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Essays in Regional Innovation Systems, Knowledge Economy and Policy-Making: An applied perspective to European context

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In first, developing a PhD research dissertation is a full time dedicated job as it requires the researcher to permanently question the way he is tracking to and not losing focus and motivation at same time. In the other hand, this journey takes an inspirational vision and is demanding because is long and painful. Thus, one has to be inspired and prepared with enthusiasm, but also with patience and resilience.

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Filipe Castro Soeiro

Abstract

EU Policy-making, Knowledge Economy and Regional Innovation Systems (RIS) are being researched with the aim of improving R&D and Innovation Investments and translate them into economic and employment growth in a sustainable and convergent way. However, in one hand, the EU[1] context is far from convergence at country-based innovation level and on the other hand is experiencing a transitional macro referential change from an economy based on natural resources and physical inputs to one based on knowledge, intellectual assets, technology market transfer processes and commercialization of innovation.

Moreover, international overview based on EU and A.P.E.C.[2] countries had been risen the priority of studying, and optimizing Regional Innovation Systems, and also the need to overcome, on the one hand, the "European Paradox" and the role of Regional Innovation Systems (RIS), translating R&D investments into economic and employment growth, and the necessary changes on EU policies, on the other hand.

Thus, the aim of this doctoral research is to provide a full comprehension of the RIS structure and respective mapping of inputs, outputs and hidden variables, in order to foster optimization and provide an empirical model on Regional Innovation System, as well as discussing implications regarding knowledge Economy processes and Policy-Making recommendations in the EU context.

This PhD thesis follows the three Essays structure. The first chapter is focusing on identifying, analyzing and discussing the dimensions that shape Regional Innovation Systems' structure and evaluate if and how the underlying RIS subsystems exert any statistically significant effect on employment and economic growth, leading to the analysis and discussion of best common practices and policy-making applied to European regions. There is empirical evidence showing that Innovation could effectively be managed in a regional scope, due to localized nature of sources of

[1] EU is the European Union. Available from: (http://europa.eu/) [Accessed 13 March 2013].

[2] A.P.E.C. is Asia-Pacific Economic Cooperation (APEC) is a forum for 21 Pacific Rim countries (formally Member Economies) that seeks to promote free trade and economic cooperation throughout the Asia-Pacific region. Available from: (http://www.apec.org/) [Accessed 20 April 2013].

competitive advantages, technological transference knowledge, new business formation and local innovation capabilities and processes. Considering empirical research models and operational datasets available concerning NEG (New Economic Geography), Knowledge Production Function, Knowledge Spillover Theory of Entrepreneurship and other "Endogenous Growth" theories, and RIS (Regional Innovation Systems) theoretical models, there is still room for improvement regarding empirical models research. In this first chapter, based in theoretical findings in the literature review and progress beyond the knowledge state-of-art concerning Knowledge Economy and Regional Innovation Systems, is discussed the idea on how the European Commission's Research and EU Innovation policies can be more effective and improved, even if that implies a paradigm change from a transnational approach to a localized-regional, operational and measurable framework, in order to effectively translate R&D investments into innovation, employment and economic growth.

The purposes of chapter two is to analyze and discuss an innovative model approach to Regional Innovation System (RIS), by applying Artificial Neural Networks (ANNs), in order to generate pattern recognition algorithms capable of capturing salient features from a set of inputs and mapping them to outputs without making a priori assumptions about the specific nature and impact of the relationships. Hence, the main goal is to cast some light inside the "innovation's black-box", describing Regional Innovation Systems (RIS) architecture and reducing the uncertainty surrounding R&D investments' effectiveness in order to promote innovation, economic growth and employment. The ANNs modelling was applied to the study of RIS architecture, aiming to identify the "hidden" mediatory variables, which could influence the overall impact on employment and economic growth. Empirical evidences demonstrate that the underlying RIS subsystems are not homogenous and can generate negative side-effects, leading to decreasing of net job formation. Results suggest that the economical agents' "quality" cannot be merely replaced with success by the implementation of "Keynesian policies" focused on enhancing "Market Potential", "Demand Sophistication" and "Governmental R&D Investments". In this sense, improving regional "Absorptive Capacity" is the most balanced and short-term development strategy for the regions characterized by a lower industrialization and income. However, the most stalwart and long-run impact on employment and

economic growth potential is provided through regional “Innovative Potential” reinforcement. The importance of applying ANN model leads to higher “goodness-of-fit” to explicative variables, when compared with other methods, namely Linear Regression, and also supports guidance on Policy-Making, in a more accurate and integrative way. The findings reinforce the idea that European Commission’s Research and Innovation policies can be restructured and improved, changing from an expenditure increase paradigm, focused on a transnational approach, to a localized regional framework in order to effectively translate R&D investments into Employment and Economic Growth. The main findings were analyzed at the light of the research knowledge that applies ANNs to study RIS and policy-making implications are discussed.

Finally, in chapter three, general and specific arguments that support the use of State policies towards the promotion of innovation and entrepreneurial activities are discussed in the EU context, and by considering the insights of the previous two chapters, is discussed the justification of current innovation entrepreneurial policies in EU and in Portugal and assessed what could be as forward recommendations to RIS model and Policy-Making.

The development of the three “Essays” focusing on Regional Innovation Systems, “Innovation Black-box” and Policy-Making in the EU context, is aiming to contribute to European Commission’s Research, namely in what regards to Regional Innovation Systems’ planning and management, and to Innovation and Growth Policies.

(Keywords: Artificial Neural networks, Knowledge Economy, Regional Innovation Systems, European Paradox, Knowledge Triangle, Innovation, 8th Framework Program for Research and Innovation, Europe 2020 Growth Strategy, Agglomeration Economics, Knowledge Spillover Theory of Entrepreneurship and Spatial Clusters, Sources of Sustained Competitive Advantages, Competitive Industry Structure, knowledge-Based Clusters, Cluster Mapping and Policy-Making).

Introduction

EU Policy making, Knowledge Economy and Regional Innovation Systems (RIS) are being researched with aim of improving R&D and Innovation Investments and translate them into economic and employment growth in a sustained and convergent way. However, in one hand, the EU context is far from convergence at a country-based innovation level and in the other hand is experiencing a transitional macro referential change from an economy based on natural resources and physical inputs to one based on knowledge, intellectual assets, technology market transfer processes and commercialization of innovation.

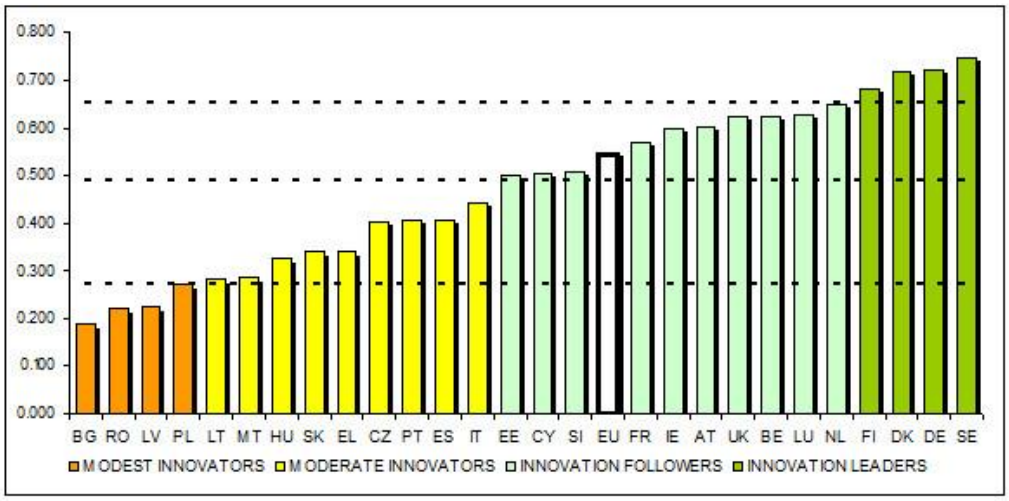

Figure 1 - EU Member States' innovation Performance, 2011

Source: Pro INNO Europe, 2011[3] (*Average performance is measured using a composite indicator building on data for 24 indicators going from a lowest possible performance of 0 to a maximum possible performance of 1)

The variation on innovation levels for each EU country as it showed in the Figure 1 (above) referred in Pro INNO Europe report[4] permits to categorize, according to

[3] See Annex C of *PRO INNO Europe report* referring to indicators about EU countries. Consult Annex C: *Definitions of indicators (Indicator, Definition numerator, Definition denominator, Interpretation and Source)* Available from: (http://www.proinno-europe.eu/sites/default/files/page/12/02/annex_C_1.pdf)

[4] See *PRO INNO Europe report*. The innovation policy initiative PRO INNO Europe combines analysis and benchmarking of national and regional innovation policy performance with support for cooperation of national and regional innovation programmes and incentives for innovation agencies and other innovation stakeholders to

average performance measured by using a composite indicator on EU data for 24 indicators and focusing on key 8 dimensions, the following groups:

- First Group / Innovation leaders: Sweden, Germany, Denmark and Finland, all show a performance well above that of the EU average;
- Second Group / Innovation followers: Netherlands, Luxembourg, Belgium, the UK, Austria, Ireland, France, Slovenia, Cyprus and Estonia all show a performance close to that of the EU average;
- Third Group / Moderate innovators: The performance of Italy, Spain, Portugal, Czech Republic, Greece, Slovakia, Hungary, Malta and Lithuania is below that of the EU average;
- Fourth Group / Modest innovators: The performance of Poland, Latvia, Romania and Bulgaria is well below that of the EU average.

The International Union Scoreboard 2011 distinguishes between 3 main types of indicators and 8 innovation dimensions, capturing in total 25 different indicators[5]. The Enablers capture the main drivers of innovation performance external to firms and it differentiates between 3 innovation dimensions: “Human resources”, “Open, excellent and attractive research systems” and “Finance and support”. Firms’ activities capture the innovation efforts and it differentiate among 3 innovation dimensions: “Firm investments”, “Linkages & entrepreneurship” and “Intellectual assets”. Regarding the Outputs, they capture the effects of firms’ innovation activities and it differentiates between 2 Innovation dimensions: “Innovators” and “Economic effects”, totalizing 8 dimensions (Figure 2).

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implement joint actions. The initiative aspires to become the main European reference for innovation policy analysis and development throughout Europe. Additional information on *PRO INNO Europe*. Available: (www.proinno-europe.eu) Accessed [23 November 2012].

[5] See *Pro INNO Europe*, 2011. “Human resources” includes 3 indicators and measures the availability of a high-skilled and educated workforce. “Open, excellent and attractive research systems” includes 3 indicators and measures the international competitiveness of the science base. “Finance and support” includes 2 indicators and measures the availability of finance for innovation projects and the support of governments for research and innovation activities. Firm activities capture the innovation efforts at the level of the firm and it differentiates between 3 innovation dimensions. “Firm investments” includes 2 indicators of both R&D and non-R&D investments that firms make in order to generate innovations. “Linkages & entrepreneurship” includes 3 indicators and measures entrepreneurial efforts and collaboration efforts among innovating firms and also with the public sector. “Intellectual assets” captures different forms of Intellectual Property Rights (IPR) generated as a throughput in the innovation process. Outputs capture the effects of firms’ innovation activities and it differentiates between 2 Innovation dimensions. ‘Innovators’ includes 3 indicators and measures the number of firms that have introduced innovations onto the market or within their organisations, covering both technological and non-technological innovations and the presence of high-growth firms. The indicator on innovative high-growth firms corresponds to the new EU2020 headline indicator, which will be completed within the next two years. ‘Economic effects’ includes 5 indicators and captures the economic success of innovation in employment, exports and sales due to innovation activities. The indicators included in each of these dimensions are listed in Table 1 and indicator definitions are presented in Annex C of the *INNO EU report*.

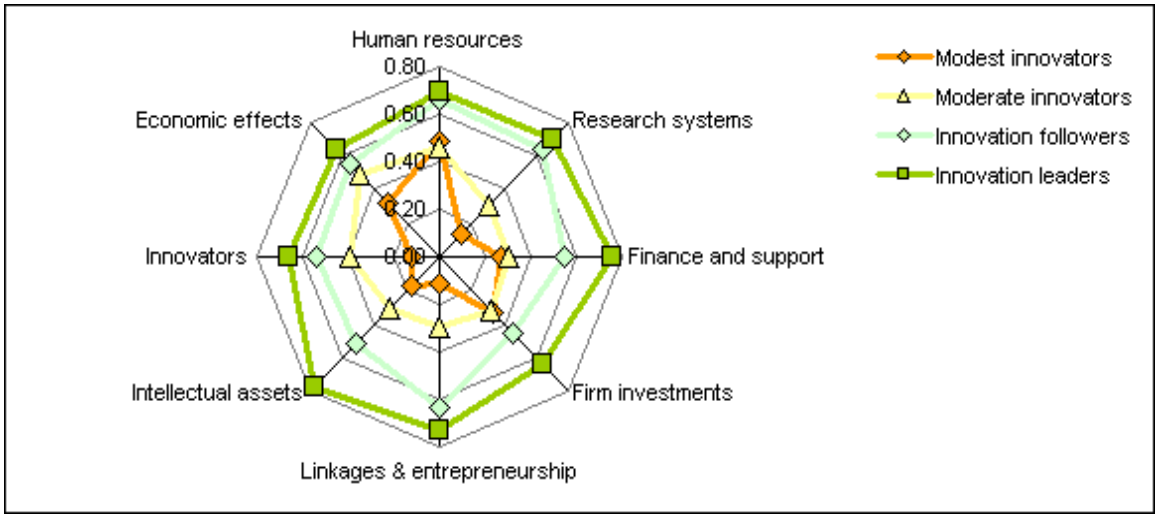


Figure 2 - Country groups: innovation performance per dimension

Source: Pro INNO Europe, 2011

The main aspects one can analyze is that countries at the top of the ranking for the composite innovation indicator share a number of strengths in their national research and innovation systems with a key role of business activity and public-private collaboration. Moreover, all innovation leaders perform very well in Business R&D expenditures. Most of the innovation country leaders also perform very well in other innovation indicators related to firms' activities and have also higher than average scores in Public-private co-publications per million populations, which suggests good linkages between the science base and enterprises. All European top country innovators excel in the commercialization of their technological knowledge, as demonstrated by their good performance on the indicator License and patent revenues from abroad.

The overall relative high level performance of the innovation country leaders reflects a balanced national research and innovation system, which means that the innovation leaders, as well as the innovation followers, have a small variance in their performance across all the 8 innovation dimensions, which demonstrate they have sustained sources of competitive advantages.[6;7]

[6] See Porter, M.E. (1985), *Generic Competitive Strategies. Competitive Advantage, Creating and Sustaining Superior Performance* (1985), Collier Macmillan, Inc. New York, p. 11, referring: "the fundamental basis of above average performance is the long run is sustainable competitive advantage. A firm can develop a myriad of

As each country has its own specificities, meaning natural resources, physical inputs, knowledge and intellectual assets, technology and market innovative solutions, policy responses should attempt not only to address relative weaknesses in national research and innovation systems, but also to have more balanced performances across all categories of key performance indicators. On the other hand, of course the moderate and modest innovators are characterized by an unbalanced research and innovation systems. This is somewhat evident in the "Innovators" dimension with very low shares of SMEs and startups introducing product, service, process or business model innovations, as well introducing marketing and organization innovations.[8]

At the same time, the growth rates of most of the modest and moderate innovators are the highest among the EU27 which indicates a gap decreasing with Bulgaria as a EU catching-up leader, followed by Romania and Estonia, although not showing neither necessarily a convergence process, or best practices from the policy-making perspective.

