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EVALUATING THE DETERMINANTS OF NATIONAL INNOVATIVE CAPACITY AMONG EUROPEAN COUNTRIES

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ABSTRACT

Innovative capacity has a decisive and crucial role in determining who is prospering in the global arena. Innovation is the base for the development of strategic advantages in companies, so necessary in the current context of global competitiveness. Innovative capacity enables countries to increase their productivity and attract investments, thereby sustaining continuous progress in the quality and standard of living. The national economic capacity of a country depends on institutional efficiency, its national culture, and its innovation framework. This paper reflects upon the factors that influence national innovative capacity, based on the European Innovation Scoreboard database. The aim is to reflect and evaluate the factors with influence in national innovative capacity. In this sense, we analyze innovative capacity in terms of innovative output and identify the main factors which differentiate the dynamics of the countries. Clusters analysis was performed to verify how different countries are positioned in terms of innovation outputs and determine which factors distinguish their level of innovative capacity. The results point to the existence of four groups of countries, and the factors identified are related to dimensions of institutional efficiency, namely efficiency of institutions, type of regulation, effective rule of law and level of corruption; the societies' cultural values associated with the level of hierarchy or "power distance" and "uncertainty avoidance" and with aspects related to the innovation framework such as doctorates in science and engineering, business R&D expenses, and level of collaboration for innovating.

Keywords: Innovative Capacity, Innovation, National Culture, Institutional Efficiency, Innovation Infrastructure

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CEEAplA- Centre of Applied Economics Studies of the Atlantic
UDI/IPG- Research Unit for Development of Inland

1. Introduction

The capacity for innovation has a dominant and decisive role in determining who thrives in the global arena. For firms, innovation has the power of establishing competitive advantages in a context of increasing globalization. For countries, the innovation capacity is the source of prosperity and growth (Belitz et al., 2008). Thus, national objectives will be achieved by increasing productivity and attracting investment, to sustain continuous improvement in standards and quality of life.

The concept of innovative capacity was introduced by Suarez-Villa (1990) to measure the level of invention and the potential for innovation in a nation. According to this author, the measurement of the innovation capacity can provide important knowledge about the dynamics of the invention in economic activity. Such knowledge can be used by policy-makers or scholars to understand the changes in invention patterns, technology and competitiveness. The national innovative capacity can provide comparative information regarding the evolutionary process of inventive activity as well as information on its relationship with the main factors of the invention. Thus, the innovation capacity of an area is linked to the territorial dynamics of innovation, legal and/or individual and is conditioned by the specific characteristics of each area based on 5 groups of factors/dimensions of this crucial process.

Considering these observations, the aim of this paper is to evaluate the factors that influence national innovative capacity. In this sense, and taking into consideration the European Innovation Scoreboard, we analyzed innovative capacity in terms of Small and Medium-sized Enterprises innovative behaviour and identified the main factors which differentiate the dynamics of the countries. In present paper five hypotheses are proposed: the first is related to the influence of the institutional efficiency on innovative capacity; the second pertains to the role of national culture; the third refers to the influence of the innovation's collective infrastructures (human resources and of the dynamic of learning and training) in the promotion of innovative capacity; the fourth is qualified to the sustain an support system of innovation; and, the fifth is associated to the linkages and cooperation networks to stimulate the innovation capacity.

This paper presents the following framework. On the second point a brief literature review is perform regarding the innovative capacity. The third point describes the hypotheses. The two last points contains the methodology and the main findings and discusses these results and

their implications, stressing the limitations of the work and suggesting avenues for future research.

2. Literature Review

National innovative capacity can be broadly defined as the institutional potential of a country to sustain innovation (Hu and Mathews, 2008; Huang and Shih, 2009). The concept of innovative capacity was introduced by Suarez-Villa (1990) to measure the level of invention and the innovative potential of a nation. According to this author, measuring the innovative capacity may provide important knowledge about the dynamics of the invention in the economic activity. Such knowledge may be used by policy-makers or academics for understanding the changes in the invention, technology and competitiveness and take actions in accordance.

The concept of innovation capacity emerged as a meta-concept to denote the real and potential capabilities of a system to convert knowledge into innovation, which is able to drive long term economic growth and wealth creation (Lundvall and Johnson, 1994, Freeman 1995, Furman at al. 2002, Schiuma and Lerro 2008). For Matheus and Hu (2007), the innovative capacity of a country is basic driving force behind its economic performance; it provides a measure of the institutional structures and support systems that sustain innovative activity.

The concept of national innovative capacity was explained in the works of Porter and Stern, (1999); Stern et al. (2001) and Furman et al. (2002). Their main purpose was to measure the origin of the differences between countries regarding the innovative production, reflecting upon the analysis of the clusters of innovation. For these authors, the national innovative capacity is the country's capacity (as a political and economic entity) to produce and trade a new flow of technologies, reflecting the fundamental determinations of the innovation process and not only at the output level of innovation (Stern et al., 2001).

