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## **THE INNOVATION SYSTEMS AND THE REGIONAL PERSPECTIVE. COMPARATIVE ANALYSIS TO NUTS II OF THE IBERIAN PENINSULA**

**Summary.** The globalization process and the opening of economies have made evident the aggravation of territorial inequalities, reducing the national plan as spatial unit of reference and inducing the origin of new strategic territories – regions and cities. Thus, it is more and more recognized that these spatial scales have become important arenas of development and the sub-national levels have translating the most appropriate geographical units for the emergency and assertion of territorial competitiveness. Not only nations and companies but also regions/cities are more and more in direct competition amongst themselves, seeking their main sources of advantages. In this context, a factor that assumes a prominent place is the innovation. The territories, regions/cities and localities will be more or less competitive consonant its behaviour face to the innovation. Taking into considerations these observations, we intend to reflect on the paper that the regional and local innovation systems carry out on the creation and diffusion of knowledge, on the innovation and on the improvement of the regions competitiveness and also present a comparative analysis of the Iberian Peninsula regions (NUTS II), in terms of innovation, with basis on the Regional European Innovation Scoreboard (2006 RIS).

**Keywords:** Regional Innovation systems, Innovation, Competitiveness

## SYSTEMY INNOWACJI W PERSPEKTYWIE REGIONALNEJ. ANALIZA PORÓWNAWCZA NUTS II PÓŁWYSPU IBERYJSKIEGO

**Streszczenie.** Proces globalizacji i otwarcie gospodarek uwydatniły w sposób oczywisty terytorialne nierówności, redukując obszar kraju, jako punkt odniesienia oraz wprowadzając nowe strategiczne obszary – regiony i miasta. Coraz bardziej oczywiste jest, iż ta skala przestrzenna stała się ważną płaszczyzną rozwoju, a na szczeblu ponadnarodowym dokonano odpowiedniej identyfikacji obszarów geograficznych, w celu zapewnienia terytorialnej konkurencyjności. Nie tylko narody i przedsiębiorstwa, ale również regiony/miasta w coraz większym stopniu konkurują ze sobą, poszukując głównych źródeł korzyści. W tym kontekście znaczącym czynnikiem są innowacje. Tereny, regiony/miasta i okolice będą mniej lub bardziej konkurencyjne, dostosowując się pod względem innowacyjności. Uwzględniając te obserwacje, opierając się na innowacyjności, poprawie konkurencyjności regionów oraz posługując się analizą porównawczą regionów Półwyspu Iberyjskiego (NUTS II), na podstawie Europejskiej Regionalnej Tablicy Innowacji (RIS 2006), zamierzamy wykazać, iż regionalne i lokalne systemy innowacji przyczyniają się do kreacji i dyfuzji wiedzy.

**Słowa kluczowe:** Regionalny System Innowacji, Innowacja, Konkurencyjność

### 1. Introduction

In the growing context of globalization, the increase in territorial competitiveness demands a greater allocation of specific regional resources. Founded on the concept of territorial competitiveness through the investment of new productive combinations of resources to assure the territory incomparable attractiveness, the purpose of this paper is to analyze the importance of the Regional Innovation Systems as a strategy to enlarge the territorial base of competitiveness in a given region. Based on the *2006 European Regional Innovation Scoreboard (2006 RIS)*, in addition to data from the Portuguese and Spanish National Institutes of Statistic, we analyze the innovative behaviours of 22 NUTS II in Portugal and Spain. After a literature review, we present the hypotheses and methodologies used in this study and the results are analyzed and discussed.

### 2. Literature Review

Innovation is a complex concept and its large scope includes, in addition to new processes and technologies, also products, services, organization, management and marketing.

Innovation is a key factor in competitiveness and is recognized as a differential factor that has a clear impact in the success of regions when dealing with a highly globalized context.