On the other hand, international benchmark considering other European countries not belonging to the European Union shows that Switzerland is the overall Innovation leader continuously outperforming all EU27 countries. Iceland is part of the Innovation followers, Croatia, Norway and Serbia of the Moderate innovators and the Former Yugoslav Republic of Macedonia and Turkey of the Modest innovators. For Croatia, Serbia and Turkey growth has been well above the EU27 average, according to INNO report. Comparing the EU27 with other group of global competitors shows that the US, Japan and South Korea have a performance lead over Innovation Union Scoreboard 2011 of the EU27. This leading pace has been

strengths and weaknesses vis-à-vis its competitors, there are two types of competitive advantage a firm can possess: low cost or differentiation".

[7] See idem. "The objective of creating and sustaining a competitive advantage to firms, or to a cluster of firms, or to a region depends on the industry structure. Cost advantage and differentiation in turn stem from industry structure" (Porter, M.E. 1985).

[8] Technological innovations can be accompanied by additional managerial and organizational changes, often referred as innovations, which leads to the definition of typology of innovations as defended by Trott, P. 2008. *Innovation Management and New Product Development*, Prentice Hall (FT), Pearson Education Limited, England, p.5, such as Product innovation (when it refers to the development of a new or improved product), Process innovation (when it refer to the development of a new manufacturing process such as Pilkington's float glass process, Logoplaste, the "Hole in the wall concept", etc.), Organisational innovation (when a new venture division, or a new internal communication system is developed (e.g., Google, Apple, Ydreams, etc.), Management innovation (when it is related to managerial processes or systems, such as TQM (total quality management) systems, BPR (business process re-engineering); introduction of SAPR3; 6 SIGMA), Production innovations, as for example, Quality circles, JIT manufacturing system, new production planning software, e.g. MRP II, new inspection system), Sales and Marketing innovations (e.g., new financing arrangements, new sales approach (direct marketing) or Service innovations (e.g., ebay; Internet banking, etc.).

increasing for South Korea, has remained stable for the US and has experienced a slight decreasing for Japan. On the one hand, the global innovation leaders US and Japan are dominating the EU27 key indicators. The nexus causality explanation for this trend in terms of performance shows that indicators capturing business activity and public-private cooperation are key, namely regarding to "R&D expenditure in the business sector", "Public-private co-publications", "License and patent revenues from abroad" and "PCT patent applications". On the other hand, the EU27 has a performance lead over Australia, Canada and all BRICS countries (Brazil, Russia, India, China and South Africa). However, it should be noticed that in spite of this lead has been increasing compared to Canada, Russia and South Africa, has remained stable to Australia and has been decreasing to Brazil and in particular to China and India.

Globally, there are demographics unbalances between West and East countries, which of course reflects in the human resources' availability and valuation and in economic growth. Hence, the 21 countries of Asia-Pacific Economic Cooperation (APEC)[9] seeks to promote free trade and economic cooperation throughout the Asia-Pacific region dominate economic activity and establish new markets for innovative products and raw materials beyond Europe, where demand had been declining in the last years. APEC countries account for approximately 40% of the world's population, approximately 54% of the world's GDP and about 44% of world trade.[10]

In particular, China has been closing the innovation gap to Europe continuously in the last few years and it should be keeping the same trend in the future. This fact is supported mainly by two different factors. In first, due to a source of competitive advantage based on cost leadership, grounded by the economies of scale and economies of scope, by cost efficient business processes and sector value chain

[9] APEC is the forum for 21 Pacific Rim countries (formally Member Economies) that seeks to promote free trade and economic cooperation throughout the Asia-Pacific region. It was established in 1989 in response to the growing interdependence of Asia-Pacific economies and the advent of regional trade blocs in other parts of the world. APEC works to raise living standards and education levels through sustainable economic growth and to foster a sense of community and an appreciation of shared interests among Asia-Pacific countries. APEC includes newly industrialized economies, although the agenda of free trade was a sensitive issue for the developing NIEs at the time APEC founded, and aims to enable "ASEAN economies" to explore new export market opportunities for natural resources such as natural gas, as well as to seek regional economic integration (industrial integration) by means of foreign direct investment. Available from: (http://www.apec.org/) [Accessed 20 April 2013].

[10] Available from: (http://www.apec.org), referring to APEC Secretariat website. [Accessed 20 April 2013]. Available from: (http://publications.apec.org/file-download.php?id=1284&filename=2012_psu_econ-trend-05-12r.pdf) referring to APEC Economic Trends Analysis in 2012. [Accessed 20 April 2013].

activities integration. Secondly, the regional innovation system China is developing is based on resources access spatial location and network synergies that potentiate value, following the design, the management and the implementation of "cross-boundary cooperative development plans", namely "cooperation plans for the adjoining areas" and the "cooperation plans for the non-adjoining areas".[11]

These introductory benchmark overview had been risen the need of studying and discussing Regional Innovation Systems and the need to overcome, on the one hand, the “European Paradox” and the role of Regional Innovation Systems (RIS) translating R&D investments into economic and employment growth is absolute key for EU policies and European countries’ policies, on the other hand. Thus, it is the aim of the present research to identify, analyze and discuss the dimensions that shape Regional Innovation Systems structure and evaluate if and how the underlying RIS subsystems exert any statistically significant effect on employment and economic growth. Besides, it is of a core importance to demonstrate empirical evidence showing that Innovation could be effectively managed in a regional scope, due to the localized nature of sources of competitive advantages, technological transference, new business formation and innovation processes. Moreover, there are “subsystems”

[11] The main purpose of the "cross-boundary cooperative development plans" detailed is to support the "master spatial coordination plans", "transportation cooperative development plans" and "ecological/environmental protection plans" in the land use and development aspects (*Planning Study on the Coordinated Development of the Great Pearl River Delta Townships Honk Kong Government Plan, 2011 -2015* (p.117)). In this study, "cross-boundary areas" cover the "adjoining areas" which are located along the boundaries among Guangdong, Hong Kong and Macao as well as the "non-adjoining areas" which do not adjoin the boundaries but have the potential for cooperative development or management by Guangdong, Hong Kong and Macao. Hong Kong's economic integration with the Pearl River Delta (PRD) has been highly beneficial for all parties. It is expected to further expand economic ties and help improve cooperation among Hong Kong, Macao and mainland China. In According to this plan, Guangdong, one of the country's economic “powerhouses”, is in alignment in terms of policy making and strategic guidelines and implementation for the expansion of ties with Hong Kong, which is playing an increasingly important role in Guangdong's economic infrastructures area, representing about 75 percent of Guangdong's overseas investment, and Hong Kong is the province's biggest trading partner. The Hong Kong section of the massive bridge linking Hong Kong, Zhuhai and Macao (the world's longest cross-sea bridge) includes three major projects, which are the Hong Kong boundary crossing facilities, the Hong Kong Link Road as well as the detailed design of Tuen Mun-Chek Lap Kok Link and Tuen Mun Western Bypass. In total, the three projects are expected to cost 48.5 billion HK dollars ($ USD 6.2 billion). According to this plan a 150-hectare artificial island would be built in the waters northeast of Hong Kong International Airport to house the boundary crossing facilities. The bridge is to be operational in 2016 which will be strategically important and would further facilitate the economic integration and development of Hong Kong, Macao and the mainland, reducing significantly reduce transportation time by 60 percent to 80 percent for travelers and goods, as well as reduce the costs, according to official statistics. The PRD Regional Innovation System will permit that important cities will fall within a three-hour radius of Hong Kong and will attract Hong Kong and International investors to access innovative business opportunities in the western Pearl River Delta, which is rich in human and land resources. Universities are also being engaged to participate in the project, namely the University of Hong Kong. In the long run, the bridge is set to create a new era in transportation link between Hong Kong and the mainland, inject new impetus to Hong Kong's long-term economic development, and generate new opportunities for Hong Kong's main industries such as tourism, finance, communication, trade, commerce, logistics and airspace industry. This regional Chinese example is aligned with Horizon 2020 view, as it fosters macro-economic competitiveness, by investing in regional environments where knowledge-communities and innovation can increase and disseminate, although focusing on differentiation through innovation, and on cost leadership at a regional scope.

that influence and shape the overall Innovation System at regional level, which can be analyzed in order to discuss common practices and policy making measures generalized to all European regions, despite their differences and idiosyncrasies.

There are mostly empirical research models operational datasets available concerning NEG (New Economic Geography), Knowledge Production Function, Knowledge Spillover Theory of Entrepreneurship and other “Endogenous Growth” theories and RIS (Regional Innovation Systems) theoretical models. However, there is room to change and improve research regarding empirical models that support theoretical findings in the literature review and progress beyond the knowledge state-of-art concerning Knowledge Economy and Regional Innovation Systems, discussing the idea on how the European Commission’s Research and EU Innovation Policies can be more effective, even if that implies a paradigm change from a transnational approach, to a localized-regional, operational and measurable framework, in order to effectively translate R&D investments in to employment and economic growth.

On the other hand, one of the most important research guidelines’ discussion is focusing on the inside Innovation’s Black-Box analysis through the use of neural network architecture and techniques, in order to understand and complement empiric modellation about Regional Innovation Systems influence on employment and economic growth. This research view can be used as a complementary approach to the complexity of innovation model for describing Regional Innovation Systems (RIS) architecture and reducing the uncertainty surrounding Governmental R&D Investments’ effectiveness over employment and economic growth. The idea of using neural network modellation, in terms of methodology, to study RIS structure has the aim of identifying the “hidden” mediatory variables of RIS, which could influence its overall impact on employment and economic growth and enhance the explanatory relations underlying RIS subsystems and their core dimensions, while discuss, monitor and fine tune their positive and/or negative side-effects. Ultimately, the three main goals of this piece of research work is in first, to discuss the “European Paradox”, secondly is “entering” in the “Knowledge Filter”, analyze, discuss and understand the “Innovation’s Black-box”, by using a different set of statistical inference, neural networks and exploratory approaches, and thirdly, to analyze and discuss the implementation of best practices and policies, providing

recommendations for Policy-Making and Regional Innovation Systems. In that sense, the present research had been developed throughout the elaboration of three “Essays” focusing on those three main areas, aiming to contribute to European Commission’s Research, namely in what regards to Regional Innovation Systems and Innovation and Growth Policies.

Chapter 1

Regional Innovation Systems Analysis: Subsystems and their impact on employment and economic growth

1.1. Abstract

The purpose of this essay is to identify and analyze the dimensions that shape Regional Innovation System (RIS) structure and evaluate if and how the underlying RIS subsystems exert any statistically significant effect on employment and economic growth.

Empirical evidence demonstrates that RIS subsystems are not homogenous and can generate positive and negative side-effects. However, RIS subsystems can be managed effectively, both for improving welfare and for achieving a higher wealth, if they are planned, managed, implemented, measured and monitored in an integrated way.

On the other hand, increasing R&D investments, both public and private, are necessary conditions for building sustainable development but should be combined with other policy measures to become more effective. Results reinforce the idea that European Commission's Research and Innovation policies aren't as effective as they could be restructured. In order to increasingly translate R&D investments into employment and economic growth, a shift from an expenditure increase paradigm throughout a transnational to a micro-regional approach, combined with operational focus and measurable framework is required.

(Keywords: Knowledge Economy, Regional Innovation Systems, European Paradox, Knowledge Triangle, Innovation, 8th Framework Program for Research and Innovation, Europe 2020 Growth Strategy, Economic Agglomeration, Knowledge

Spillover Theory of Entrepreneurship and Spatial Clusters, Sources of Sustained Competitive Advantages, Competitive Industry Structure, knowledge-Based Clusters)

1.2. Introduction

Technological change and knowledge are critical key drivers to achieve long-term competitiveness and build economic sustainable growth (Arrow, 1962; Romer, 1990; Krugman, 1991). Nevertheless, "the advent of knowledge-based economy the focus of the analysis has shifted from technological change to innovation–the creation and diffusion of new knowledge in the form of novel products and processes" (Tappeiner, Hauser and Walde, 2008, p. 861). A knowledge context could also be interpreted as a community where people group together, using resources, information and communication technologies, with the clear goal of co-producing and sharing new knowledge. In such, information sharing communities, rather than just high-tech sectors, is the key driver of innovation[12] (David and Foray, 2002; 2004). To foster macro-economic competitiveness, developed economies must invest in environments where knowledge-communities can proliferate (Tappeiner, Hauser and Walde, 2008). The underlying regional contextual knowledge-based economies rely on the interaction between Research, Education and Innovation, quite often conceptualized as the Knowledge Triangle (Maassen and Stensaker, 2010).

European[13] regions have experienced considerable industrial re-structuring in the last three decades, towards a more decentralized and flexible industry structure in order to harness the forces of technology and globalization (Audretsch, Carree, van Stel and Thurik, 2000). Shifting from traditional manufacturing industries towards new and more complex technologies such ICT, Biotechnologies and Pharmaceutical

[12] New Economic Geography's literature highlights the role creative cities in sustainable economic growth (Acs, Borma and Sternberg, 2008). These authors, using *GEM database* found that most large cities have more entrepreneurial activity than their own countries. As less entrepreneurial is the country, larger is the gap between cities and countries, concerning entrepreneurship measures. These findings may suggest that the linkage between entrepreneurship and economic growth should be studied at "community level" (e.g. cities and regions) instead country and transnational level.

[13] This effort is materialized in "Europe 2020 Agenda" that consists in EU's growth strategy for the coming decade. The *8th Framework Program for Research and Innovation*, which is just a part of "Europe 2020 Agenda", will provide €80 billions of R&D public funding for the time span between 2014 and 2020, representing a significant increase when compared with *7th Framework Program (2007-2013)* with an overall budget of just about €50 Billions.

(Carlsson, Acs, Audretsch, Braunerhjelm, 2007; Choudhary and Gabriel, 2009; Audretsch, Grilo and Thurik, 2012). Nowadays, Regional Innovation Systems play an important role for three main reasons. The first one is that the usage of new technologies, like software and e-commerce has reduced the importance of scale economies in many sectors (Piore and Sabel, 1984; Carlsson, 1989; Norman, 2002; Audretsch, Grilo and Thurik, 2012). The role of new firms in technological development is enhanced by economies of scale reduction and by the increasing degree of uncertainty in world economy (Mata and Machado, 1996; Audretsch, Carree, van Stel and Thurik, 2000; Audretsch and Thurik, 2001) startups rely on their regional contexts to access knowledge sources and to develop innovative and marketable products (Audretsch and Lehmann, 2005; Audretsch, Lehmann and Warning, 2005; Gilbert, MacDougall and Audretsch, 2008). The second motive consists in the increasing pace of innovation[14] and the shortening of product and technology life-cycles (Klepper, 1996; Agarwal, 1998; Agarwal and Gort, 2002; Adner and Levinthal, 2001; Klepper and Sleeper, 2005; Fritsch, 2008; Dinlersoz and MacDonald, 2009; Auerswald, 2010) that seem to favour new entrants and knowledge-based startups, that have greater flexibility to cope with time-to-market shortness and with radical change rather than large corporations (Zenger, 1994; Baumol, 2004). Thirdly, because of the impact of geographical labor mobility, transport costs and communication costs as the knowledge spillovers that drive economic growth are likely to be regionalized, ensuring sufficient resources are available for both knowledge creation and knowledge commercialization (Acs and Sanders, 2008).[15]

However, that begs questions such as how can societies engage innovation in a way that R&D investments, both public and private, have a measurable and sustainable positive impact on economic growth? Could it be possible to describe innovation in a

[14] Adner and Levinthal (2001) developed a demand-based explanation for the technological change. Demand heterogeneity is considered to be the key driver of the technology life cycle instead “endogenous innovation”. In this sense, firms innovate to fulfill consumer needs that are continuously evolving and to achieve a bigger market-share, through targeting or keeping broader market segments. Later in life cycle, progressive decreasing of the marginal utility coming from performance improvements (i.e. product upgrades) empowers “customer satisfaction” with technological features, making companies develop new technologies with improved performance at constant prices in order to address “market needs”. This explanation looks coherent with the “supply-side” Moore’s Law which says that the processing capacity doubles in each 18 months, with the same costs.