In the last few years several works have been enriching this analysis, clarifying the concept. It has been introduced and adopted by different scholars interested in researching and understanding the factors and root determinants of innovation dynamics and the capabilities of development (Furman et al., 2002; Howells, 2005, Schiuma and Lerro, 2008). In a managerial approach, Suarez-Villa (2003) analyzed the relationship between the inter-organizational networks and innovative capacity, from which emerges a new type of

organization: the "experimental firm". Belderbos et al. (2004) analyzed the impact of the Research and Development (R&D) in cooperation with the innovative performance of the firm at the level of employment creation and innovation productivity, by considering the countries in the Community Innovation Survey II.

Camelo-Ordaz et al. (2005), studied how certain top management teams characteristics influence innovative capacity in companies, conceptualized in terms of levels of product innovation. Ganzaroli et al. (2006) examined the relationship between business succession and innovative capacity, in order to explore business transfer as potential source of innovation in Small and Medium-sized Enterprises (SMEs). Henttonen (2006) points out the role of internal and external innovation networks in driving forward the firm's innovative capacity.

At territorial level, several authors seeking to identify factors or determinants affecting innovative capacity in the country and/or regions. Ridel and Schwer (2003) used the model proposed by Romer (1990) and tested by Furman et al. (2002), putting in evidence the endogenous relation between the employment growth and the innovative capacity, applying it to the United States of America. By other hand, Archibugi and Coco (2005) compared the different methodologies adopted by worldwide organizations (World Economic Forum - WEF, UN Development Program - UNPD, UN Industrial Development Organization – UNIDO and RAND Corporation), to measure the national technological capacity. In the research of Pontikakis et al. (2005) and of Jaummotte (2006), it is pointed out the functioning of the national innovation systems, its performance and the role of incentives to maintain and improve the national innovative capacity.

Hu and Mathews (2005) extend and modify the Furman et al. (2002) approach, applying it to five "latecomer" countries from East Asia, in particular to Taiwan. While the results are in broad agreement with the findings of Furman et al. and Hu and Mathews document some important differences for latecomer East Asian economies: the number of national factors matter is smaller and an important (though subtle) role seems to be assume by the public R&D expenditure acting as a steering mechanism for the private sector.

While university-based R&D (a basic research resource) does not show a significant effect over the past two decades. Hu and Mathews (2005) demonstrate that the public R&D funding in East Asia greatly strengthens the contribution of specialization in the high-tech industries -

but this effect was only be register when a latecomer country is pursuing a targeted strategy of catch up, as the case of Taiwan.

More recently, Mathews and Hu (2007) examine the efforts of Taiwan's academic innovation through institutional and organizational reforms, and evaluate its impact in assisting Taiwan in moving beyond the phase of being a catch-up manufacturing fast follower to that of an innovation-based technology developer. In 2008, Hu and Mathews performed the first study on China's national innovative capacity', extending their earlier work conducted on the East Asian Tiger economies. They found an increasing on patenting activity by Chinese firms and organizations since 2001, and analyse the drivers behind this, as well as the quality characteristics of patenting, in terms of intensity impact and links with the science base.

The innovation capacity in China is also studied by Fan (2008). He analyzed the innovation capacity and economic development in China and India, focusing on the transformation of national innovation systems. Fan (2008) considers the financial investment and human resources in R&D as two important input factors for building up the innovation capacity of a nation. But he also stresses the role of both governments in transforming their national innovation systems, to become more adaptable to economic development, and one of main focus of R&D reforms was to integrate the science and business sectors and to provide incentives for innovation activities.

The study of Natário et al. (2007) reflects upon the factors that influence national innovative capacity, based on the European Innovation Scoreboard (EIS) database. These authors test the importance to innovation of variables that were not been considered in the innovation scoreboard namely national culture aspects and institutional efficiently, together with variables that are normally compiled in the scoreboard such as expenditures and human resources qualifications, namely tertiary education and sciences and engineering graduates.

At regional level, Schiuma and Lerro (2008), discuss the role and relevance of knowledge-based capital as a strategic resource and a source of regional innovation capacity. They identify human, relational, structured and social capital, as the four main knowledge – based categories building the knowledge-based capital of a region. Schiuma and Lero (2008) used the concept of innovation capacity to refer the overall innovation capabilities that a region can express, both in practice and potentially. It includes both the innovation dynamics taking

place at regional level, and those that could potentially be developed by policy and management actions by leveraging local and external knowledge resources.

The relationship between national innovative capacity and network contamination effects on international diffusion of embodied and disembodied technology was analysed by Huang and Shih (2009). Their work examines two different social network models: cohesion models, which are based on diffusion by direct communication; and, structural equivalence models, which are based on diffusion by network position similarity. The empirical results found distinguishable influences upon the performance of national innovative capacity between countries with different technological diffusion forms and social proximity.