The debate on the competitiveness of national and regional economies vis a vis globalization that brought to the surface the idea of National Innovation Systems, which was then disseminated by Freeman (1987), Nelson and Rosenberg (1993), Lundvall (1992), Edquist (1997) e Chaminade and Vang (2006), among others.

These authors discuss the base of innovation at national level, neglected the local and regional efforts as an indispensable element to the production of local regional innovations. However, this point requires the definition of Industrial, Scientific and Technological policies to articulate the various actors and institutions involved in the processes of production and innovation.

For those who defend the National Innovation Systems, the coordination of the actors involved is a key element to assure the success of the innovation process. This success depends more and more on coordination and information, specialized human resources, skills, infra-structure supporting the Research and Development (R&D), and favorable conditions to assure that the productive sector will make use of the knowledge produced by the R&D institutions and by the universities, which requires a proactive dynamic of the local governance systems.

In order to specify and adapt the analysis to local conditions, some authors adopted the Regional Innovation Systems approach (Cooke et al., 1997), or Local Innovation Systems (Courlet and Pecqueur, 1992); Charbit et al. (1991), in an attempt to give innovation a more regional tone and to integrate it to the local society.

The perception that regional factors may influence a company's innovative capacity led to the interest in the analysis of innovation in a regional scope. Regional differences in innovation activities may be substantial, and the identification of the main characteristics and factors that promote the innovation process and the development of specific sectors in the regional scope may help to understand the innovation process and the development of innovation policies.

The Regional Innovation Systems may develop in parallel to the National Innovation Systems. The combined presence of dynamic companies, an industrial agglomeration, risk capital and a strong business environment, in addition to local institutes of research may influence the innovation performance of a region. This may attract more public research institutes, competitors, consumers and suppliers. The infrastructure also exerts an important role in this process.

The concept of Regional Innovation Systems is relatively recent. Only during the 90's this idea began to gain the attention of researches and policy makers, through the works developed

by, among others, Cooke et al. (1997), Cooke (2001), Asheim et al (2003), Isaksen, (2001), Cooke and Laurentis (2002), Asheim and Isaksen (1997), Doloreux (2003), Gertler (2003) Asheim and Coenen (2006), Doloreux and Parto (2005), Tödting and Trippel (2005), Pinto and Guerreiro (2006) e Trippel (2006), which highlighted the regional scale as the ideal geographical measure to foment sustainable regional innovation.

The rising importance of these new territorial scales is attributed by the necessity to reduce the regional unbalances and to bring the policy makers to these territories. This approximation is vital in order to create, format, and adapt the innovation policies to the specificities of each region, thus increasing its attractiveness and competitiveness.

Thus, when compared to the level of complexity of the national scale, the Regional Innovation Systems present themselves as more viable options, due to the greater homogeneity within the region and the proximity of the various intervening agents. It is possible thus a greater rate of application of the guidelines and a greater possibility of achieving the objective of stimulate innovation dynamics, without forgetting that the variations in terms of R&D and innovation are greater among regions than among countries (Pinto and Guerreiro, 2006).

Therefore the architecture of Regional Innovation Systems is complex and reflects a systemic analysis where it must focus conjunctively four subsystems that include the following dimensions:

- a) Institutional Dimension, which includes all the institutional resources of the region, namely, the enterprises, the technological centers, the institutions of support and assistance to the economic activity, the R&D's and the universities.
- b) Territorial Dimension, encompassing all the territorial resources of the region, such as: the natural and human resources, the architectural patrimony and the location factors.
- c) Relational Dimension, where we find the formal and/or informal interactions and networks of cooperation and collaboration intra and inter territorial concerning institutions, markets and knowledge.
- d) Intangible Dimension, which finds in each region its culture, its implicit and explicit knowledge and its value systems.