[15] Acs and Sanders (2007) developed evidences and assumptions at aggregate level for innovation, entrepreneurship and the search for knowledge spillovers, which support the claim that knowledge spillovers are important for regional economic growth. The underlying assumptions require further empirical research to test and validate modellation predictions.

systematic and reproducible process? Could that same operating model be applied effectively across different nations, sectors or regions despite the differences in knowledge-production contexts? From a wider perspective, this is a very important overarching research background because governments and policy-makers quite often engage actively in policies aimed at supporting innovation and entrepreneurship to foster economic growth. European Union countries' governments efforts in fostering innovation is considerable because 34.9% of Gross Domestic Expenditure on R&D (GERD) in 2009 was assured by the public sector, and 1.0% by higher-education sector (Eurostat, 2012). In 2009, OECD's countries average GERD, achieved about 2.4% of GDP (OECD, 2012). Under such context, it would be expected that higher-levels of R&D investments induce higher economic growth rates and that knowledge-based entrepreneurship would had reduced unemployment (Thurik, Carree, van Stel and Audretsch, 2007; Fritsch, 2008). However, as shown by the "Swedish Paradox" and the so called "European Paradox", these conditions are not enough to foster both employment and economic growth (van Stel and Storey, 2004; Ejermo, Kander and Henning, 2011). Thus, the main purpose of this essay is to analyze, discuss and fulfill the gap between R&D effort and the attainment of measurable and sustained results in employment and economic growth, by proposing a new approach for managing European research and innovation policies from a regional perspective. In this sense, under the assumption that innovation is a "located phenomena"[16] (Atherton and Johnston, 2010) this essay addresses the following research questions:

a) Is it possible to identify the underlying dimensions that shape the core of RIS that could be generalized to all regions despite their idiosyncrasies?

b) Is it possible to find statistically significant relationships between the RIS structural components and the attainment of measurable outcomes at a macro-

[16] Andrew Atherton and Andrew Johnston (2010) discussed cluster formation as a business dynamic of relational as well as spatial proximity, considering a bottom-up process perspective. "Relational proximity catalysts the formation of clusters, i.e. geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and all the relevant key stakeholders, in particular fields that compete but also cooperate (Porter, 1998). Such considerations point out that besides geographic proximity, inter-firm relationships and cooperation are also important, originating so called "coopeting models". Hence, the conditions within clusters emerge are influenced and shaped by relational as well as locational proximity, reflecting a focus on transaction and interaction, as well as place and space" (e.g. Amin, 2002; Amin, 2004). The localization of sources of competitive advantages dispersed throughout the different regional key stakeholders reinforces the importance of the industry mapping and their potential interconnections and interrelations on a locational and regional basis, leading to ways of sector's value chain optimization and, ultimately, increasing profit margins and industry sector competitiveness, favoring economic growth.

economic level (i.e. Unemployment, Youth-Unemployment, Global Value-Added and Gross Domestic Product?

In terms of structure, this essay proceeds as follows: In section 1.2. it is provided an introduction and section 1.3 is review of the literature. The section 1.4. aggregates the formulation of dataset and defines the methodology. In section 1.5. it is presented the empirical evidence and results. Finally, in section 1.6. it is discussed the major theoretical referential and policy-making findings.

1.3. Literature Review

Knowledge is considered to be a source of competitive advantage for nations as illustrated by David and Foray who point out that “nowadays disparities in the productivity and growth of different countries have far less to do with their abundance (or lack) of natural resources than with the capacity to improve the quality of human capital and factors of production: in other words, to create new knowledge and ideas, and “incorporate” them in equipment and people” (2002, p. 1). If so, what are the mechanisms through knowledge that can be converted into economic activity, in a sustainable and benchmarking way? It was found that firms located within geographic clusters exhibit higher innovation performance, rates of growth and survival when compared with firms not located within clusters boundaries (Sternberg and Litzenberger, 2003; 2004; Gilbert, McDougall and Audretsch, 2008; Bercovitz and Feldman, 2011). Relational proximity underpins the formation of clusters, including those that incorporate dynamic spatial factors, as for example, when occurs in geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and associated entities that contribute for the value creation; in particular fields that compete but also cooperate (Porter, 1998, p. 197-8). The conditions within clusters emerge are influenced and shaped therefore by relational as well as by locational proximity factors, reflecting a focus on transaction and interaction as “place” and “space”, that impact positively to the globalizing phenomena and the increasing of interconnected regions (Amin, 2002; 2004). The accountability concerning the fact that economic activities and people are generally clustered together in space under a specific environmental context

conditions is supported by the notion that economies of scale can be place specific and that there are efficiency benefits of industrial clustering.[17] However, this notion that clusters represent location-specific economies of scale corresponds to a rather static conceptualization, which is hard to relate to economic growth unless other dynamic elements are introduced to the activities and characteristics of the clusters (McCann, 2008).

The localization of competitive advantages, through clusters formation, can be symptomatic of the "globalization of competition phenomena" (Enright, 2000)[18]. In fact, globalization has reduced marginal cost of transmitting information and physical capital across geographic space to virtually zero. It has also shifted the comparative advantage of a "high-cost Standort", or location, in the developed countries from being based on capital to being based on knowledge.

This shift in the relative cost of (tacit) knowledge (Audretsch and Aldridge, 2009) vis-à-vis information has been identified as increasing the value of geographic proximity.[19]

If R&D investments generate the creation of new knowledge and the expansion of technological opportunity set, knowledge endowment enhances profitability of

[17] This assumption is of the most relevance because the clustering activities in "space" increases competition for resources, namely the land and other natural resources, and in turn increases in nominal "local" labour prices are required to maintain real wages. The overall resulting increases in both local land and labour prices will increase the costs and reduce the profitability of local firms, unless there are some than compensating benefits associated to with clustering (McCann, P. 2008, in Agglomeration economics, *Handbook of Research on Cluster Theory*). For the sustainability of these benefits can contribute localized sources of competitive advantages, which can decrease activities' costs contribution and increase profit margin of the overall value chain.

[18] Locational proximity is an important element to access knowledge. However, the paradox of globalization is that geographic proximity and location are considered to be more important, not in spite of a globalizing economy, but because of it (Audretsch and Aldridge, 2009). Literature also sustains a second impact of globalization on the organization of economic activity, which involves the enterprise. While early analysis showed large corporations were endowed with a competitive advantages in accessing, producing and commercializing knowledge, and recent studies have indicated a very different organizational form that is the entrepreneurial firm, which has the competitive knowledge in the knowledge-based global economy.

[19] Industrialized regions and large multinational corporations, e.g. Volvo at Sweden or Siemens at Germany, have been constantly shifting production out of the high-cost *Standort* into lower cost countries through outward foreign direct investment, which lead to waves of corporate downsizing (Audretsch, 1995) and can be easily explained by the theory of the industry life cycle. The three stages in an industry's development that identifies an early exploratory stage, an intermediate development stage and a mature stage, which for a specific industry vary in what refers to levels of design, manufacturing techniques, production volume and market uncertainty. Hence, "the life cycle theory is as much a theory of evolution of technological knowledge and its diffusion, as it is about the flows of exports, imports and foreign direct investment. Evolution of technological knowledge shows that over the industry's life cycle the cost of innovating relatively to the cost of imitating also diminishes as the industry matures, in fact at this stage the cost of imitating falls to the cost of innovation, so that it becomes increasingly economical to transfer that technological knowledge to less costly location of production, either through trade or foreign direct investment" (Addison and Welfens, 2003). In fact, by remaining locked in the same industry and technology it became increasingly difficult to maintain the international competitiveness of a high cost Standort, even though the company itself may be able to retain competitiveness by shifting production of out high-cost Standort to a lower-cost Standort through outward foreign direct investment operation.

entrepreneurial activity by facilitating the recognition and the exploitation of new business opportunities (Acs, Braunerhjelm, Audretsch and Carlsson, 2009; Wersching, 2010). In this sense, industry sectors with a greater share of R&D employment tend to host more new fast-growing companies (Eckhardt and Shane, 2011), while firms with high "technological-competence-enhancing capability" are able to translate knowledge accumulation in sustained economic growth, when leveraged by the initial size of their technological endowment (Lee, 2010).

Resuming, the subject of the present research study has a hybrid nature, which is reflected in the variety of models and analytical approaches. Hence, there are five main different families of models that are described in the literature, which are then fragmented in several variants, dealing with the relationship between industrial clusters, agglomeration and innovation (McCann, 2008). The first one is the "Growth Pole Model" (Perroux 1950; Boudeville, 1966), that employs some of the ideas of Schumpeter (1934) and emphasizes the ways in which economic relationships can exhibit polarity effects over network structures, via which financial transactions are mediated and occurred, particularly when larger firms made decisions that lead to major financial implications for the behaviour of other firms, via the logic of buyer-supplier relationships, inducing "polar" effects to industry structure. On this argument, knowledge of these network structures and behavior of these large local firms is key for innovation, and proximity may induce and engender such knowledge to produce significant local growth effects; the second theoretical model is the "Incubator or Nursery-Cities Model" (Chinitz, 1961, 1964; Duranton and Puga, 2001), which operates in the antipodes of the previous one and argues that agglomerations (cities) contain a high level of diversity, namely a broad range of types of industries and sizes of firms, which will play the role of incubators to smaller firms, e.g., SME's and startups, sharing and supporting businesses services to them. On this argument, knowledge and the diversity[20] and size distribution of clusters is critical to innovation; the "Product Cycle Model" is the third (Vernon, 1966, 1979; Markusen, 1985) analytical approach, which states that relationships between geography proximity and innovation depend essentially on the location behavior of firms and the structure of the agglomeration system (Vernon, 1960), and that firms tend to separate activities

[20] This model approach focus on the sectoral diversity in a more important way than in geographical proximity (McCann, 2008).

by location according to the stage in the life cycle product. Spatial considerations of this model highlight that the innovation behavior of geographical area or region is directly associated to the way the location behavior of larger oligopolistic firms (Markusen, 1985), which are linked to the structure of the agglomeration system. On this argument, larger oligopolistic firms will tend to locate knowledge, R&D, design, prototyping and strategic decision making activities, which are linked to the early stages of the product life-cycle, while they will locate standardized activities such as manufacturing and production to more geographically peripheral areas with lower labour costs and skills, and land costs. According to this approach agglomeration systems will have at the inner center differentiated activities and more standardized activities at peripheral areas; the fourth model is the "Clusters Model" (Porter, 1990, 1998) which argues that geographical proximity is a key factor to industry evolutionary process, as it promotes mutual visibility and transparency between competitors and spurs continuous improvement and competitiveness to all local firms and industry key stakeholders. Porter's model also states that in result of this process of localized competition the final outcome is the increasing of the competitiveness of the local industrial cluster;[21] and the fifth analytical approach is the "New Industrial Areas and Innovative Milieux Models" (Scott, 1988; Saxenian, 1994; Aydalot and Leeble, 1988; Paniccia, 2002; Becattini, 2004), which suggests that the growth of regions is dominated by large numbers of small firms, such as Silicon Valley, Emilia-Romagna region of Italy, Badden-Wurttenberg region of Germany and Cambridge region of UK[22]. These observations suggest that industrial spatial clusters of small firms tend to be more highly innovative than industries comprising mainly large firms (Saxenian, 1994). The innovation is assumed to be most likely to occur in small firms, than in large firms because they have neither the scale nor the risk-bearing capacity when compared to larger ones. In fact, new entrants provide a strong incentive for incumbents to behave efficiently and to adopt new technologies and organizational innovations, increasing competiveness, and quality of service, and leading to market innovation and to fulfilment of costumers' needs, new markets and niches. The geographical proximity of SMEs and startups is noticed to be a core criterion for the

[21] Porter defends that this argument applies to both small and large firms, but spatial clustering phenomena of firms in the same sector is more relevant for small firms, which rely depend mainly on external sources of information and technology (McCann, 2008).

[22] Corroborated by (Jones, M., Jones, R. Woods M., 2004) in a research called *Introduction to Political Geography Space, Place and Politics*.

development of mutual trust relations based on shared experience of interaction with decision-making processes and agents, resources and capabilities. These arguments are supported in the social network theory analysis of environments, which reduce opportunism and promote trust between local firms and the so called “social capital”, recently introduced into economics (Glaeser et al., 2000, 2002).

The recent decades showed a significant increase in interest over the studies and research developed in agglomeration economics and industrial clustering and the comparison of these analytical models highlights the identification of approaches to different contexts, a vary of assumptions, different types of agglomeration economies and different empirical challenges.

The bottom line is that on the one hand main empirical evidence suggests that Knowledge Triangle[23] can have a regional scope, that is also found in Knowledge Spillover Theory of Entrepreneurship literature which demonstrates that regions experience higher knowledge investments tend to get more R&D spillovers (e.g. Audretsch and Feldman, 1996; Audretsch and Keilbach, 2008). Other authors tend to see regions as interactive systems that comprise all economical, social, organizational, institutional players evolved in interactive development, communication and application of innovations (Markard and Truffer, 2008). On the other hand, technological ventures are influenced not only by the traditional economic dimensions, such as market potential, but also by the opportunity to access knowledge generated by the surrounding universities (Audretsch, Lehmann and Warning, 2005). Hence, while modern growth theory emphasizes the role played by knowledge in the aggregate macro-growth process, modern thinking about agglomeration and clusters underlines the intermediate role played by regions (cities) in facilitating the process of knowledge generation, information transmission and firm creation. As the analytical focus of agglomeration economics is therefore on the relationship between industrial clusters, cities and innovation one easily concludes that its generation process combines many different aspects regarding returns to scale and externalities from economics, with innovation, social and management,

[23] The knowledge triangle refers to the interaction between Research, Education and Innovation, which are key drivers of a knowledge-based society. In the European Union, it also refers to an attempt to better link together these key concepts, with research and innovation already highlighted by the development of the Lisbon Strategy and, more recently, lies behind the creation of the European Institute of Technology (EIT).

science and technology, regional planning, economic geography and policy making (McCann, 2008).

In what concerns to European policy trends concerning academic research they are focused in merging and partnering universities in order to gain critical mass and increase capabilities, aiming the creation of elite higher-education programs and research institutions and initiatives. Research capacity agglomeration policies started in 2004 at national level, with Denmark. Other countries, namely Germany and Finland followed the Danish strategy destined to increase research installed capacity and enabling research institutions to compete with top universities worldwide (Maassen and Stensaker, 2010). However, the conglomeration policies aren't confined to country scale, but are already being implemented at transnational level by the European Commission, within the establishment of the European Research Council (ERC) and of the European Institute of Innovation and Technology (EIT). ERC purpose is to provide funding for promising scientific research projects, in order to leverage the scientific standards and academic excellence all over European Union geographical space. The main focus is supporting basic research performed by individual researchers or by research teams from universities or other research institutions, instead of applied research or university-industry pathways. On the other hand, EIT goals are defined precisely to fulfill the previous gap, by promoting the development of applied research, engaging open innovation and entrepreneurship, enhancing R&D integration between businesses (including SMEs), entrepreneurs, research and technology organizations, higher education institutions, investment communities (private investors and venture capital), research funders (including charities and foundations) and local, regional and national governments. Innovation Management frameworks[24] (Trott, 2005) are referring that organisation's knowledge base accumulates knowledge over time, while ensuring the strategic alignment of core resources and capabilities to generate at the end of the process value added products and services, and supporting research programs and projects, ultimately increasing value to end consumer and to all key stakeholders; and the external inputs to organizations and business strategies such as macro factors return on investment (ROI), costs and competition; to research and technology such as scientific and

[24] See Trott, P. (2008), *Innovation Management and New Product Development*, Pearson Educational, 4th edition.

technological development, competitors, suppliers, customers and university departments; and to marketing and communication such as societal needs, competitors, supplier partnerships, distributors, customers and strategic alliances.