Embodied or disembodied technology diffusion through structural equivalence mechanisms has significant influence on the performance of national innovative capacity. However, a country is affected more by its structurally equivalent competitors than by its cohesion partners. Moreover, embodied or disembodied technology diffusions through cohesion mechanisms have negative effects on the performance of national innovative capacity, which can be regarded as international technology diffusion via global stratification patterns (Huang and Shih, 2009).

Thus, the innovative capacity is not concerned with any single aspect of innovation performance, but with the sources of its sustainability (Matheus and Hu, 2007). A country's innovative capacity, consider as the ability of people and companies to create and transform knowledge into new, marketable products and services and more efficient processes, cannot be measured directly (Belitz et al., 2008).

The innovative capacity of a territory, nation or region, is grounded in its microeconomic environment and related to the number of scientists and engineers in the workforce and in the degree of protection of intellectual property and in the power of the clusters. This last reflects the concentrated location of the resources that harnesses the managerial competitiveness.

For Stern et al. (2001) national innovative capacity lays on three vectors: (1) the endogenous growth based on the ideas of Romer (1990); (2) the theory of the industrial clusters based on the nation's competitive advantages developed by Porter (1990); and (3) the research developed in the national innovation systems presented by Nelson (1993). Its differences

reflect the variations in economic geography, namely the impact of the knowledge and spillovers of innovation amongst closely situated companies, and in the innovation's policies trough the level of public support for basic research or protection of intellectual property.

Stern et al. (2001) and Porter and Stern (1999) have highlighted the importance not only of the present competitiveness, but also the capacity of sustaining it in the future, considering the following aspects as determinants of the national innovative capacity: common facilities such as public institutions, resources committed, policies that support innovation; the environment for innovation in the industrial clusters of a nation; and the quality of the relations amongst the capacity to narrow the gap between research and the companies and the collective efforts that contribute to a whole set of specialized personnel and technology. The innovative performance of economies results from the interaction among these three categories. The national innovative capacity is supported by the innovation systems' approach, amongst others. This systemic innovation approach has brought a new knowledge about the performance and the innovative and economic capacity of the countries.

In order to be innovative, country requires, first and foremost, a well-functioning national innovation system[1], in addition to a favourable social climate for innovation (Belitz et al., 2008). These authors present a composition of the innovation indicator for Germany, 2008; compose by innovation system and social climate for innovation.

The first indicator is composed by education (highly qualified individuals), R&D (new knowledge), financing (sufficient capital), that together are responsible for impelling networking (from partners), competition, implementation and demand market. The social climate for innovation (second indicator) is related to public opinion on the process change, social capital, trust, and science and technology.

For Natário et al. (2007) a country's national economic capacity depends on that country's institutional efficiency, its national culture and its innovation framework. The main differences in the level of innovative capacity are associated with the efficient functioning of the national innovation systems. This requires a combination of the economic framework and the different institutions of the countries, in the determination of the direction and of the ratios

[1] The designation - national innovation systems - refers to enterprises, institutions and surrounding conditions that influence the process by which innovation arise (See, Lundvall , 1992, Edquist 1997) .

of the innovative activities, a strong national culture for innovation and infrastructures supporting innovation.

To measure the innovative capacity Matheus and Hu (2005), Hu and Matheus (2008), applied a ratio of take-up of patents issued by US Patents and Trademarks Office (USPTO). For these authors patents are widely recognized as providing a reliable and unbiased indicator of the innovation effort of a country and the adoption of patenting activities by Chinese firms and organization at the USPTO was used as a measure of China's National Innovative capacity (Griliches, 1990; Trajetnberg, 1990). Natário et al. (2007), in order to group the countries according to innovative capacity and innovation output, also used the ratio of patent registration of the European Patent Office (EPO) and United States Trademark Office (USPTO), measured by the ratios of high tech patents applications and general patent applications relative to the population.

However, patents are not only acknowledged as providing a reliable and unbiased indication of the innovation effort being expended by a country, but also regarded as a country's R&D performance (Huang and Shih, 2009). R&D and patents are indicators that have major limitations for understanding the complexity of innovation processes. In fact, the innovation output indicator may be biased by the very characteristics of the National Innovation Systems, as Lorenz (2005) has shown.

This topic has been the focus of discussion in the context of the revision of the EIS (Arundel and Hollanders, 2007; Hollanders and van Cruysen, 2008; Simões, 2008). A number of previous studies (Archibugi and Pianta, 1996; Smith, 2005) have assessed the strengths and weaknesses of different technology indicators, pointing out that R&D and patents have limited relevance in the innovative activities of some manufacturing and most service sectors, resulting in a serious underestimation of the extent of innovative efforts in these industries. In empirical analyses, these data have the advantage of being available over long time series for firms, industries and countries (Bogliacino and Pianta, 2009).

Therefore, there is little doubt that patenting indicators cannot be considered as innovation performance indicator. First, as several studies have shown, the use of patents is volatile variable varying according to the industries characteristics (Winter, 1987). Therefore, it is not totally accurate to consider patents as an innovation performance indicator, much less the

innovation performance indicator. For this reason, the EIS 2008 no longer labelled patents as an output indicator, but rather a throughput indicator (Hollanders and van Cruysen, 2008).