### **Institutional Dimension**

The importance of institutions in the process of innovation is highlighted by Edquist (1997). Doloreux and Bitard (2005) define Regional Innovation Systems as a set of actors and organizations (enterprises, universities, R&D centers, etc.), which are systematically involved in the innovation and interactive learning through common institutional practices. Thus, each region's specific institutional context plays an important role in the creation of a Regional

Innovation Systems (Trippel, 2006) and the interaction between the regional actors, both public and private, is fundamental to promote dynamics of innovation and to improve the regional competitiveness.

### **Territorial Dimension**

To obtain a successful Regional Innovation Systems it is necessary that each region be competitive and attractive, and to be able to generate high rates of income and employment. The territorial dimension is related to a region's capacity to create a comparative advantage and external networks in order to raise its competitiveness. The interactions established territorially assume an important role in the development of innovation processes, because they highlight the role of the external economies, of the learning synergies and the relationships between several agents present in a region (Silva, 2007:1711).

The region's natural and human resources endowment, in terms of quantity and quality, its architectonic patrimony and its location allow for built and acquired advantages in terms of competitiveness and act as factors of differentiation and attractiveness, influencing the regional innovation dynamic.

### **Relational Dimension**

The interaction, the relationship and the cooperation networks, formal or informal, between the actors involved in the innovation process is fundamental to achieve high levels of innovation and competitiveness (Lundvall, 1992; Nelson 1993; OECD, 1997; Edquist, 1997; Guimarães, 1998). The cooperation and collaboration among the actors involved in the innovation process within a region and between different regions is vital to facilitate the continuous flux of knowledge and of human and material resources.

The partnerships and cooperation networks between the companies, clients, suppliers and competitors are also crucial to share new knowledge, to increase the level of innovation and to reduce the level of uncertainty inherent to the innovation process (Camagni, 1991; Planque, 1991; Maillat et al., 1993; Lundvall, 1992; Edquist, 1997).

### **Intangible Dimension**

Each region differs from others in some requisite, such as the qualification of the work force, the level of education, the existence of R&D centers, the diffusion of knowledge, and the external factors (Silva, 2007). Some of these requisites are specific to each region and difficult to transfer, thus they become a strong advantage to the region (Porter, 1990; Tödting, 1992; Malecki, 1997; Simmie, 1997; Autio, 1998).

Therefore, access to knowledge is a key element, not only explicit or codified knowledge but also implicit or tacit knowledge (Polanyi, 1966). The exchange and transference of the tacit knowledge presupposes an effect of collective learning through social interaction that is localized and rooted in specific organizations and environments (Camagni, 1991; Johnson and Lundvall, 2001), which requires individual mobility and face to face contact (Kaufmann and Tödtling, 2001). The Regional Innovation Systems provide the adequate spatial level because they facilitate these contacts through the spatial proximity between the various interacting actors. It is also at regional level that we find a greater continuity and homogeneity of value systems and culture, which helps bring about a greater identification in the creation and development of the innovation process.

Although it was argued in the architecture of the Regional Innovation Systems the inclusion of the anterior dimensions, it is true that these systems is situated in a well-defined administrative and territorial limit (the region), which may bring some limitations, since it is more and more evident the existence of knowledge networks that integrate various contexts, that is, a new reality that is often a-territorialized (Pinto and Guerreiro, 2006).

It is also important to note that no single Regional Innovation Systems is auto-sufficient and that its success depends on how coordinated its functioning is to the superior networks of knowledge, since they are integrated in the national and global economies (Cooke, 1998). However, it is reserved to the Regional Innovation Systems the ability to create complementarities between the private and public sectors, thus assuming a larger and larger role in the construction of regional advantages (Asheim et al., 2006).

### **3. Hypotheses**

With globalization and the opening of national markets to the exterior we begin to see a new unit of spatial measure in which territories and regions play an important role. The innovation dynamics of the territories depend on their capacity to create, disseminate and reproduce knowledge in the creation of value of products and services offered in the market. These dynamics are favored by the concentration of knowledge-based, highly technological activities that employ qualified human resources in the Science and Technology domain, such as the high-tech manufacturing and high-tech services.