The access to ERC public funding is ensured on a transnational basis for Knowledge and Innovation Communities (KICs) implementation and for technology transfer networks establishment or scale-up. Both entities, ERC and EIT, are currently under the umbrella of the 7th Framework Program (FP7) which aims to support research projects with the following identifiable patterns:

(1) Transnational Integration: applicant projects should comprise entities from at least two different countries. This typology permits to focus on Capacities – "Regions *of Knowledge's"* program, which goal is to enable regions to strengthen their capacity for investing in and conducting research and technological development activities in a way that can contribute significantly to their sustainable economic development. To this end, "*Regions of Knowledge"* will support the cooperation, the development and the integration of regional research-driven clusters on a transnational basis (European Commission, 2011, p. 4).[25] Another call from *Capacities*' work program, "*Research Potential"*, intends to promote the "integration of research entities from the EU´s convergence and outermost regions [...] and the enhancement of their innovation potential" (European Commission, 2011, p. 12).[26] In this case each applicant must establish partnerships with at least three research organizations in the same scientific or technological domain or in a complementary field, from three or more member states or associated countries, other than that of the applicant. Other important work program is "*People"* that focus on the development of transnational Initial Training Networks (ITNs) for young researchers. In this case the main implementation mode is through "*Multi-partner's ITNs"* and it must comprise at least three managing partners, established in different member states or associated countries. Finally, another type of ITNs, namely *European Industrial Doctorates*, allows applications with two partnering institutions from different countries (European Commission, 2011);[27]

[25] Capacities Work Program: *Regions of Knowledge Call*, p. 4.
[26] Capacities Work Program: *Research Potential Call*, p. 12.
[27] People Work Program: *Initial Training Networks* (ITNs), p. 11

(2) Industry-Academy Partnerships/Research Joint Ventures (RJVs): both *Capacities'* and *People's* work programs intend to promote open innovation Public–Private–Partnerships (PPPs) and the reinforcement of University–Industry pathways, aiming effective knowledge transfer and human capital[28] mobility between public and private sectors. Although ERC is focused on financing basic research also allows applications for the development of applied research, international R&D networks implementation and technology transfer projects;

(3) Measurable Outcomes: calls from *Capacities'* and *People's* programs require co-substantiation about the potential feasibility of Research Joint-Ventures (RJVs). In this case, applicants must provide evidence that milestones are reliable and feasible during project length. The demand for measurable outcomes is also reflected on knowledge *state-of-art* upgrade consubstantiation for ERC's calls,[29] on effective technology transfer and career integration of early-stage researchers for ITNs and on action plans requirement for all activities taking place in the following 36 up to 42 months for *Research Potential's* calls;

(4) Interdisciplinary and Intersectorial research and training: in a wider perspective, the FP7 promotes the integration of several scientific and technological domains or complementary fields, in order to produce multidisciplinary basic and applied research that could enhance economic activity through the introduction of novel value-added marketable products or services and of knowledge-based new business formation. In the EC's perspective, the adoption of a multidisciplinary framework also enhances the emergence and the consolidation of new supra-disciplinary fields leading to further knowledge breakthroughs with social and economic impact (European Commission 2011).[30] In this sense, the ERC strongly encourages the presentation of interdisciplinary and intersectoral research proposals, as formally outlined by "*Ideas"* work program and informally advertised at "road-shows" across several universities and research institutions. After 2013, FP7[31] will be replaced by the 8th Framework Program (FP8) which has a forecasted endowment of

[28] i.e. career integration of graduating students and early-stage researchers, as they move from university to a labor market.
[29] ERC's Research Grants are financed by *Ideas Work Program*, and integrate FP7's calls (Ideas Work Program, 2011).
[30] People Work Program: *Initial Training Networks* (ITNs), p 12.
[31] FP7's overall budget according decisions of European Parliament and European Council is €50.521 million. The length of calls implementation is from 2007 to 2013 (European Commission 2006).

€80bn and will take place from 2014 to 2020. The FP8 will be a significant part of the *Europe 2020 Growth Strategy* umbrella program, which has an overall budget of €140 billion (European Commission 2012).[32] The EC already pointed out *Scientific Excellence*, *Industrial Leadership* and *Facing Societal Challenges* as the key-goals for the new Research and Innovation Framework Program as well as its main guidelines which are coherent with FP7's approach. In terms of the *Scientific Excellence* area the main priorities are kept reinforced and intend to make Europe a more attractive destination for cutting-edge research from a wider transnational perspective. Regarding *Industrial Leadership*, the investment priorities seem to become narrowly focused on specific high-technology domains, more precisely ICT, nanotechnologies, advanced materials, biotechnology, advanced manufacturing and processing. The last priority consists on *Facing Societal Challenges*, previously identified by the EC, more precisely: (1) Health systems sustainability, demographic change and active-ageing; (2) Food security, sustainable agriculture and marine resources exploitation; (3) Renewable energy generation, energy efficiency and smart-grids; (4) Eco-friendly, efficient and integrated public transportation; (5) Resource sustainability and efficient raw materials application and (6) Developing inclusive, innovative and secure societies. In this case FP8´s strategy seems to reinforce the weight of the multidisciplinary applied research, already highlighted on FP7. In spite of that, the investment focus moves from multidisciplinary *basic research* towards *research-to-market* activities such as piloting and demonstration, test-beds and support towards public procurement and market uptake.

Hence, EU Policy-Making, namely FP7 program is focusing on increasing the potential of the knowledge triangle, by fostering access to ERC public funding on a transnational basis for Knowledge and Innovation Communities (KICs) implementation and for technology transfer networks establishment or scale-up processes which ultimately would reinforce network contextual conditions and globalization to support the increase of agglomeration economics and industrial clustering.

[32] Europe 2020 Strategy Communication. Available from (http://ec.europa.eu/research/horizon2020/pdf/proposals/communication_from_the_commission-horizon_2020_-the_framework_programme_for_research_and_innovation.pdf#view=fit&pagemode=none) [Accessed: 22 Novembro 2011].

On the other hand, to analyze and discuss the potential of transnational approaches innovation policy one has to address the phenomena at a national and regional scope from economic attractiveness and market potential perspectives. Harris (1954) observed that in United States of America (USA) the manufacturing industries were concentrated in just about a twelfth of the country area but at the same time, that regional cluster aggregated almost half of national demand and retains nearly 70% of total labor force. In this sense, regional intrinsic features become crucial in modelling the R&D-growth linkage and an innovation policy that only relies on increasing R&D outlays is ineffective on increasing economic growth (Fritsch and Mueller 2004; 2008; Pessoa 2010). On the other hand, the capability of regions attracting and retaining advanced sectors or industries also depend on their market potential (Harhoff 2000; Norman 2002). Pires (2005) applied New Economic Geography (NEG) model to assess regional market potential and its correlation with welfare in Iberian regions (NUTS II). It was found that – at an Iberian scale – are only three consolidated economic centers (Madrid, Cataluña and País Vasco) and two emerging (Valencia and Sevilla). The existence of statistically significant economic centers at NUTS II level has a crucial importance because demonstrates that regions with higher demand of goods and services are also more attractive destinations for industry and Foreign Direct Investment (FDI). Regions with higher market potential tend to attract and retain more qualified critical-mass and to produce more wealth while the economically peripheral regions tend to become poorer and loose resources and FDI streams to more central regions. For instance, Madrid had a market potential (F_I) of 1.44 which is about 0.66 times higher than Lisbon (F_I=0.87). This means that given the spatial distribution of markets and if the technology in the two regions were the same, one firm in Madrid would be able to pay for production factors[33] nearly 70% more, than a firm located in Lisbon. As economic centers like Madrid can pay more for capital and labor, they are able to attract and keep more investment flows and some of the most qualified, creative and productive human capital available. The capability of having more qualified human capital and better technology allows regions to improve their productivity (Harhoff 2000; Fritsch and Mueller 2004; 2008;

[33] If the technology used by market players were the same. As pointed out by Pires (2005), the market potential analysis considers that technological landscape is the same in all regions. This assumption exists to isolate the location effects from technological incorporation and inputs endowment differences between regions. By analysing the NEG (New Economic Geography) models we suggest that technological and knowledge intensity upgrade could become a sustainable approach for achieving productivity gains, additional competitiveness and market potential growth despite a less favourable geographical location.

Pe'er and Vertinsky 2008; Choudhary and Gabriel 2009; Teixeira and Fortuna 2010) and subsequently their investment return rates (Klepper 1996; Jovanovic 2001; Gilbert et al. 2008; Ciftci and Cready 2011) leading to more sustained investment flows (Norman 2002; Audretsch and Weigand 2005; Brown and Petersen 2010) and thus to market potential reinforcement (e.g. Pires 2005). In other words, globalization still is shifting the competitive landscape in developed economies away from being based on traditional inputs of production, such as land, labor and capital towards knowledge (e.g. David and Foray 2002; Audretsch et al. 2012).

Hence, the globalization game is played at the "region" as a strategic knowledge base so that SMEs rely on their Regional Innovation Systems (RIS) to access marketable knowledge and also to take opportunities from incumbents for commercialize it (Klepper and Sleeper 2005; Fritsch 2008; Acs et al. 2009). The competitiveness of developed economies is vulnerable to social dumping[34] and constrained by production factors endowment at a regional scope (Norman 2002; Pires 2005), but the knowledge as key-resource is less susceptible of replication, due the specific competencies required and the long-run know-how needed, while converting research outlays into marketable products and services (Friedman 2005; Kim and Mauborgne 2005; Lindic et al. 2012). In this sense, the knowledge base reinforcement (e.g. Audretsch and Keilbach 2004; 2008), the R&D intensity upgrade (Eckhardt and Shane 2011) and the University-Industry-Government pathways (Leydesdorff and Meyer 2003; Sternberg and Litzenberger 2003; 2004; Leydesdorff and Fritsch 2006) rather than just increasing R&D expenditures (Furman and Hayes 2004; Breznitz and Zehavi 2010) could become effective policy instruments in order to overcome the unfavorable effects from regional inputs endowment and spatial location (e.g. Bottazzi and Peri 1999; Cooke, 2001; Caragliu and Bo 2011; Knoben et al. 2011; Fagerberg et al. 2012). In spite of the highest uncertainty, the asymmetric information and the difficulties on appropriating returns from investments on newly

[34] According literature we interpreted social dumping like the adoption of low wages and social-standards and the conscious enhancement of higher return rates to capital investors as part of a long-term adjustment process adopted by less-developed economies. Sinn (2001) describes social dumping as an inevitable reality rather than intentionally neglecting of social workplace, safety legislation and labour co-determination rights by national governments in European less-developed countries. This author pointed out that labour force mobility towards countries with higher wages will lead to a gradual wage and social standards harmonization within less developed countries. The sustainable inflation, while below the European Union average, generates labour productivity growth and progressive harmonization of effective wages. As the wage gap between developed and less-developed economies becomes narrow, Foreign Direct Investment (FDI) will decrease, gradually slowing down further effective inflation and keeping at the same time a sustainable long-term competitiveness.

created knowledge that characterize innovation-driven markets, the R&D intensity positively influences the access to financing (Eckhardt et al. 2006; Brown and Petersen 2010; Ciftci and Cready 2011) and even SMEs benefit from better access to funds than their larger counterparts within less knowledge intensive industries (Audretsch and Weigand 2005). The R&D intensity presumably provides an enhancing environment for SMEs to grow by continuously investing on innovation and attracting external capital (Audretsch 1995; Harhoff 2000; Baumol, 2004; Carlsson et al. 2007; Huynh and Petrunia 2010). The quality improvement of the technological environment is also connected with higher market power by firms (Wersching 2010) and as pointed out by Auerswald "in industries where production processes are more complex, persistent profits accrue to surviving firms. Such profits are significant in the early stages of industries where technology is of intermediate complexity—that is, where learning is rapid enough to confer a competitive advantage, but imitation is sufficiently uncertain to deter later entry" (2010, p 578).

However, despite the role of knowledge complexity or sophistication, the innovation policies should consider a mixed framework of different technological levels and maturities in order to improve their effectiveness. If the main goal is improving the overall RIS quality, medium-technology manufacturing has much more impact than high-tech production because supports the establishment of local synergies by improving University-Industry-Government "stickiness" within a cluster or geographical unit (i.e. such as NUTS II or NUTS III). On the other hand, the risk is that high-tech manufacturing doesn't provide "structure" to local knowledge contexts, because besides being small scale, is focused on internal, centralized and "globalized" production within multinational corporations, taking place as spinoffs of highly specialized research institutions and involving global markets more than local human capital or knowledge sources. Besides, from an industrial organization perspective, medium-tech manufacturing can work as seedbed for high-tech production, because allows maintaining the absorptive capacity, so that knowledge and technologies developed elsewhere can be understood, disseminated more easily and adapted to local circumstances (Doloreux 2003; Doloreux and Parto 2005; Leydesdorff and Fritsch 2006; Pessoa 2010; Teixeira and Fortuna 2010).

The co-substantiated hypotheses regarding RIS configuration and their impact on economic and employment growth could become even more important when EC's Research and Innovation policies consist mainly on transnational research-driven clusters and KICs implementation. The *Europe 2020 Growth Strategy* is also focused on enhancing high-technology production towards industry leadership instead balancing a mix of several technological features, levels and maturities, such as medium-tech manufacturing or simply improving the availability of high-tech service providers. Knowledge intensive services are usually decoupled from local economies, but the high-tech services have the capability of shaping the underlying knowledge base configuration. Despite "size" and "location" issues, if stimulated on a high-tech end, the knowledge intensive services may contribute to improve the absorptive capacity in economically peripheral areas and, thus, to reduce asymmetries in manufacturing technologies, by spreading and disseminating specialized know-how, across the several regions (Leydesdorff and Fritsch 2006; Teixeira and Fortuna 2010).

Considering all these aspects strongly supported by the literature, one could ask him/herself if the R&D financial incentives shouldn't be measured, planned and implemented at a regional scope instead at EU's space as a "homogenous macro-conglomerate". In other words, shouldn't the European funding framework be adapted to the spatial location, knowledge base maturity, absorptive capacity, technological sophistication, productivity and potential competitive advantages of each region?

1.4. Formulation of the Dataset and Methodology

It was chosen the OECD Regional Statistics Database as initial dataset, comprising a total of 231 regionally standardized variables. The geographical scope selected for analysis is the OECD Territorial Level II (TL II) and the sample consists in 158 regions[35] which make part of 18 European countries[36] and were selected from an original dataset of 396 regions across 34 OECD's countries.

[35] OECD Regional Statistics Database includes two aggregation levels: Territorial Level II (Large Regions) and Territorial Level III (Small Regions). However, the set of variables made available for Territorial Level III is quite different, more incomplete and much smaller than Territorial Level II.

Table 1

Themes available on OECD Regional Statistics Database

Variables Segmentation	
Themes available in OECD Database	Number of variables
Economics	44
Demographic Statistics	15
Innovation Indicators	61
Regional Labour Market	101
Social Indicators	10
Total Variables included in Dataset	*231*

Source: Own preparation and OECD Regional Statistics Database

The sample includes all European countries available in OECD Regional Statistics Database. It was only considered the European countries because their Regional Innovation Systems (RIS) aren't comparable, for instance, with the North-American ones (Cooke 2001) as shown by the emergence of the so called European Paradox (Ejermo et al. 2011; Audretsch et al. 2012).