Effectively, a new methodology has been used for the EIS 2008 report and also intended for the 2009 and 2010 reports, following a better understanding of the innovation process. The revision of the EIS methodology was a direct result of the challenges discussed in the EIS 2007 report to: 1) measure new forms of innovation; 2) assess overall innovation performance; 3) improve comparability at national, regional and international levels; and 4) measure progress and changes over time. The purpose of this revision has developed dimensions that bring together a set of related indicators in order to give a balanced assessment of the innovation performance. The blocks and dimensions have been designed to accommodate the diversity of different innovation processes and models that occur in different national contexts (Hollanders and van Cruysen, 2008).

Thus, it appears that under the new methodology used by EIS, patents that were in the previous Community Innovation Survey included in the definition of indicators "OUTPUT - Intellectual property" will be considered as an indicator, "Throughputs" (as stated), one of the dimensions used to capture innovation efforts of firms. In view of this and attempting to contemplate these concerns, to measure the innovative capacity of a nation was chosen by the required output of the EIS, which captures, the outputs of firm activities namely Innovators dimension.

This dimension captures the success of innovation by the number of firms that have introduced innovations onto the market or within their organizations. It covers both technological innovations and non-technological. Consequently, the variables considered to measure innovation were SMEs introducing product or process innovations (% of SMEs), SMEs introducing innovations marketing or organisational (% of SMEs); Reduced labour costs (% of firms) and Reduced use of materials and energy (% of firms).

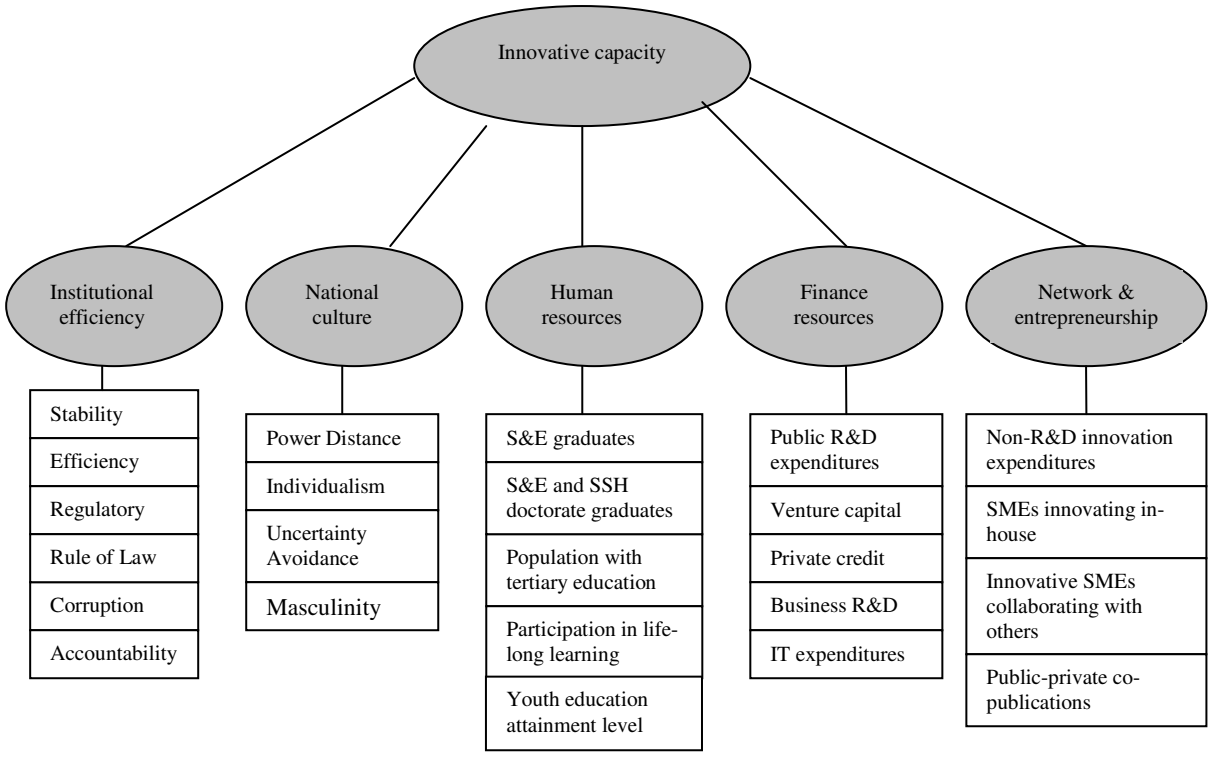
3. Conceptual Model and Hypothesis

With the understandings that stands out in the theoretical foundations, the following dimensions or groups of factors can be consider as determinants of the territorial innovative capacity (See, Figure 1): institutional efficiency, based on the commitment and performance of the institutions, the national culture, the human capital, in the form of innovation's workers

skills and in the technological intensity, the finance resources for innovation and linkages & entrepreneurship.