In this process, the regional performance is facilitated by the processes of knowledge generation and the regional growth is associated with high levels of R&D (Brettell, 2005), which is why it is essential to promote R&D activities (Wei; Li and Wu, 2007) and the cooperation among public and private investments.

Based on these theoretical foundations we defined the first hypothesis in the following terms:

**H1: The institutional dimension influences the innovation capacity of a region.**

Knowledge and innovation are indispensable elements in competitive performance, greatly contributing to the economic growth of a country or a region. The regions wishing to maintain a position of sustainable competitiveness must invest on immaterial resources, where knowledge appears as a valuable strategic resource (Senge, 1990; Garvin, 1993; Drucker, 1995; Davenport and Prusak, 1998; Nonaka et al., 2000) and a great innovation input, this being the key to territorial competitiveness (CE, 2004).

In this context, it is vital those who work with specialized knowledge and useful information transforming these into new knowledge and information consequential to the evolution of the economy, of the society, or of the knowledge (Alves, 2002). These workers represent the work force in the developed countries (Drucker, 1999).

Thus, the qualified individuals, the continuous accumulation of skills, the lifelong learning and the continuous transmission of knowledge becomes decisive to activate the innovation process, improving the productivity. "Firms employing highly skilled workers are both productive and innovative" (Brettell, 2005). Also the creation of patents is considered one of the main indicators of innovation (OECD, 1992) and of explicit knowledge.

Considering that the development of intellectual activity of the qualified human resources, in conjunction to an environment that stimulates intensive learning processes may combine previous knowledge and explore new possibilities (Laranja, 2001), stimulate innovation and creativity (Davenport and Prusak, 1998; PNUD, 2001) we defined the second hypothesis in the following terms:

**H2: The regional dynamic of innovation vary according to the intangible dimension.**

An innovative milieu influences the R&D activity, employment, the productivity, the GDP (Gross Domestic Product), and the commerce. Several studies show that innovation and employment are related (Van reenen, 1997; Hauschildt, 1999; Spiezia and Vivarelli, 2000; Zwick, 2002) and that dynamic of productivity and the development of knowledge and innovation encourage competition, cohesion (Brettell, 2005), and competitiveness (Porter, 1990).

Other studies stress the importance of the territorial dimension of the R&D levels in innovation (ESPON 2004; DG REGIO 2004), insofar as the productivity is related to companies with innovative vocation, responsible for high rates of R&D and of industrial property rights (Andrez, 2002). Some authors defend the idea that the characteristics of a

given region, it's R&D, the flux of information and sharing of knowledge of new opportunities, and the international connections are related to the variety of exports and are fundamental to the region's innovation performance (Tindemans, 2007; Andersson and Johansson, 2007). With this, the region may become an ideal space for the generation of new ideas and innovations.

Based on these theoretical foundations and the interdependence between the aforementioned elements we defined the third hypothesis in the following terms:

**H3: The territorial dimension influences the innovation capacity of a region**

#### 4. Methodology and Results

The main data source utilized to analyze the NUTS II of the Iberian Peninsula in terms of innovation was the *2006 European Regional Innovation Scoreboard (2006 RIS)*, which includes 208 regions in 25 countries (EU25), with additional data taken from the Portuguese and the Spanish National Institutes of Statistics. The analysis concerns 22 NUTS II in Portugal and Spain, 5 of which were Portuguese (Lisbon, Centro, Norte, Algarve e Alentejo) and 17 were Spanish (Comunidad de Madrid, Pais Vasco, Comunidad Foral de Navarra, Cataluña, Aragón, Comunidade Valenciana, Castilla y León, Galicia, Región de Murcia, Cantábria, Principado de Asturias, Andalucía, La Rioja, Canarias, Extremadura, Castilla-la Mancha e Illes Balears).