Table 2

European Countries covered: Territorial Level and Number of Regions

European countries covered	Territorial Level	Number of Regions
Austria	Level II OECD	7
Belgium	Level II OECD	3
Czech Republic	Level II OECD	8
Finland	Level II OECD	4
France	Level II OECD	21
Germany	Level II OECD	16
Greece	Level II OECD	4
Hungary	Level II OECD	7
Ireland	Level II OECD	2
Italy	Level II OECD	21
Netherlands	Level II OECD	4

[36] All of them are members of European Union (EU 27), with exception of Norway.

Norway	Level II OECD	7
Poland	Level II OECD	9
Portugal	Level II OECD	4
Slovakia	Level II OECD	4
Spain	Level II OECD	17
Sweden	Level II OECD	8
United Kingdom	Level II OECD	12
Total number of regions		158

Source: Own preparation and OECD Regional Statistics Database

On the other hand, the regional variables were collected over a time span between 1998 and 2008, in order to maximize the series fit with available data. The number of regions included in the sample is less than total of the regions made available by OECD Regional Statistics Database for Territorial Level II (TL II) due to only the series that have a reasonable number of original values were considered to be included in the analytical approach. This procedure is justified by the need of obtaining the yearly variation-rates for further estimation of an unbiased geometrical-average for each region and over the studied period. In this sense, the time span was also chosen taking into consideration the fit with original information available, in order to maximize the usage of unprocessed data. The remaining missing values were completed using different methodologies, according to its nature: (1) Single intermediate values were calculated with an arithmetical mean of the two nearest years; (2) Whenever missing a sequence of two or more values in the middle years, was estimated the yearly variation-rate matching the previous and the subsequent existent values in order to fulfil that “gap”; (3) If the value fells near the beginning or the end of the series, a geometrical-average of the variation-rates between the available values sequence was applied. Due the existence of missing values in all studied variables, these were the procedures applied for each one of the 231 variables available in OECD Regional Statistics Database. After data collection and the implementation of missing values estimation procedures, it was calculated the yearly variation-rates and the correspondent geometrical-average for each region over the ten years time span. In other words, the geometrical-averages belonging to the 158 regions and covering the period between 1998 and 2008 are the concrete data series for the 231 variables considered in the sample.

In order to test the first hypothesis that is possible to identify a clear set of composite dimensions which constitute the input layer of RIS one could recur to Factorial Analysis. This statistical method allows defining the underlying structure of the data matrix in order to reduce the original and larger group of variables into a smaller number of factors that could resume the explanatory capacity from the original set. The extracted factors are also less sensitive to potential data recording errors than single variables would be, because the bias effect is dispersed by the whole set of original variables within each factor. The accomplishment of the assumptions of normality, homoscedasticity and linearity are not required or can be applied in a less restrictive mode. According to this methodology, the multicolinearity which causes serious difficulties in other types of statistical analysis, in this case is desirable, given that the main goal is to identify sets of variables which might be found to be interrelated. Whenever clearly differentiated subgroups of variables emerge in which each one of them are highly interrelated or doesn't show any relationships, the original group of indicators will be able to be simplified to a few factors. These will summarise the information held in common by the several variables included in each factor (Pestana and Gageiro 2008). Moreover, to check the second hypothesis regarding the identification and measurement of statistically significant relationships between the RIS "subsystems" and the attainment of measurable outcomes at a macro-economic level, it was applied an Ordinary Least Squares (OLS) regression, assuming the non-observable core-components generated through Factorial Analysis as Independent or Input variables and Unemployment rate, Youth-Unemployment rate, Gross Value-Added (GVA) and Gross Domestic Product (GDP) as Dependent or Output variables generating 4 "hypothetical models" to be tested:

Unemployment (1), Youth-Unemployment (2), GVA (3) and GDP (4)

= const. + β_1 x Corporate R&D + β_2 x Market Potential + β_3 x Demand Sophistication + β_4 x Governmental R&D Investment + β_5 x Technological Capacity + β_6 x Knowledge Intensity + β_7 x University R&D Employment + β_8 x Governmental R&D Employment + ε

1.5. Core-dimensions of RIS

The Factorial Analysis[37] started from the original dataset of 231 variables and by means of a process of trial-and-error only 25 have finally been kept, generating 8 factors or underlying dimensions[38] that are linear combinations of the originals. These factors reflect better the core-components of a RIS, than each one of the individual variables could do so, as they not only group together all related variables, but also reflect the interaction between factors, as the model correlates each variable to all factors, not only to the one in which it is included.

Table 3

Hypothetical Components: Factorial Weights, Communalities and Theoretical Dimensions

Matrix of Rotated Components	RIS Hypothetical Components		
	Components	Communalities	Theoretical Dimensions
1. Corporate R&D Expenditures (% of GDP)	.943	.910	**Corporate R&D**
2. Corporate R&D Expenditures (USD, PPP)	.938	.911	
3. Corporate R&D Employment (Number)	.895	.834	
4. Corporate R&D Employment (% of total employment)	.820	.727*	
5. Corporate R&D Expenditures (USD)	.815	.689*	
6. Population (Number)	.920	.911	**Market Potential**
7. Density (Persons per square kilometre)	.914	.909	
8. Labour Force (Number)	.914	.926	
9. Employment (Number)	.847	.839	
10. GDP per worker (USD)	.914	.899	**Demand Sophistication**
11. GDP per Capita (USD)	.907	.870	
12. Primary Income per Household (USD)	.890	.908	
13. Disposable Income per Household (USD)	.759	.791	
14. Governmental R&D Expenditures (% GDP)	.960	.955	**Governmental R&D Investment**
15. Governmental R&D Expenditures (USD, PPP)	.957	.988	
16. Governmental R&D Expenditures (USD)	.952	.979	
17. High and Medium Technology Employment (% total employment)	.947	.945	**Technological Capacity**
18. High and Medium Technology Employment (Headcount)	.936	.927	
19. High and Medium Technology Manufacturing (% total manufacturing)	.910	.840	
20. Knowledge Intensive Services Employment (% of total employment)	.908	.879	**Knowledge Intensity**
21. Knowledge Intensive Services (% total services)	.905	.884	

[37] For further analysis on the necessary validation requisites, procedures and implications of Factorial Analysis, as statistical inference method, please see Pestana and Gageiro (2008).

[38] The 8 Factors and their composition are entirely congruent with theoretical framework already highlighted in literature review, are compatible with Frascati's Manual (OECD 2002) and also with a important previous research from Buesa et al. (2010).

22. University R&D Employment (% total employment)	.897	.890	**University**	**R&D**
23. University R&D Employment (Number)	.726	.720*	**Employment**	
24. Governmental R&D Employment (% total employment)	.804	.806	**Governmental**	**R&D**
25. Governmental R&D Employment (Number)	.745	.790	**Employment**	

Source: Own Preparation. The asterisks* indicate the communalities values which are less than 0.750

The communalities (i.e. correlation of each variable with regard to the set of the other variables making up the factor) of the variables are relatively high, most of them over 0.750,[39] which indicates a high degree of preservation of their variance, assuring the reliability of the findings. Moreover the 8 factors retain nearly 87 per cent of the original variance and there is a scarcely 13 per cent loss of the information held in the original set. Besides, other important dimension to judge the outcomes of Factorial Analysis is qualitative validation (Manso and Simões 2009) in which one must take in consideration two important principles to support the present analytical approach:

(1) Parsimony: Factorial Analysis aims to explain the correlations between the original variables, retaining at the same time most of the variability from the initial set, with less factors as possible in order to make theoretical constructs become more interpretable, measurable and operational for policy making purposes;

(2) Interpretability: Factorial Analysis is recommended to be used only if the outcomes are coherent with the theoretical background and with the previous empirical findings within the respective research domains or complementary fields generating clear but consistent "interpretability gains".

Hence, the 25 original variables were integrated in 8[40] composite dimensions improving significantly the interpretability of RIS construct with only 13 per cent of variability loss. In other words, the extracted factors are consistent and also interpretable in accordance with the theoretical framework of the research field, i.e.,

[39] The only exceptions are Corporate R&D Employment (% of total employment) with 0.727; University R&D Employment (Number) with 0.720 and Corporate R&D Expenditures (USD) with 0.689.

[40] Quantitative criteria were applied to Factorial Analysis ensuring an explicative, coherent and consistent analysis. Firstly, it was assured that communalities (i.e. the correlation of each variable with regard to the set of the other variables making up the factor) of the variables were relatively high, most of them over 0.750. Secondly, the Cronbach's α (Alpha), that is the coefficient of internal consistency of the factors, and measures the correlation among the original independent variables that compose each one of the factors. This measure can be viewed as an extension of the Kuder–Richardson Formula 20 (KR-20), and although Alpha is not robust against missing data, the Alpha value was always over 0,7 which means there is a high internal consistency of the factors. In fact as it measures the multicollinearity among original independent variables (25) in each one of the factors (8), that can be applied in complementary statistic and/or econometric analysis.

Regional Innovation Systems (RIS). The interrelated variables belong to the same "subsystem" of the overall RIS, in which, the variables belonging to a certain structural component are located only on that factor. Therefore, each factor can be labelled with a "name" that clearly expresses the nature of their whole set of original variables. According to Pestana and Gageiro (2008), one can select Factorial Analysis by Principal Components with VARIMAX rotation and KAISER normalization, because this procedure makes possible to obtain more interpretable factors, as well as other advantages of statistical nature, such as, predetermining the angle between axes. Besides, the factorial pattern obtained through this specific rotation procedure tends to become more robust than the ones obtained from alternative methods, assuring the maximum orthogonality between factors, which is important for the use of further statistical analysis.[41]

1.6. Macro-economical Outcomes of RIS and Interpretation of Results

The first model suggests that Technological Capacity (-0.650) and University R&D Employment (-0.415) reduce Unemployment. However, other RIS components, namely Knowledge Intensity (+0.436) and Market Potential (+0.424) seem to favour Unemployment. In this case, the overall RIS structure exerts a statistically significant influence (ρ-value of 0.038) and explains 10.2% of Unemployment variance (R^2 of 0.102).[42] The results from the second model, suggest that level of *Demand Sophistication* (-1.219), *University R&D Employment* (-1.195) and *Governmental R&D Employment* (-0.564) have an important role on reducing Youth-Unemployment. The regression model is significant (*ρ*-value of 0.000) and 18.7% of Youth-Unemployment variance is explained by the overall RIS (R^2 of 0.187). It seems important to point out that the RIS configuration doesn't have any downside in terms

[41] The four Dependent or Output Variables are also part of OECD Regional Statistics Database, are already included in presented dataset and were submitted exactly to the same procedures than the Independent or Input variables.

[42] R^2 measures the variance of the dependent variable (factor) in function of the variance of the independent variable (Unemployment, Youth-Unemployment, GVA, GDP), i.e., the percentage of the variance of the dependent variable that is explained by the independent variable. In the Linear Statistical Model R^2, as a coefficient of determination, represents the proportion of variability in a data set that is accounted for by the model, in which the term "variability" is defined as the sum of squares. Thus, R^2 represents an analysis of variance decomposition, or a measure of goodness of fit of the model that shows its multi-impact, which reflects, globally, the adherence of the model.

of Youth-Unemployment. In the third regression model it was found that *Demand Sophistication* (+1.039), *Market Potential* (+0.599), *Governmental R&D Investment* (+0.167) and *Technological Capacity* (+0.132) and *Corporate R&D* (+0.095) have a positive impact, enhancing Gross Value Added (GVA), but at the same time *Governmental R&D Employment* (-0.101) has a negative influence on GVA. The regression model is statistically significant (*ρ*-value of 0.000) with the RIS model being responsible for 87.8% of GVA variability (R^2 of 0.878). The fourth model estimation shows that *Demand Sophistication* (+1.257), *Market Potential* (+0.601), *Governmental R&D Investment* (+0.145), *Knowledge Intensity* (+0.093) and *Corporate R&D* (+0.081) have an enhancing effect on Gross Domestic Product (GDP) although the effort on increasing *Governmental R&D Employment* appears to "consume" (-0.088) some of the wealth generated. The estimation is significant (*ρ*-value of 0.000) and explains 91.8% of GDP variance (R^2 of 0.918).

Table 4

Estimation Results. Endogenous Variables: Unemployment (1), Youth-Unemployment (2), GVA (3) and GDP (4)

	OLS			
	1. Unemployment	2. Youth-Unemployment	3. Global Value Added	4. Gross Domestic Product
Corporate R&D	*0.200 (0.430)*	*-0.073 (0.829)*	0.095 (0.013)***	0.081 (0.020)***
Market Potential	0.424 (0.094)*	*0.293 (0.387)*	0.599 (0.000)***	0.601 (0.000)***
Demand Sophistication	*-0.136 (0.592)*	-1.219 (0.000)***	1.039 (0.000)***	1.257 (0.000)***
Governmental R&D Investment	*0.013 (0.960)*	*0.520 (0.125)*	0.167 (0.000)***	0.145 (0.000)***
Technological Capacity	-0.650 (0.011)**	*-0.367 (0.278)*	0.132 (0.001)***	*0.010 (0.767)*
Knowledge Intensity	0.436 (0.086)**	*0.414 (0.221)*	*-0.038 (0.308)*	0.093 (0.007)***
University R&D Employment	-0.415 (0.100)*	-1.195 (0.001)***	*0.011 (0.778)*	*-0.053 (0.128)*
Governmental R&D Employment	*-0.228 (0.367)*	-0.564 (0.097)*	-0.101 (0.008)***	-0.088 (0.011)***
Constant	96.500 (0.000)***	98.607 (0.000)***	105.337 (0.000)***	105.430 (0.000)***
F test	2.115 (0.038)**	4.289 (0.000)***	134.382 (0.000)***	209.297 (0.000)***
R^2	0.102	0.187	0.878	0.918

Source: Own preparation. In brackets the *p*-value. In italics are the non-significant coefficients to 90%. The asterisks *, ** and *** indicate significance at the 10%, 5% and 1% level, respectively. The data includes 158 European regions from OECD Regional Statistics Database.

1.7. Final Remarks, Discussion and Policy implications

This chapter provides empirical evidences that innovation could be managed effectively through a regional scope due the localized nature of knowledge spillovers, absorptive capacity, technological transference, manufacturing set-up and new business formation. It is possible to identify the "subsystems" that shape the overall RIS and that could be generalized to all European regions despite their differences and idiosyncrasies. Surprisingly, the relationships between RIS core-dimensions and the attainment of measurable outcomes at a macroeconomic level show that Governmental R&D Investment doesn't have statistically significant impact on Unemployment or Youth-Unemployment. Increasing Governmental R&D Investment contributes to a higher GVA and GDP but is far away from being a "panacea" for stagnant growth due the small weight of the impacts. Although Governmental R&D Investment is a necessary condition for sustainable development (Carlsson et al. 2007; Ejermo et al. 2011) is not the most important factor when aiming economic growth, at least, in the context of European developed economies. Governmental R&D Investment has less impact than Demand Sophistication and Market Potential, respectively, either in GVA or in GDP.[43] This means that RIS effectiveness translating R&D investments into economic growth relies on creating the necessary conditions for keeping or increasing the consumption of goods and services, at a regional scope. In other words, regions should have the levels of income needed for absorbing and leveraging the growth and the technological development of a local supply. The Demand Sophistication also affects the capability of a certain region to grow or to increase their Market Potential by attracting skilled, qualified, creative and productive human capital that can develop, design and produce, more and better products or services, at competitive prices. In this sense, the results are congruent with the previous findings from Norman (2002); Pires (2005); Acs et al. (2008); Gilbert et al. (2008); Pe'er and Vertinsky (2008) and Teixeira and Fortuna (2010) suggesting that Market Potential has a double-role:[44]

[43] Increasing R&D Investments, either public or private, is not enough to enhance economic growth. Specific market factors are crucial shaping R&D-growth link and an innovation policy that only relies on increasing R&D outlays is ineffective in increasing economic growth (Pessoa 2010).