The national innovative performance is conditioned by the specific characteristics of each country on the basis of five dimensions. In this paper, five hypotheses are proposed: the first is related to the influence of the institutional efficiency on innovative capacity, the second pertains to the role of national culture, the third refers to the influence of the innovation's infrastructures in the promotion of innovative capacity, the fourth is qualified to the financing support of innovation and the fifth is associated to the linkages and cooperation networks to stimulate/promote the innovation capacity.

Figure 1: Determinants of Innovative Capacity



Academic institutions are increasingly seen as influencers in the innovation capacity in a triple perspective or mission: *triple helix* (Vang-Lauridsen et at. 2007) acting as a spiral of knowledge capitalization. They produce and coordinate the available scientific and technological knowledge; they give superior graduation and skills for the industry, and through interaction with industry and the creation of incubators, directly contribute to the development of the region (Vang-Lauridsen et al., 2007). Relying on the innovation systems' approach of Lundvall (1992), Nelson (1993), Edquist (1997), Lundvall et al., (2006) and Asheim and Coenen (2006) and considering that the national innovation system is defined as

a complex set of actors (companies, and institutions), that whether in interaction or assembled, they are organized to foment innovation (creation, diffusion and appropriateness) and promote competitiveness of this country, one can admit that the efficient functioning of these systems is associated with its institutional efficiency.

The specific institutional factors setting prevailing in a region plays a significant role as regard the formation of a RIS (Regional Innovation System) and it is one of five main sub-systems of the RIS suggested by Trippl (2006). The focus is on both formal institutions (such as laws, regulations, among others) and informal institutions (values, practices, routines, among others). Institutions matter, because they shape the behaviour of actors and the relations between them. Factors such as prevalent patterns of behaviour, values and routines, culture of cooperation, and attitudes towards innovation constitute key factors of region's distinct institutional endowment (Trippl, 2006).

In order to test this hypothesis, we considered as measurement variables the stability and absence of violence and terrorism, government efficiency, regulatory quality, effective rule of law, control of corruption and voice and accountability as defined by Evans and Rauch (1999) and Kaufmann et al. (2008) , which calculated an index of these variables for different countries. Therefore the first hypothesis is:

H1: Institutional efficiency has a positive influence on innovative capacity.

Another determinant of national innovative capacity is the national culture, which influences the relationships, the constitution of innovation and cooperation networks, as well as the innovation system, and therefore, the innovative capacity. Porter (1990, 1998) and Dunning (1998) reiterated the importance of the national elements in international localization and the significance of the clusters to promote competitive advantages. The conditions to innovate are not applied universally, thus each nation must find its own characteristics in light of its own history, culture and values.

Therefore, to measure the influence of the national culture upon the innovative capacity, the cultural dimensions of Hofstede (1987) were taken in to consideration. The first of these dimensions is *Power Distance* that reflects the capacity of a society to accept an asymmetrical distribution of power and varies from country to country. The second dimension is *Individualism*, which may be apprehended as the importance that is given to the objectives

and individual efforts as opposed to the objectives and collective efforts. The third is *Uncertainty Avoidance*, which is the amount of uncertainty about future events that people of a certain national culture are willing to accept. The fourth is *Masculinity* and reflects the level of assertiveness which is promoted in the national culture. These dimensions when taken together allow the classification and distinguishing national cultures.

The definition of the second hypothesis rests upon a body of literature which includes papers by Hofstede (1987), Ronen and Shenkar (1985), Kogut and Singh (1988) and Schneider and Barsoux (1997) and the variables used correspond to Hofstede cultural dimensions, namely: power distance, uncertainty avoidance, individualism and masculinity. In face of these considerations the following hypothesis was established:

H2: The Dimensions of National Culture have a positive influence on the Innovative Capacity.

The innovation's collective infrastructure is the third pillar of national innovative capacity, according to several authors (Asheim and Coenen, 2006; Stern et al., 2002; Riddel and Schwer, 2003; Stern et al., 2001; Suarez-Villa, 1990, 1997). The creation of new knowledge is heavily dependent on a sufficient number of qualified scientists and engineers; for diffusion to take place, what matters most is the competence and talent of the workforce. In this sense, the works qualifications are essential for the success or failure of a country's innovation efforts for the creation and diffusion of new knowledge.

Territories acquire great value from their innovation dynamics, depending 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 human resources with high levels of education and qualification in the S&T domain, such as the high-tech and service sectors. The highly qualified individuals (education) are key players in innovation (Belitz et al., 2008). Consequently, the qualified human resources, in conjunction to an environment that stimulates intensive learning processes in R&D may combine previous knowledge and explore new possibilities (Laranja, 2001), stimulate innovation and creativity (Davenport and Prusak, 1998; PNUD, 2001).