As a starting point of the analysis we made use the multivariate statistics: cluster analysis in order to group the regions (NUTS II) according to its results of the Regional European Summary Innovation Index: 2006RIS. This methodology of cluster analysis proved adequate and the objective realization variable used to classify the regions revealed a contribution with statistical significance for the found classification, as we can verify through the results of the ANOVA analysis, constant (table 1).

Table 1

Análise ANOVA

	Cluster		Error		F	Sig.
	Mean square	df	Mean square	df		
RIS	,156	2	,003	19	48,858	,000

The cluster analysis allowed the identification of three groups of regions in what concerns innovation (RIS). The first group presents the best results in innovation (RIS), those that



include the most innovative regions, and includes only two regions: Comunidad de Madrid and the Pais Vasco. A second group, where the results in terms of innovation are very modest, formed by the less innovative regions (12): Región de Murcia, Cantabria, Principado de Asturias, Andalucía, La Rioja, Canarias, Norte, Algarve, Extremadura, Castilla-la Mancha, Illes Balears e Alentejo. A third group presents a medium level of innovation, and includes 8 regions: Comunidad Foral de Navarra, Cataluña, Aragón, Lisboa, Comunidad Valencian, Castilla y León, Galicia e Centro (table 2 and 3).

Table 2

## Final Clusters

<b>Final Cluster Centers</b>			
	Cluster 1	Cluster 2	Cluster 3
	(n = 2)	(n = 12)	(n = 8)
RIS	0,58	0,22	0,40

Table 3

## NUTS II of Iberian Peninsula by Cluster

<b>Cluster 1</b>	<b>Cluster 2</b>	<b>Cluster 3</b>
Comunidad de Madrid	Región de Murcia	Comunidad Foral de Navarra
Pais Vasco	Cantabria	Cataluña
	Principado de Asturias	Aragón
	Andalucía	Lisboa
	La Rioja	Comunidad Valenciana
	Canarias	Castilla y León
	Norte	Galicia
	Algarve	Centro
	Extremadura	
	Castilla-la Mancha	
	Illes Balears	
	Alentejo	

We proceeded the analysis using the test of independence Chi-squared, to estimate the influence of variables of the institutional dimension and that are related to the capacity of promoting continuous innovation and developing new products, over the results obtained in the regions in terms of innovation. The variables tested were the total number of people employed in medium-high and high technology in the manufacturing sector (MED\_HI\_TECH\_MANUFACTURING), the number of people employed in high technology in the service sector (HI\_TECH\_SERVICES), Public R&D expenditures (% of GDP) (PUBLIC\_RD) and Business expenditures on R&D (% of GDP) (BUSINESS\_RD).

Table 4

## Results from the Chi-square Test

	<b>X<sup>2</sup></b>	<b>Prob.</b>	<b>Observações</b>
MED_HI_TECH_MANUFACTURING <sup>1</sup>	30,250	0,066	X
HI_TECH_SERVICES	25,230	0,032	V
PUBLIC_RD	22,115	0,076	X
BUSINESS_RD	27,958	0,063	X

The results of this test allow us to deduce that, in relative terms, the total number of people employed in high-tech services, revealed to be a relevant factor in terms of the results obtained in innovation. However the number of people employed in the medium-high and high technology in the manufacturing sector, the Public R&D expenditures and the Business expenditures on R&D, did not influence the results obtained in the region's innovation capacity.

The interpretation of the way the relationship is established between the explicative variable and the dependent variable can be observed, verifying the differences of the average of the groups to distinguish the unique characteristics of each cluster.

Therefore we can observe that, according to the aspects related to the intangible dimension the differences between the groups are meaningful. Group 1 differs from groups 2 and 3, for having the greater levels and efforts in what relates to the percentage of people with a degree in S&T and people's involvement in continuing their education throughout their lives. In what concerns the requests for legal protection of ideas and innovative projects in the form of patents, groups 1 and 3 present better averages than Group 2.