[44] The findings are also congruent with NEG (New Economic Geography) models (e.g. Krugman 1991).

(1) Assuring demand: generating economies of scale that can guarantee the necessary levels of demand for products and services produced, assembled, distributed or sold inside regional boundaries in order to leverage an attractive level of remuneration for production factors (i.e. capital and labor) leading to FDI and to medium technology manufacturing set-up;

(2) Building “critical mass”: increasing the availability of qualified human capital – embodied in Technological Capacity and in Knowledge Intensity – tends to improve the companies absorptive capacity, productivity, rates of growth, technological update and the fit with market needs, leading to higher value-added and thus to enhance competitiveness.

Regional market size and income growth encourage firms to move away from centralized operations and to adopt multi-location strategies, leading to FDI and to medium technology manufacturing set-up (Harhoff 2000; Leydesdorff and Fritsch 2006). The critical importance of Market Potential and Demand Sophistication demonstrates the need of managing innovation in an integrated way, instead of focusing narrowly on increasing R&D expenditures. For instance, factors that are value-drivers in terms of increasing wealth can reduce welfare at the same time and the opposite is also true. This is demonstrated by the particular cases of Knowledge Intensity and Governmental R&D Employment. A higher availability of knowledge intensive services within a specific region creates an incentive for companies using outsourcing as a replacement of regular employment. Given the economies of scale availability and the mobility of service providers inside regional boundaries, companies tend to increase their level of outsourcing generating additional Unemployment (Friedman 2005). The knowledge intensive services are also decoupled from configuration of the regional economy and the headquarters location of service providers is more influenced by geographical and logistic reasons than by the specific RIS characteristics (Leydesdorff and Fritsch 2006). However, replacing – on a higher degree – non-core regular employment by specialized service providers allows companies to reduce overall costs and to improve their competitiveness by converting structural costs into variable ones (Piore and Sabel 1984). This will produce an optimization effect in the value chain profit margin, by externalizing non-core activities, decreasing overall fixed costs and focusing on differentiated value

added activities and sources of competitive advantages. In this sense, Knowledge Intensity contributes to prices flexibility and to firms coping capability with competitive market environments, generating more sales and thus leading to higher GDP growth rates. On the other hand, Governmental R&D Employment can have the opposite effects, because is important for reducing Youth-Unemployment, but at a same time has a negative impact on competitiveness as expressed by GVA and GDP series. These are precisely the differential effects of specific RIS "subsystems" that make it difficult to operationalize for policy making purposes as pointed out by Uyarra (2010).

Despite Governmental R&D Employment negative side-effects in what concerns to GVA and GDP, University R&D Employment seems to have a quite important role reducing Unemployment and specially Youth-Unemployment, but at the same time doesn't have any downsides in terms of economic growth. This means that replacing the Governmental R&D Employment for the University R&D Employment, at least until a certain level, could be an effective policy for promoting both employment and youth-employment without consuming public resources inefficiently. This is recommended mostly, when R&D outlays from regional universities are measurable, competitive and aiming for international benchmarking in terms of scientific outputs, absorptive capacity improvement, productivity incorporation and technological transference and thus have a tangible impact on the value-added and on the competitiveness of the economic tissue. Although some subsystems (i.e. Knowledge Intensity and Market Potential) contribute to additional Unemployment, seems important to point out that none of the RIS core-components has downsides in terms of Youth-Unemployment. If balanced with other policies and accounting for the specific trade-offs of each subsystem the overall RIS "quality" improvement appears to be one of several possible solutions for providing additional youth-employment despite the several impacts favoring Unemployment.

On the other hand, Governmental R&D Investment and Technological Capacity enhancing policies seem to be linked to GVA growth, showing that managing innovation in a regional scope can be used to increase wealth in an effective and measurable way. The Technological Capacity role in GVA growth is congruent with previous findings of Auerswald (2010) that the development of a higher technological degree, embodied in a more complex production and in less replicable technologies

and products, whenever fitting the market needs (Adner and Levinthal 2001) and matching firms' absorptive capacity (Harhoff 2000; Teixeira and Fortuna 2010) allows practicing higher prices and thus increasing the profit margins without decreasing the demand levels (Wersching 2010).

It was also found that Governmental R&D Investment and Knowledge Intensity have significant positive impacts on GDP and according the insights provided by Piore and Sabel (1984), Zenger (1994), Norman (2002) and Friedman (2005), the knowledge intensive services scale-up generates competitiveness gains and business volume growth through:

(1) Increased flexibility: conversion of structural costs into variable ones, improving companies coping capability with demand volatility;

(2) Improved competitiveness: production optimization supported by the knowledge intensive services availability allows companies to reduce prices without deter profitability and to improve coping strategies with bullish conjunctures and intensive pricing competition.

In conclusion, although Knowledge Intensity enhances GDP growth, also generates higher Unemployment because works as incentive for outsourcing, inducing regular employment replacement by external service providers at a deeper scale, the creation of additional Unemployment, in this case, is much stronger than the contribution to GDP growth, pointing out the need of considering the specific trade-offs of this policy. The Corporate R&D also contributes to creating the necessary conditions for achieving a higher economic growth (Audretsch 1995; Harhoff 2000; Huynh and Petrunia 2010; Eckhardt and Shane 2011) and that seems to be reflected both on GVA and on GDP growth rates provide by the empirical model. According to literature, the firms' R&D intensity improves the access to financial resources despite their size (Audretsch and Weigand 2005) creating an enhancing environment for growth within regional clusters (Gilbert et al. 2008). However, despite the small positive effects on economic growth, Corporate R&D is not linked to additional Employment or Youth-Employment gains.

Results suggest that RIS core-dimensions can be used effectively, both for improving welfare and for achieving higher Economic Growth, if they are measured, planned

and implemented in an integrated way. However, the RIS subsystems are not homogenous and some of them have significant negative side-effects, such as creating Unemployment or reducing Economic Growth. Increasing Governmental R&D Investment can have a positive contribution to economic growth but increasing R&D expenditures may be ineffective if not combined with Demand Sophistication and Market Potential policies. It is also worth to mention that Government R&D Investment doesn't have any impact on employment, pointing out the need of assessing the trade-offs of policies that could lead to significant expenditure increases. Surprisingly, Governmental R&D Employment doesn't contribute to mass-market employment despite its quite important role on reducing Youth-Unemployment. At the same time, Governmental R&D Employment seems to be a quite inefficient policy because it consumes financial resources, penalizing economic growth, as expressed by the negative relationships with GVA and GDP. Besides, translating R&D outlays into employment and economic growth doesn't work on a simple "input-output" logic. On the other hand, increasing R&D investment scale, either public or private, is a necessary condition for building sustainable development, but must be combined with other policy measures to become effective. In terms of wider policy implications, results reinforce the idea that European Commission Research and Innovation policies must be restructured, shifting from a transnational framework to a more localized, measurable, operational and goal-oriented approach. Finally, the emergence of the so called "European Paradox" shows that R&D public investments are not being as effective as possible and increasing public R&D expenditures scale is not enough to generate employment and sustained economic growth. In other words "throwing money on the problems" policy is neither an efficient nor an effective solution. In the present conjuncture, RIS approach may be a valid alternative, because it seems to improve regions capability for exploiting their differential competitive advantages in order to overcome the unfavorable effects from inputs endowment, spatial location or knowledge base maturity.

On the one hand, the fact that entrepreneurial and innovative activity varies across geographic space has been observed and on the other hand spatial activity is not random but shaped by factors associated with particular regions instead (Reynolds, Storey and Westhead, 1994).

Moreover, several studies have tried to identify characteristics and attributes specific to particular regions that account for inter-spatial variations in entrepreneurship and innovation, originating conceptual thinking and modelling of "Entrepreneurial clusters". In spite of the strong basis in terms of literature review which pointed out the linkage between the new firm startup and innovation activity to region-specific characteristics and attributes (Fritsch, 1997; Reynolds, Storey and Westhead 1994; Carlton, 1983; Bartik, 1985; Audretsch and Fritsch, 1994)[45], none of those studies provided a measure of knowledge spillovers, supporting theoretical basis for the propensity for entrepreneurial activity to cluster spatially, or established a clear linkage between entrepreneurial and innovative activity to knowledge context. The present research and empirical model moves forward in this direction identifying, analyzing, measuring and discussing the dimensions that shape RIS structure, and impacts in terms of policy-making on how to "generate the next Silicon Valley", revealing the importance of geographic proximity elements and regional agglomerations and evaluating how the underlying RIS subsystems exert statistically significant effect on employment and economic growth as well as its potential integrative management. Finally, in what concerns to policy-making at a regional scope, increasing R&D investments, public and private, are necessary conditions for building sustainable development and growth, although should be combined complementary with other policy measures influencing the contextual conditions to increase market potential, level of consumption of goods and services, and demand sophistication, which will promote GVA and GDP. Moreover, higher levels of income are necessary for absorbing and leveraging consumption, growth, technological development and differentiation at regional scope, focusing on core spatial geographical sources of competitive advantages, attracting qualified human resources and increasing competitiveness and regional economic attractiveness.

Last, but not least, there is an opportunity of shifting and restructuring R&D investment policies at European Commission's Research and Innovation from a transnational to a micro-regional approach following an integrative managing and monitoring framework, aiming for higher innovation, and consequently, employment and economic growth rates.

[45] See *The knowledge spillover theory of entrepreneurship and spatial clusters*, defended by Audretsch, D.B. and Aldridge, T.T., 2006).

Chapter 2

Artificial Neural Network Econometric Model approach on Regional Innovation Systems and their impact on Employment and Economic Growth

2.1. Abstract

Following the previous chapter, the purposes of this section is to analyze and discuss an innovative model approach to Regional Innovation System (RIS), by applying Artificial Neural Networks (ANNs), in order to generate pattern recognition algorithms capable of capturing salient features from a set of inputs and mapping them to outputs without making a priori assumptions about the specific nature of the relationships. Hence, the main goal is to cast some light inside the "innovation's black-box", describing Regional Innovation Systems (RIS) architecture and reducing the uncertainty surrounding R&D investments effectiveness in order to promote innovation, economic growth and employment.

The ANNs modelling was applied to the study of RIS architecture, aiming to identify the "hidden" mediatory variables, which could influence their overall impact on employment and economic growth.[46]

Empirical evidences demonstrate that the underlying RIS subsystems are not homogenous and can generate negative side-effects, leading to decreasing of net job formation. Results suggest that the economical agents' "quality" cannot be merely replaced with success by the implementation of "Keynesian policies" focused on enhancing "Market Potential", "Demand Sophistication" and "Governmental R&D Investments". In this sense, improving regional "Absorptive Capacity" is the most

[46] See Castro Soeiro, F. and Moutinho, R., 2013. *Inside the "Innovation's Black-Box": neural network architecture and its influence on employment and economic growth*. Small Business Economics Journal (Entrepreneurship Journal / Editors-in-Chief: Z.J. Acs; D.B. Audretsch). This was a research paper accepted for the 3rd INBAM Conference to be held in Lisbon 17-19 June 2013.

balanced and short-term development strategy for the regions characterized by a lower industrialization and income. However, the most stalwart and long-run impact on employment and economic growth potential is provided through regional Innovative Potential reinforcement.

From the methodological stand point the present explicative model encompasses novelty, revealing hidden layer's variables and demonstrating RIS subsystems are not homogenous, either generating positive, null or negative side-effects. The importance of this chapter is that ANN model leads to higher "goodness-of-fit" to explicative variables, when compared with other methods, namely Linear Regression, and also supports guidance on Policy-Making, in a more accurate and integrative way. The findings reinforce the idea that European Commission's Research and Innovation policies can be restructured and improved, changing from an expenditure increase paradigm, focused on a transnational approach, to a localized regional framework in order to effectively translate R&D investments into employment and economic growth.

The main findings were analyzed at the light of the research knowledge that applies ANNs to study RIS and Policy-Making implications were discussed.

(Keywords: Neural networks, Knowledge Economy, Innovation, Regional Innovation Systems, European Paradox, Knowledge Spillover Theory of Entrepreneurship, knowledge-Based Clusters, Cluster Mapping, Employment and Economic Growth, Policy-making)

2.2. Introduction

In the last few years many researchers who are working in the field of economics and management have found artificial neural networks (ANNs) very useful in explaining and predicting problems arising mostly in policy-making, finance, manufacturing, and marketing areas (see Zhang & Huang, 1995; Wong, Bodnovich & Selvi, 1997), and recently within behavioral research in organizations (Palocsay & White, 2004; Scarborough & Somers, 2006; Somers & Casal, 2009; Minbashian, Bright, & Bird, 2010). The aim of the previous studies was to establish the predictive accuracy of

neural networks in relation to more traditional statistical approaches and to explore the main differences and benefits of a new methodology in regarding to data and issues encountered in business research. Mostly, ANNs have been found to offer various advantages over conventional statistical methods such as linear regression, and many of these benefits were addressed by DeTienne (DeTienne and Johsi, 2003). The two advantages which are most relevant in this instance are that: firstly, neural networks are capable of learning an approximation to any functional form, providing their complexity (in number of hidden nodes) is increased sufficiently in the last decades (White, 1989). This means that there is no need for the researcher to specify underlying directional paths prior to analysis (Bejou, Wray, & Ingram, 1996) he/her wants to carry out. Secondly, there is significant value for scholars in the hidden layer nodes, which can be regarded as latent or unobserved variables related to macroeconomics phenomena, e.g., permitting to examine and predict variables of a RIS, or variables of a RIS' subsystem, or study variables from a core-component located in a specific factor; or related to microeconomics phenomena e.g., firms' variables, entrepreneurs and innovators' attitudes and behaviors that can, thus, be used in examining the survival and performance of small ventures or startups.[47]

After several studies using ANNs have been undertaken and the benefits of these networks been found to be outstanding, it is still worthwhile to note that this modelling approach remains open, and, unexpectedly, its application to some domains, namely to RIS and to knowledge Economy, which indicates this research encompasses novelty and point for additional research studies and modelling approaches.

Technological change and knowledge are critical drivers to achieve long-term competitiveness and to build economic sustainable growth (Arrow, 1962; Romer, 1990; Krugman, 1991). Nevertheless, "the advent of knowledge-based economy brought a shift over the analytical focus from technological change to innovation – the creation and diffusion of new knowledge in the form of novel products and processes" (Tappeiner, Hauser and Walde, 2008, p. 861). Nowadays, a knowledge context can also be interpreted as a community where people group together, using information and communication technologies, with the clear goal of co-producing and

[47] See Coelho, A. Zinga, A., Castro Soeiro, F. and Moutinho, R., 2012. *Using Artificial Neural Networks in the context of Research on Entrepreneurship: the case of SME performance and its determinants*. Journal of Business Research.

sharing new knowledge. In fact, knowledge's sharing communities, rather than just high-tech sectors, are the key drivers of innovation[48] (David and Foray, 2002; Foray, 2004) and change. Thus, to foster macro-economic competitiveness developed economies must invest in environments where knowledge-communities can proliferate (Tappeiner, Hauser and Walde, 2008). Moreover, regional contexts, underlying knowledge-based economies, rely on the interaction between Research, Education and Innovation, quite often conceptualized as the Knowledge Triangle[49] (Maassen and Stensaker, 2010). In the last three decades European regions have experienced a considerable industrial re-structuring, towards a more decentralized and flexible industry structure, in order to harness the forces of technology and globalization (Audretsch, Carree, van Stel and Thurik, 2000), shifting from traditional manufacturing to new and more complex industries, such as ICT, Biotech and Pharmaceutical (Carlsson, Acs, Audretsch, Braunerhjelm, 2007; Choudhary and Gabriel, 2009; Audretsch, Grilo and Thurik, 2012).