According to several authors human resources are a key element of innovation, and innovation growth depends on the quality and availability of knowledge, thus being fundamental the qualification of human resources and the participation in life-long learning, it was admitted that the dynamic of learning and training influence the innovative capacity of territories (Lundvall, 1992; Edquist, 1997; OECD, 2000a; Doloreux, 2004; Lundvall et al., 2006; Vang- Lauridsen and Chaminade, 2006; Vang- Lauridsen et al, 2007).

Therefore, to test this hypothesis as the following variables were considered: science and engineering (S&E) graduates (percentage of 20-29 years age class); population with tertiary education (percentage of 25-64 years age class); the participation in life-long learning per 100 population aged 25-64 and the youth education attainment level. The third hypothesis derives has the following configuration:

> **H3: The Innovation's Collective Infrastructures Training have a positive influence on the Innovative Capacity.**

The creation of new knowledge may be stimulated through the increase of public and managerial R&D and through the investment in information and communication technologies (ICTs). Countries make interactions affecting each other performance on economics, politics and culture, due to the development of information technologies (Huang and Shih, 2009).

As largely emphasized in literature, ICTs are first of all vehicles for process innovation. The effects of ICTs on firms' competitiveness do not only regard process innovation, but also influence product innovation, by stimulating product differentiation, the development of new market niches, and by allowing directly the implementation of new technological products (Camagni and Capello, 2005). Therefore, at territorial level, ICTs spontaneously act on accessibility, allowing overcoming territorial peripherality, and generating the popular perception of "dead of distance" (Castells and Hall, 1994; Camagni and Capello, 2005).

For Mathews and Hu (2007) the significant effect of public R&D expenditures emerges as an important determinant of the degree of specialization of the countries and can be seen as a source of innovation. Therefore they examine inputs in the form of R&D expenditures to measure the national innovative capacity of country. In turn, Hu and Mathews (2005) document and there are seems to be an important role of public R&D expenditures to act as a steering mechanism for the private sector.

The private credit conditions and the venture capital can be considered obstacle or vehicle for development of innovations. Thus, in order to test this hypothesis, we considered as measurement variables the Business and Public expenditures on R&D (percentage of GDP), Venture capital (% of GDP), Private credit (relative to GDP) and IT expenditures (% of GDP). These considerations lead us to frame the fourth hypothesis of the work as presented bellow:

H4: The financing resources for innovation have a positive influence on the Innovative Capacity.

Another relevant aspect in the innovative performance of the territories is the coordination approach of the innovation activities: individually or in cooperation. The collaboration and the behavior in cooperation to innovate are modalities which present many benefits: sharing of risks and costs which the innovation entails; accessing to new and different markets; obtaining of additional fundamental resources for innovation; accessing to information, skills and specialists; and, reducing development time for innovations (Von Stamm, 2005).

Related R&D management literatures stress the necessity for interaction among organizations to bring forth the progress of technological innovation and between developers and users of new technology to enhance the development (Huang and Shih, 2009). Schiuma and Lerro (2008) argued that innovation requires long-term cooperation between investors, entrepreneurs, researchers, firms, public authorities and consumers. Networking, i.e., the synergetic relationships linking the stakeholders, among themselves, within a region, and external innovation players, it is one of three main dimensions affecting a regional innovation capacity. Effectively, the learning process is an interactive character and involves networking among firms as well as dynamism in local reworks. This requires the development of linkages, networks and cooperation between different actors (Lundvall, 1992).

In the territory there is a particular importance to promote the regional innovation, the artificial creation of the milieu through technological parks and the cooperation between the various local actors and the network linkage (Landabaso, 1997). Many studies have shown that cooperation relationships as an efficient vehicle to promote innovation and competitiveness in a region or territory (Lundvall, 1992; Edquist, 1997; OECD, 1997; Bramanti, 1999; Doloreux, 2004; Henttonen, 2006; Vang- Lauridsen et al, 2007).

The network relationships of cooperation facilitate the production and transmission of the knowledge flow, the innovative performance determination of the companies and the territorial innovation process influence. For Huang and Shih (2009) amplifying the influence of national innovative capacity requires reinforcing their internal elements and in addition concentrating on the interaction with cohesive countries. Developing networks represents a method to increase the amount of accessible knowledge and improves innovation capacity (Schiuma and Lerro, 2008). In face of these considerations the following hypothesis was established:

H5: The Systems of Interactions and Entrepreneurship have a positive influence on the Innovative Capacity.

4. Methodology and Results

The main data source used to evaluate the national innovative capacity was the European Innovation Scoreboard for 2008. This database contains data on European countries innovative activities and performance and is annually revised. The method used for the analysis is based on the application of cluster analysis, in order to group the countries according to innovative capacity, measured by the level of innovation output. To verify the hypothesis we have applied multiple means comparison tests to distinguish the unique characteristics of each cluster. This methodology groups the countries according to their level of product and process innovation, marketing and organizational innovations, innovations that reduce labor cost and innovations that reduce the use of materials and energy.

