities, however, cannot or should not be studied with the same methodological and theoretical instruments, since they hold different attributes that need to be captured with equally distinct approaches. Ultimately, our very concept of innovation needs to change, so does our way to conduct research in the field. We need to *innovate how to research innovation*, in order to include innovative activities that take place in virtually all spheres of life.

This is unsurprisingly the topic of chapter 8, by Monteiro, Noronha and Neto. Portugal is a country with a vast maritime region, which includes the Mediterranean Sea and the Atlantic Ocean. This long-standing relationship with the seas has steered the country to build some of its industries around or dependent on the maritime economy. Like agriculture and other rural sectors, however, innovation in maritime industries has somehow been understudied in Portugal. Monteiro and collaborators contribute to mitigate this scarceness, since their comparative analysis with other European maritime clusters puts forward a set of arguments for the reconceptualization of Porter's Diamond framework for diagnosing the competitiveness of this type of clusters.

Maldonado and Noronha, in chapter 9, again call attention to issues and challenges outside the innovation research mainstream. Most existing knowledge in the area has been produced with data collected in large urban centres, and has largely neglected the reality in smaller cities and peripheral regions. Tourism in the Algarve region, in the south of Portugal, is the main engine of its regional economy, with a large percentage of existing companies developing their activities on or around tourism. Cooperation and collaboration across entities involved in tourism is on the increase, since companies are gradually acknowledging the importance of establishing partnerships to foster innovation. Thus, this chapter explores in a timely manner the potential for knowledge spillovers and for the emergence of a tourism-based regional innovation system in the Algarve.

In the last chapter, Hobeica, Gomes and Bernardo used a qualitative, grounded-theory approach, to elicit the themes and structural determinants underlying innovation networks. The authors interviewed key informants from 45 units involved in innovation networks in three Portuguese regions, and found that there is an individual – and not always self-recognized – understanding lying beneath these collective entities, characterized by three tenets: professionalism mind-set, like-mindedness, and trust mind-set. The significance of this chapter lies in the fact that it endeavours to identify the cultural and human dimensions behind innovation networks.

Innovation is a fascinating area. It is the science and art of delivering newness out of the oldness. It includes the inputs and the outputs involved in deliberate change processes, but it also includes those processes themselves. Creativity and knowledge are two essential ingredients for innovation, which are present in individuals, groups, organizations, and also in inter-organizational entities, such as industries, regions, and nations. This book focused on the regional innovation level, but as shown, its chapters offer a variety of ways to address the topic.

The future of innovation research, at a regional level of analysis, is unfolding at a rapid pace. Traditionally authors have looked at fast-changing industries in large urban centres and cities; many of our current models and theories in the innovation area have been built with these important anchors in mind. However, as the chapters of this book have shown, there is much to be learned if we change our focus, from big cities, to small cities; from central regions, to peripheral regions; and from fast-changing industries and sectors, to slow- and medium-changing industries and sectors. If while reading this book, you found that innovation is a pervasive and ubiquitous activity, that can be studied and understood in whichever activities humans get involved in, then we have achieved our main objective.

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