Nowadays, the Regional Innovation Systems (RIS) plays an important role for two main reasons. The first one is that the usage of new technologies, like software and e-commerce has reduced the importance of scale economies in many sectors (Piore and Sabel, 1984; Carlsson, 1989; Zenger, 1994; Norman, 2002; Klepper and Sleeper, 2005; Audretsch, Grilo and Thurik, 2012). What happens is that the role of new business formation in technological development is enhanced by economies of scale reduction and by the increasing of the degree of uncertainty in world economy (Mata and Machado, 1996; Audretsch, Carree, van Stel and Thurik, 2000; Audretsch and Thurik, 2001) and startups rely on their regional context to access knowledge sources and to develop innovative and marketable products (Audretsch and Lehmann, 2005; Audretsch, Lehmann and Warning, 2005; Gilbert, MacDougall and Audretsch, 2008). The second main reason consists in the increasing pace of

[48] New Economic Geography's literature highlights the role of creative cities in sustainable economic growth (Acs, Bosma and Sternberg, 2008). These authors, using GEM database found that most large cities have more entrepreneurial activity than their own countries. As less entrepreneurial is the country, the larger is the gap between cities and countries, concerning entrepreneurship measures. These findings may suggest that the linkage between entrepreneurship and economic growth should be studied at "community level" (e.g. cities and regions) instead at country and transnational level.

[49] This effort is materialized in "Europe 2020" that consists in EU's growth strategy for the coming decade. The 8th Framework Program for Research and Innovation, which is just a part of "Europe 2020 Agenda", will provide €80 Billions of R&D public funding for the time span between 2014 and 2020, representing a significant increase when compared with 7th Framework Program (2007-2013) with an overall budget of just about €50 Billions.

innovation[50] and in the shortening of technology and product life-cycles (Klepper, 1996; Agarwal, 1998; Agarwal and Gort, 2002; Adner and Levinthal, 2001; Klepper and Sleeper, 2005; Fritsch, 2008; Dinlersoz and MacDonald, 2009; Auerswald, 2010) that seem to favor new entrants and knowledge-based startups which have greater flexibility to cope with time-to-market shortness and with radical change than large corporations (Zenger, 1994; Baumol, 2004; Klepper and Sleepper, 2005).

In this scope, some of the key research questions one can put are the following: How can societies engage innovation in a way that R&D investments – both public and private – have a measurable and a sustainable positive impact on economic growth? Could it be possible to describe innovation in a systematic and reproducible process? Could the same "operational model" for innovation be applied effectively across different nations, industries or regions despite their differences in knowledge-production contexts?

In first, from a broader perspective, this is an important research question because governments quite often engage actively in policies aimed at supporting innovation and entrepreneurship and consume significant time and resources. European Union (EU 27) governments' effort fostering innovation is considerable because 34.6% of Gross Domestic Expenditure on R&D (GERD) was assured by the public sector and 0.9% by higher-education sector in 2010 (Eurostat, 2013) and the average R&D Expenditures achieved about 2.0% of GDP in 2011 (Eurostat, 2013). In such context, it would be expected that increasing R&D investments would induce higher economic growth and that knowledge-based entrepreneurship reduces unemployment (Thurik, Carree, van Stel and Audretsch, 2007; Fritsch, 2008), but as shown by the "Swedish Paradox" and mainly by the so called "European Paradox", these conditions are not enough to foster both employment and economic growth (van Stel and Storey, 2004; Ejermo, Kander and Henning, 2011). Thus, the main purpose of this chapter is to fulfill the remaining gap between R&D effort and the attainment of measurable and

[50] Adner and Levinthal (2001) developed a demand-based explanation for the technological change. Demand heterogeneity is considered to be the key driver of the technology life cycle instead "endogenous innovation". In this sense, firms innovate to fulfill consumer needs that are continuously evolving and to achieve a bigger market-share, through targeting or keeping broader market segments. Later in life cycle, progressive decreasing of the marginal utility coming from performance improvements (i.e. product upgrades) empowers "customer satisfaction" with technological features, making companies develop new technologies with improved performance at constant prices in order to address "market needs". This explanation looks coherent with the "supply-side" Moore's Law, which says that the processing capacity doubles in each 18 months, with the same costs.

sustained results, in terms of economic and employment growth, by proposing a new approach for managing the European research and innovation policies from a regional scope. Having as a clear assumption that innovation is “also” “located phenomena” this section tries to address the following research questions:

(a) It is possible to identify the composite dimensions of RIS which are susceptible of being adopted and managed as independent economic policies and that could be generalized to all regions despite their own idiosyncrasies?

(b) It is possible provide mapping on the overall RIS architecture through identifying the underlying mediatory variables (i.e. hidden nodes) and by measuring their influence on the attainment of statistically significant outcomes at a macro-economic level (i.e. Youth-Unemployment, Unemployment, Gross Value Added and Gross Domestic Product)?

This chapter proceeds as follows: In Section 2.2. it is developed a review of the literature. Section 2.3. aggregates the formulation of the dataset and resumes the empirical methodologies adopted. In Section 2.4. it will be described and labeled the set of independent dimensions that shape the input layer of RIS. In Section 2.5., the RIS model will be estimated by mapping the non-linear relationships that entail its overall structure and by measuring their impact on employment and economic growth. Section 2.6. provides a detailed interpretation of the RIS neural network, according to the theoretical background and the empirical framework available within the research field and finally, in Section 2.7., I resume the major theoretical and Policy-Making implications.

2.3. Literature Review

Artificial Neural Networks are nonlinear mapping systems, which structure is based on equivalent principles observed in the nervous biological (humans and animals) systems (Kohonen, 1988). The analogy is clear i.e. an ANN consists of a large number of “processing units”, linked by weighted connections, called “neurons” or “nodes”. Each unit receives “inputs” from many other nodes and generates a single scalar “output” that depends only on locally available information, either stored

internally or arriving via weighted connections. The output is distributed too and acts as an input to other "processing nodes".[51]

Hence, the ANN reproduces the "network of neurons", which carry out the lower level computational actions (as opposed to the high level cognitive operations) in the human brain. In this sense, ANNs are pattern recognition algorithms that capture characteristic features from a set of inputs and map them to outputs (Bishop, 1995; Swingler, 1996). In this regard, neural networks do not require neither a knowledge base to be constructed, nor an explicit inference procedure to be developed and subsequently encoded. In each computing cell, one can identify three fundamental elements: a set of connecting links, each one characterized by a "weight w_{kj}" where k and j indicate the receiving and the emitting neuron, respectively; an "adder for summing the input signals $x_1, x_2, ..., x_n$" and an "activation function f", in order to limiting the amplitude range of the output of the neuron. Note that a neuron model can also include an "external constant input $x_0 = 1$" known by the bias term that is added to the sum of the weighted inputs and that plays a similar role to the intercept term in multiple regressions. As such, each unit of a neural network performs a weighted sum on the inputs received from many other nodes and applies the function, f, to the resultant value of the previous operation, generating a single scalar output that depends only on locally-available information, either stored internally or arriving via the weighted connections, as referred. As the output is distributed too, and acts as an input to other processing nodes it is very important to define the activation function f, which can be classified into three basic types: "Threshold or Heaviside step function", "Piecewise linear function", and "Sigmoid (S-shaped) function". In this study it was selected the sigmoid function because it is by far the most common form of activation function used in the construction of a neural network (Davies, Goode, Mazanec, & Moutinho, 1999; Mitchell, Davies, Moutinho, & Vassos, 1999; Phillips, Davies, & Moutinho, 2001; DeTienne et al., 2003), and it is nonlinear function that exhibits smoothness and asymptotic properties and is capable to find patterns of nonlinearity behavior that linear statistics such as regression analysis

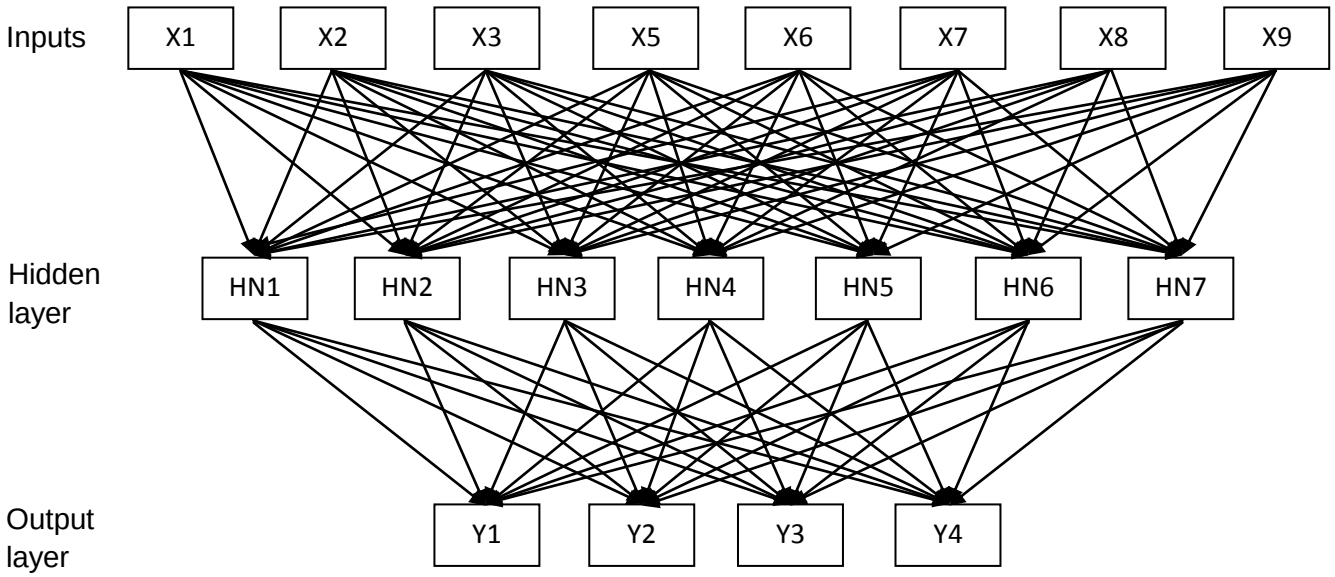
[51] See, for example, Reed and Marks (1998). *Neural Smithing, Supervised Learning in Feedforward, Artificial Neural Networks*, The MIT Press, England.

cannot model or explain (DeTienne et al., 2003). An example of sigmoid is the logistic function defined by

$$f(x) = \frac{1}{1+\exp(x)}.$$

In accordance to previous referred, a neural network is composed of an input layer, hidden layer(s), and an output layer (Figure 3).

Figure 3 - Hypothetical Neural Network Model



Source: A layered feedforward network

As illustrated in Figure 3, each layer comprises a predetermined number of neurons, which in general, define the topology of a neural network. An “input layer” is used to represent the “predictor or independent variables” in the study and an “output layer” is used to represent the “dependent or criterion variables”. Nevertheless, mapping occurs in the intermediary layers (hidden layers), where the number of neurons is discretionary (DeTiene et al., 2003; Somers & Casal, 2009). These interior layers of neurons are not directly observable from the inputs and outputs system. Each hidden node is linked to each input node and to each output node, with the network computing values for each processing unit as a weighted sum of the neurons in the preceding layer, according to the connection weights. ANNs with this architecture are usually designated by feedforward networks, and by adding hidden layers, the

network is enabled to extract high-order statistics because it acquires a global perspective in spite of the extra set of links and extra dimensions of the neural interactions. In fact, multilayer networks that use arbitrary activation functions are universal approximators (Stinchcombe and White, 1989; Hornik, Stinchcombe, and White, 1989),[52] and in the organizational and economic context, hidden layer nodes play an interesting role as they can assume the role of "latent" or "unobservable variables", and, in this case, the neural network can be used to cast light on these variables through their links, identifying communal behaviors, which are labeled by considering their connections and the sum of the weighting to the input variables (Moutinho et al., 1996, p. 135).

In this chapter ANN method was applied to Regional Innovation Systems to potentiate knowledge economy. This is very significant in terms of relevance since "Knowledge" is considered to be a source of competitive advantage for nations and has been at heart of economic growth, as illustrated by David and Foray who pointed out that nowadays' disparities in the productivity and growth of different countries have far less to do with their abundance (or lack) of natural resources than to the capacity of improving the quality of human capital[53] and factors of production.

And if so, what are the mechanisms through which knowledge can be converted into economic activity on a measurable and sustainable way? The R&D intensity generates the creation of new knowledge and the expansion of technological

[52] Cybenko (1988 and 1989) provided one of the first rigorous proofs of universal approximation capability, showing that a network with linear output units and a single hidden layer of sigmoid units is sufficient for uniform approximation of any continuous function in the unit hypercube. Hornik, Stinchcombe and White showed that standard multilayer networks using arbitrary squashing functions are universal approximators; single-hidden-layer nets are included as a special case.

[53] Although it is recognizable that disparities in the productivity and economic growth of different countries can be highly influenced by the capacity of improving the quality of human capital there is still room for research regarding this matter (David and Foray, 2003).
Paul A. David from the University of Oxford, United Kingdom and Stanford University, USA; and Dominique Foray, from the CNRS and Paris-Dauphine University, France, contributed for Policy Futures in Education, (see Volume 1, Number 1, 2003), studying further research questions as the following: "Does the Knowledge-based Economy Demand Specific Skills and Abilities? Are 'new skills and abilities' required for integration into today's knowledge economy? If so, what are they? Are they really as new as some might like to make out?" are very relevant and had been also addressed by David and Foray, who referred that "beyond the levels of proficiency needed for the use of information technologies, there do appear to be a number of set requirements, as for example, teamwork, communication and learning skills. On the other hand, many experts underscore the importance of generic learning abilities (learning to learn, knowing what we do not know, being aware of the main forms of heuristic bias that can distort the power of reasoning) (Favereau, 1998). Besides of being able to master specific repertoires of technical skills, the need to keep up with incessant change is essentially what drives employees to develop new kinds of skills and abilities. These go beyond the constant updating of technical knowledge, for they also pertain to the capacity to understand and anticipate change (Lam, 2002) on the comparative analysis of the societal organisations underpinning the development of skills in the knowledge-based economy."

opportunity set and that knowledge endowment enhances the profitability of entrepreneurial activity, by facilitating the recognition and exploitation of new business opportunities (Fritsch 2008; Acs et al. 2009; Auerswald 2010; Wersching 2010). In this sense, industry sectors with a greater share of R&D employment tend to host more innovative and new fast-growing companies (Eckhardt and Shane 2011) while firms with a high "technological-competence-enhancing capability" are able to translate knowledge accumulation into sustainable growth, when leveraged by the initial size of their technological endowment (Lee 2010). It was found that firms located within geographical clusters tend to exhibit higher innovation performance and rates of growth and survival when compared with firms not located within the cluster's boundaries (Gilbert et al. 2008); and empirical evidences suggesting that University-Industry-Government pathways that have a regional scope (e.g. Sternberg and Litzenberger 2003; 2004) can also be found in the Knowledge Spillover Theory of Entrepreneurship literature. Hence, the regions that experienced higher R&D investments also tend to get more knowledge spillovers (e.g. Audretsch and Feldman 1996; Audretsch and Lehmann 2005; Audretsch and Keilbach 2004; 2008) and ventures sustainability is influenced not only by the traditional economic dimensions, such as market potential (e.g. Krugman 1991; Fujita et al. 1999; Pires 2005) or demand sophistication (e.g. Buesa et al. 2010; Lindic et al. 2012), but also by the opportunity to access knowledge and technology market transfer processes generated by the surrounding universities (Audretsch et al. 2005), showing that knowledge contexts can be a source of a sustained competitive advantage for regions (e.g. Fritsch 2008; Pe'er and Vertinsky 2008; Tappeiner et al. 2008).