The groups are constituted by countries with more similar records among them and with dissimilarities from other country belonging to the remaining groups. Considering that similarities are a set of rules that serve as criteria for grouping or separating items and in the present case were the SMEs introducing products or process innovations; SMEs introducing marketing or organizational innovations; reduced labor costs; and, reduced use of materials and energy. This methodology maximizes the homogeneity of countries within a group and constitutes groups that are heterogeneous to each other, by minimizing the variance within the groups and maximizing the variance between groups.

The use of cluster analysis proved adequate and the variables used to classify the countries were all significant for the final solution estimated, as we can verify by the results of the ANOVA analysis presented in Table 1.

Table 1: ANOVA Analysis

	Cluster		Error		F	Sig.
	Mean Square	df	Mean Square	df	Mean Square	df
SMEs introducing product or process innovations	670,658	3	24,848	20	26,990	0,000
SMEs introducing marketing or organisanational innovations	975,489	3	44,731	20	21,808	0,000
Reduced labour costs	242,534	3	14,098	20	17,204	0,000
Reduced use of materials and energy	86,490	3	8,096	20	10,683	0,000

The results show that all the classification measurements used in this analysis were significant in the classification process of the countries. What we can verify by the value of the F statistic, that is above the critical acceptance level and also by the value of the significance probability that is almost null and therefore permits us to rejects the null hypothesis that the measurements' are not significant in classifying the countries.

The application of the cluster analysis identified four groups of countries. The first constituted by Austria, Germany, Estonia and Luxembourg; the second, constituted by Belgium, Czech Republic, Denmark, Ireland, Italy, Netherlands, Norway and Turkey; the third, constituted by Bulgaria, Spain, Hungary, Lithuania, Malta, Poland, Romania and Slovakia; and, the fourth, constituted by Cyprus, Greece, France and Portugal (See, Table 2).

Table 2: Cluster Membership

Cluster 1	Cluster 2	Cluster 3	Cluster 4
Austria	Belgium	Bulgaria	Cyprus
Germany	Czech Republic	Spain	Greece
Estonia	Denmark	Hungary	France
Luxembourg	Ireland	Lithuania	Portugal
	Italy	Malta	
	Netherlands	Poland	
	Norway	Romania	
	Turkey	Slovakia	

These four groups present different patterns regarding its performance in terms of innovative capacity. Has we can verify by the results in Table 3, the first cluster is the one with stronger percentage of firms that have done introduction of new products or process and also introduced innovations on their marketing and organization.

The fourth group follows in terms of innovation indicators, but with an emphasis on innovations that reduce labor costs and materials and energy consumption. The second group presents less innovation then the first and fourth, but is the third group that shows a much lesser innovative profile.

Table 3: Clusters' Constitution

	1 (n=4)	2 (n=8)	3 (n=8)	4 (n=4)
SMEs introducing product or process innovations	45,9	32,8	19,6	35,1
SMEs introducing marketing or organisanational innovations	57,9	39,9	27,2	49,2
Reduced labour costs	13,6	16,0	12,2	28,2
Reduced use of materials and energy	8,4	8,7	10,3	17,9

To interpret the relation between the explanatory variables and the dependent variable of innovative capacity we have tested the groups' mean differences regarding the variables considered in the hypothesis.

Regarding the importance of the institutional efficiency in the innovative capacity we may state that cluster 3, with minor innovative capacity, evidences a lower institutional efficiency in most of the variables used to measure this aspect, namely in relation to the first cluster, with the exception of the stability and the accountability indicators, has we can observe in Table 4.

Table 4: Mean Differences among Groups - Institutional Efficiency

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Dif.
Stability	1,22	0,95	0,88	0,84	
Efficiency	1,62	1,36	0,59	1,12	1>3
Regulatory	1,61	1,32	0,85	1,27	1>3
Ruleoflaw	1,61	1,31	0,57	1,06	1>3
Corruption	1,58	1,31	0,41	1,06	1>3
Accountability	1,32	1,17	0,95	1,15	

Considering the influence of the differences in the dimensions of the national culture on the innovative capacity, we can observe that the countries that constitute cluster 3, by opposition to the ones of cluster 1, are the ones that reveal a national culture characterized by a higher power distance. This higher power distance, verified in the countries of cluster 3, seems to have a negative influence innovation, possibly due to aspect that derive from high power distance like, less open communication channels, leading to lower cooperation, to minor network relations and to less interaction, which, in turn, limits the country's innovative capacity (See, Table 5).

The results show also that the countries in the fourth group have much higher uncertainty avoidance then countries in the first and second group. Being the characteristics of the countries in this cluster the innovation activities in reducing labor costs and materials an energy use we can speculate if these cultural characteristics are related to the objectives considered in terms of innovation.