Table 5

Differences of Averages between Groups  
The intangible dimension and its regional dynamic of innovation

	<b>Sum of Squares</b>	<b>df</b>	<b>Mean Square</b>	<b>F</b>
KNOWLEDGE_WORKERS <sup>2</sup>	0,009	2	0,004	1 > 3 > 2
LIFE_LONG_LEARNING	0,002	2	0,001	1 > 3,2
PATENTS	0,006	2	0,003	1,3 > 2

<sup>1</sup> MED\_HI\_TECH\_MANUFACTURING: Employment in medium-high and high-tech manufacturing (% of total workforce). HI\_TECH\_SERVICES: Employment in high-tech services (% of total workforce). PUBLIC\_RD: Public R&D expenditures (GERD – BERD) (% of GDP). BUSINESS\_RD: Business expenditures on R&D (BERD) (% of GDP).

<sup>2</sup> KNOWLEDGE\_WORKERS: Human Resources in Science and Technology – Core (% of population) (Number of persons who have successfully completed education at the third level in a S&T field of study and who are employed in a S&T occupation). LIFE\_LONG\_LEARNING: Participation in life-long learning (% of 25 – 64 years age class). PATENTS: EPO patent applications (per million population).

In relation to the influence of the defined variables concerning the region's size and its dynamic of production and internationalization over the region's innovative attitude, we verified that the variable of greater significance to the formation of the groups are the GDP (Gross Domestic Product prices of market) the GDP per capita, the productivity, and export and import rates. Group 1 stands out because it reaches better results in terms of GDP per capita, productivity and import rates. At the level of the region's capacity of internationalization through exports, the results found for group 1 and 3 are far above those of group 2.

Table 6

Differences of Averages between Groups  
The territorial dimension and the innovation capacity of a region

<b>Final Cluster Centers</b>	<b>Cluster 1 (n = 2)</b>	<b>Cluster 2 (n = 12)</b>	<b>Cluster 3 (n = 8)</b>	<b>Mean Differences</b>
Population03	3865452	1763202	2871086	
GDP2003	93294	25013	52146	1,3 > 2
GDPpercapita2003	23,78	15,94	17,97	1 > 2,3
Employment2003	1717,55	675,88	1257,70	
Produtivity2003	35,77	27,15	29,04	1 > 2,3
Exports2003	13127,00	3242,00	12282,76	1,3 > 2
Imports2003	27326,47	3751,76	9465,95	1 > 2,3

It is important to note that aspects such as population and employment are variable and did not present meaningful differences in the grouping of the regions, and turned out to be insufficiently unequal to justify differences in the innovative behavior of the regions.

## 5. Conclusions

From the gathered data, as well as from the application of the described methodology we may highlight the following results: (1) the confirmation of the hypotheses that the most innovative regions vary according to the continuous innovation of services through inventive activity and creativity through patents, (2) that the dynamic of training and learning and the private/public dynamic in terms of Research and Development (R&D) may affect the results, namely the present commitment or the stage of initial preparation toward innovation capacity; (3) that the impact of the companies' R&D are greater in the more innovative regions and (4) that the results are related to the level of productive effort, to the productivity and to the internationalization effort.

As for the practical implications of the present study, we may point that these results suggest that regions must have a clear engagement and a proactive attitude in the adoption of innovation as a strategic and differential element. The benefits are greater to those regions that try to act toward a more complete growth of their innovation capacity and that are, from the onset, better positioned at the national level, with greater levels of investment in those areas and that translate this position into a commitment toward innovation.

Another aspect that appears as an implication to the regions is the fact that innovation is a especially capable way of promoting the region's competitiveness, which translates itself into wealth and welfare.

As for the limitations of this study we may point out a few aspects which were not sufficiently covered and that necessitate a future analysis, namely the relational dimension: the analysis of the influence of the cooperation networks and local culture in the capacity for innovation.

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