Table 5: Mean Differences among Groups - National Culture Dimensions

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Dif.
PowerDistance	39,00	41,38	72,17	63,67	1<3
Individualism	69,25	67,38	50,33	44,33	
UncertaintyAvoidance	48,50	57,50	71,50	100,67	1,2<4
Masculinity	64,50	43,63	67,00	43,67	

Regarding the human resources indicators we can observe that the number of doctoral graduates in S&E and in Social Sciences and Humanities (SSH) is higher in cluster 4 that all the other, but the remaining indicators are not significantly different (See, Table 6). So based in these results, although there are some differences, we can not see a clear pattern that differentiates the clusters in terms on human resources capabilities.

Table 6: Mean Differences among Groups – Human Resources

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Dif.
S&E and SSH graduates	34,00	34,56	40,95	34,05	
S&E and SSH doctorate graduates	1,30	0,93	0,74	2,87	1,2,3<4
Population with tertiary education	26,20	25,19	20,14	24,95	
Participation in life-long learning	8,53	11,55	4,74	6,02	
Youth education attainment level	77,05	78,68	80,16	77,57	

When we look at the financing of innovations, we can see significant differences in the Business R&D expenditures (See, Table 7). In this aspect the countries in the first and second clusters have higher levels then countries in the third and fourth cluster. In all other aspect there are no statistical significant differences between the groups. Therefore we can see that is the business efforts that seams to make a difference in the innovation performance.

Table 7: Mean Differences among Groups – Support Systems

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Dif.
Public R&D expenditures (% of GDP)	0,60	0,62	0,40	0,49	
Venture capital (% of GDP)	0,04	0,08	0,05	0,05	
Private credit (relative to GDP)	1,48	1,38	0,85	1,65	
Business R&D expenditures (% of GDP)	1,38	0,92	0,31	0,58	1,2>3,4
IT expenditures (% of GDP)	2,87	2,54	2,39	2,03	

In terms of linkages and entrepreneurial efforts we can see major differences between the groups. In terms of non R&D innovation expenditures, SME's in-house innovation activities and innovative collaboration we can observe significant differences between the clusters. Namely the countries in cluster one have higher levels on these three aspects of innovation and also cluster four tend to have a higher level when related to cluster 3 (See, Table 8).

Table 8: Mean Differences among Groups – Linkages & entrepreneurship

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Dif.
Non-R&D innovation expenditures	3,10	0,49	0,88	0,77	1>2,3,4
SMEs innovating in-house	40,07	30,48	17,29	34,18	1>2,3 and 4>3
Innovative SMEs collaborating with others	15,79	9,62	6,10	19,29	4>2,3 and 1>3
Public-private co-publications per million population	5,37	6,03	2,49	4,62	

This results show the importance of entrepreneurial efforts in no R&D innovation expenditures and in developing in-house innovation activities, but also the need for collaboration between firms.

5. Discussion and Conclusions

In general terms this paper contributes to the existing literature in the way it test the importance of variables that have not been considered in the innovation scoreboard namely national culture aspects and institutional efficiency, together with variables that are normally considered in the scoreboard in terms of expenditures and human resources, financing of innovation and linkages & entrepreneurial efforts of firms.

We found that the main differences in the level of innovative capacity are associated with the efficient functioning of the national different institutions of the country, a low power distance national culture, doctoral graduates in S&E and SSH, business efforts do finance R&D, firms efforts do develop in-house innovation and support non R&D innovation activities and collaboration among firms to innovate.

These results support hypothesis 1 that stated that national innovation capacity is influenced by institutional factors, since the aspects of institutional efficiency, the type of regulation and effective rule of law and the control of corruption levels were found to be significant variables in distinguishing the more innovative countries from the less innovative ones.

The second hypothesis that stated that the national culture has influence on the country innovative capacity was also supported since lower power distance countries were found to have higher innovative capacity then does with lower scores. This may suggest that hierarchical societies have less freedom of initiative and communication necessary to collaborative efforts and therefore produce lesser innovations.

The results are in line also with hypothesis 3, since the human resources qualifications are relevant for innovation, namely the level of doctoral graduates in S&E and SSH where higher in more innovative countries, when compared with lesser innovative ones. We found also evidence to support hypothesis 4, which related innovation to the financing solutions used, since the level of business R&D financing is much higher in countries with better innovative performance indicators. The entrepreneurial efforts to develop in-house R&D and finance innovation on non R&D activities were also a feature of the more innovative countries, together with the importance of collaboration among firms, thus in accordance with hypothesis 5 statement.

The practical implications of this study suggest in order stimulating their innovative capacity, countries need a constant commitment to and the active involvement in their institutions and organizations, the investment in education and qualification, values of openness and commitment to invest and collaborate.

This research presents some limitations to the comprehension of the micro mechanisms which create innovation: a more detailed analysis of the effectiveness of the several national innovative strategies. These limitations arise as a pathway for future research about this theme, and appear to be of great interest to the embodiment of indicators about national and regional innovative strategy. This paper can be developed enlarging the sample and considering some countries such as the USA and Japan, given its history regarding the innovative capacity. Another field of future research should address the inclusion of micro level variables, in order to measure the real leveraging of firms from the fact of being present in countries with more innovative capacity, so our future research will begin to tackle these challenges.

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