European policy trends concerning academic research are focused in merging universities and research labs in order to gain critical mass, aiming the creation of elite higher-education and research institutions. Scale-up policies started since 2004 at a national level just in Denmark and after that other countries – namely Germany and Finland – followed the Danish strategy destined to increase research installed capacity and enabling research institutions to compete with top universities worldwide (Maassen and Stensaker 2010). However, the conglomeration strategy isn't confined or applied to country scope, but already being implemented at a transnational level by the European Commission (EC) with the establishment of the European Research Council (ERC) and the European Institute of Innovation and

Technology (EIT). The main goals of ERC are attracting top researchers from all over the world and leveraging the available funding provided by national sources, in order to make the overall EU's space a more competitive destination for conducting cutting-edge research. The main focus goes in supporting basic research activities, performed by individual researchers or by international research teams, incorporated either in universities or research institutions, instead the University-Industry pathways. On the other hand, EIT goals are precisely fulfilling the previous gap by:

(1) Promoting the development of applied research and technology transfer networks;

(2) Engaging open-innovation and entrepreneurship and

(3) Enhancing the international R&D networks integration.

The overall workflow follows an ecosystem approach, and implies connecting businesses (including SMEs), entrepreneurs, research and higher education institutions (i.e. Universities and Polytechnics), investment communities (i.e. business angels, venture capital funds, matching-funds, private-equity and investment banking), research funders (i.e. governmental institutions, charities and foundations), regional development agencies, specialized public institutions and national governments. To achieve this, provides funding incentives aiming the implementation of Knowledge and Innovation Communities (KICs) and the set-up of technology transfer networks on a transnational basis. Both ERC and EIT are currently under the umbrella of the 7th Framework Program (FP7), which aims to support research and innovation projects with the following identifiable patterns:

(1) Transnational Integration: applicant projects should comprise entities from at least two different countries. For instance, we found Capacities - Regions of Knowledge call, which "goal is to enable regions to strengthen their capacity for investing in and conducting research and technological development activities in a way which can contribute significantly to their sustainable economic development. To this end, Regions of Knowledge, will support the cooperation, the development and the integration of regional research-driven clusters on a transnational basis"

(European Commission 2011, p 4).[54] Another call from Capacities work program, Research Potential, intends to promote the "integration of research entities from the EU´s convergence and outermost regions [...] and [the] enhancement of their innovation potential" (European Commission 2011, p 12).[55] In this case each applicant must establish partnerships with at least three research organizations, from three or more member states or associated countries, other than that of the applicant. On the other hand, the People work program supports financially the development of transnational Initial Training Networks (ITNs) for young researchers. The most proposed configuration is Multi-partner ITN which must comprise at least three managing-partners, established in different member states or associated countries. Another type of ITN, more precisely the European Industrial Doctorates, allows applications with just two partnering institutions from different countries (European Commission 2011);[56]

(2) Research Joint Ventures (RJVs): both Capacities and People work programs intend to engage open innovation Public-Private Partnerships (PPPs) and consolidate University-Industry pathways, aiming effective knowledge incorporation and human capital[57] mobility between public and private sectors. Although ERC is focused on financing basic research also allows applications for the development of applied research, international R&D networks implementation and technology transfer projects;

(3) Measurable Outcomes: the calls from Capacities and People work programs require co-substantiation about the potential feasibility of the proposed Research Joint Ventures (RJVs). Applicants must provide evidence that milestones are reliable and achievable during the project length. The quest for measurable outcomes is also reflected on knowledge state-of-the-art upgrade for ERC's calls,[58] on effective technology transfer and career integration of early-stage researchers for ITNs and on action-plans requirement for all activities taking place in the following 36 up to 42 months for Research Potential projects;

[54] Capacities Work Program: *Regions of Knowledge*, p 4.
[55] Capacities Work Program: *Research Potential* (known by the RegPot), p 12.
[56] People Work Program: *Initial Training Networks* (ITNs), p 11.
[57] i.e. career integration of graduating students and early-stage researchers, as they move from university to a labor market
[58] ERC's Research Grants are financed by Ideas Work Program, and integrate FP7's calls.

(4) Interdisciplinary and Intersectoral research and training: in a wider perspective, the FP7 promotes the integration of several scientific and technological domains or complementary fields, in order to produce multidisciplinary basic and applied research that could enhance economic activity through the introduction of novel value-added marketable products or services and of knowledge-based new business formation. In the EC's perspective, the adoption of a multidisciplinary framework also enhances the emergence and consolidation of new supra-disciplinary fields leading to further knowledge breakthroughs with social and economic impact (European Commission 2011).[59] For instance, even the ERC strongly encourages the presentation of interdisciplinary and intersectoral research proposals, as formally outlined by Ideas work program and informally advertised at "road-shows" across several universities and research institutions. After 2013, FP7[60] will be replaced by the 8th Framework Program (FP8) which has a forecasted endowment of €80bn and will take place from 2014 to 2020. The FP8 will be a significant part of the Europe 2020 Growth Strategy umbrella program that has an overall budget of €140Bn (European Commission 2012).[61] The EC already pointed out Scientific Excellence, Industrial Leadership and Facing Societal Challenges as the key-goals for the new Research and Innovation Framework Program and the respective guidelines seem, at a first glance, coherent with FP7's approach. In terms of Scientific Excellence the main priorities are kept and reinforced and intend to make Europe a more attractive destination for cutting-edge research. Regarding Industrial Leadership, the investment priorities seem to become narrowly focused on specific high-technology domains, more precisely ICT, nanotechnologies, advanced materials, biotechnology, advanced manufacturing and processing. The last priority consists on Facing Societal Challenges, previously identified by the EC, more precisely: (a) Health systems sustainability, demographic change and active-ageing; (b) Food security, sustainable agriculture and marine resources exploitation; (c) Renewable energy generation, energy efficiency and smart-grids; (d) Eco-friendly, efficient and integrated public transportation; (e) Resource sustainability and efficient raw

[59] People Work Program: *Initial Training Networks* (ITNs), p 12.
[60] FP7's overall budget according decisions of European Parliament and European Council is €50.521M. The length of calls implementation is from 2007 to 2013 (European Commission 2006).
[61] Europe 2020 Strategy Communication. Available from: (http://ec.europa.eu/research/horizon2020/pdf/proposals/communication_from_the_commission_-_horizon_2020_-the_framework_programme_for_research_and_innovation.pdf#view=fit&pagemode=none) [Accessed: 22 November 2012].

materials application and (f) Developing inclusive, innovative and secure societies. In this case the FP8´s strategy seems to reinforce, even more, the weight of the multidisciplinary applied research, already highlighted on FP7. However, the investment focus moves from multidisciplinary basic research towards research-to-market activities such as piloting and demonstration, test-beds and support towards public procurement and market uptake.

Harris (1954) observed that in United States of America (USA) the manufacturing industries were concentrated in just about a twelfth of the country area but at the same time, that regional cluster aggregated almost half of national demand and retains nearly 70% of total labor force. In this sense, regional intrinsic features become crucial in modelling the R&D-growth linkage and an innovation policy that only relies on increasing R&D outlays is ineffective on increasing economic growth (Fritsch and Mueller 2004; 2008; Pessoa 2010). On the other hand, the capability of regions attracting and retaining advanced sectors or industries also depends on their market potential (Harhoff 2000; Norman 2002). On the other hand, Pires (2005) applied New Economic Geography (NEG) model to assess regional market potential and its correlation with welfare in Iberian regions (NUTS II). It was found that – at an Iberian scale – there are only three consolidated economic centers (Madrid, Cataluña and País Vasco) and two emerging (Valencia and Sevilla). The existence of statistically significant economic centers at a NUTS II level has a crucial importance because demonstrates that regions with higher demand of goods and services are also more attractive destinations for industry and Foreign Direct Investment (FDI). Regions with higher market potential tend to attract and retain more qualified critical-mass and to produce more wealth while the economically peripheral regions tend to become poorer and loose resources, and FDI streams to more central regions. For instance, Madrid had a market potential (Fr) of 1.44 which is about 0.66 times higher than Lisbon (Fr=0.87). This means that given the spatial distribution of markets and if the technology in the two regions were the same, one firm in Madrid would be able pay to production factors[62] nearly 70% more, than a firm located in Lisbon. As

[62] If the technology used by market players were the same. As pointed out by Pires (2005), the market potential analysis considers that technological landscape is the same in all regions. This assumption exists to isolate the location effects from technological incorporation and inputs endowment differences between regions. By analysing the NEG (New Economic Geography) models we suggest that technological and knowledge intensity upgrade could become a sustainable approach for achieving productivity gains, additional competitiveness and market potential growth despite a less favourable geographical location.

economic centers like Madrid can pay more for capital and labor, they are able to attract and keep more investment flows and some of the most qualified, creative and productive human capital available. The capability of having more qualified human capital and better technology allows regions to improve their productivity (Harhoff 2000; Fritsch and Mueller 2004; 2008; Pe'er and Vertinsky 2008; Choudhary and Gabriel 2009; Teixeira and Fortuna 2010) and subsequently their investment return rates (Klepper 1996; Jovanovic 2001; Gilbert et al. 2008; Ciftci and Cready 2011) leading to more sustained investment flows (Norman 2002; Audretsch and Weigand 2005; Brown and Petersen 2010) and thus to market potential reinforcement (e.g. Pires 2005). In addition, regardless of how analysts and researchers define a geographic region, in accordance to the "Learning Region" concept (Polenske, 2004), the community, region or country combines with academic institutions, firms and government in the "region" in collective-learning environments (Keeble and Wilkinson, 1999). The learning region is characterized by a set of horizontal relationships among all the agents of the ecosystem, which shares knowledge, experiences and best practices to solve problems and improve results (Asheim, 2001b, pp. 9). Conceptually, the "Learning Regions" and the work program "*People"* are both aligned, even considering the "extension" of the last one as it is focusing on the development of transnational Initial Training Networks (ITNs) (European Commission, 2011) for researchers from different countries. For the firms, the learning may be based on intra-firm, inter-firm, and collaborative arrangements, but these can also include partnering with universities and technology centers. Learning drives to innovation and change. In this context, the learning economy is positively affected by the increasing use of information technology and communication considering regions and communities as "knowledge macro centres". [63] On the contrary, Porter defended a different perspective, when he defined clusters as "geographic concentrations of interconnected companies and institutions in a

[63] Although the term "learning region" is relatively new it has its anchors in the flexible production and flexible-specialization (Plummer and Taylor, 2001), (Asheim, 2001), (Asheim and Dunford, 1997), (Boekema et al., 2000), (Florida, 1995), (Lundvall, 1996), (Lundvall and Johnson, 1994) and (Morgan, 1997), among others. The introduction of this concept brought a major conceptual difference, which is the view of a learning region changed the interpretation and the implications of industrial districts by incorporating social relations, competitiveness, networks, learning, knowledge and innovations. By locating in industrial districts there is possibility of firms to achieve multiplier effects and agglomeration economies of growth poles (Piore and Sabel, 1984). Another implication of this analysis is to use "flexible-specialization" for policy-making purposes, i.e., providing favorable environmental context to foster conditions to SMEs and startups, research and development institutes, technology centres, and contractual management activities in order to potentiate firms to share supply chain (push and pool systems), production and distribution inputs, as well as information, technologies and other resources.

particular field. According to Porter's definition, all learning regions, but Ennals and Gustavsen (1999) define a different type of learning region "model", which follows coalitions of all ranges, referring, for example, small and medium workplaces to regions and larger networks of firms and other entities to countries.

This means globalization is still shifting the competitive landscape in developed economies away from being based on traditional inputs of production, such as land, labor and capital towards knowledge (e.g. David and Foray 2002; Audretsch et al. 2012). Moreover, the globalization game is played at the "region" level, as a strategic knowledge base, and SMEs and startups rely on their Regional Innovation Systems (RIS) to access marketable knowledge, to take opportunities from incumbents and to commercialize them (Klepper and Sleeper 2005; Fritsch 2008; Acs et al. 2009). Moreover, the competitiveness of developed economies is vulnerable to social dumping[64] and constrained by production factors endowment at a regional scope (Norman 2002; Pires 2005) but the knowledge as key-resource is less susceptible of replication due the specific competencies required and the long-run know-how needed while converting research outlays into marketable products and services (Friedman 2005; Kim and Mauborgne 2005; Lindic et al. 2012). In this sense, the knowledge base reinforcement (e.g. Audretsch and Keilbach 2004; 2008), the R&D intensity upgrade (Eckhardt and Shane 2011) and the University-Industry-Government pathways (Leydesdorff and Meyer 2003; Sternberg and Litzenberger 2003; 2004; Leydesdorff and Fritsch 2006) rather than just increasing R&D expenditures (Furman and Hayes 2004; Breznitz and Zehavi 2010) could become effective policy instruments in order to overcome the unfavorable effects from regional inputs endowment and spatial location (e.g. Bottazzi and Peri 1999; Cooke, 2001; Caragliu and Bo 2011; Knoben et al. 2011; Fagerberg et al. 2012). Nevertheless the highest uncertainty, the asymmetric information[65] and the difficulties

[64] According to literature it is interpreted social dumping like the adoption of low wages and social-standards and the conscious enhancement of higher return rates to capital investors as part of a long-term adjustment process adopted by less-developed economies. Sinn (2001) describes social dumping as an inevitable reality rather than intentionally neglecting of social workplace, safety legislation and labour co-determination rights by national governments in European less-developed countries. This author pointed out that labour force mobility towards countries with higher wages will lead to a gradual wage and social standards harmonization within less developed countries. The sustainable inflation, while below the European Union average, generates labour productivity growth and progressive harmonization of effective wages. As the wage gap between developed and less-developed economies becomes narrow, Foreign Direct Investment (FDI) will decrease, gradually slowing down further effective inflation and keeping at the same time a sustainable long-term competitiveness.

[65] The Minister for Jobs, Enterprise and Innovation, Richard Bruton T.D. has announced in March, 2013, details of the €1 million initial investment in a research programme in data analytics, a key sector growing at 40% per

on appropriating returns from investments on newly created knowledge that characterize innovation-driven markets, the R&D intensity positively influences the access to financing (Eckhardt et al. 2006; Brown and Petersen 2010; Ciftci and Cready 2011) and even SMEs benefit from better access to funds than their larger counterparts within less knowledge intensive industries (Audretsch and Weigand 2005). The R&D intensity presumably provides an enhancing environment for SMEs and startups to grow by continuously investing on innovation and attracting external capital (Audretsch 1995; Harhoff 2000; Baumol, 2004; Carlsson et al. 2007; Huynh and Petrunia 2010). An improved quality of technological environment is also connected with higher market power by firms (Wersching 2010) and as pointed out by Auerswald "in industries where production processes are more complex, persistent profits accrue to surviving firms. Such profits are greatest in the early stages of industries where technology is of intermediate complexity - that is, where learning is rapid enough to confer a competitive advantage, but imitation is sufficiently uncertain to deter later entry" (2010, p. 578).

However, despite the role of knowledge complexity or sophistication, the innovation policies should combine a mix of different technological levels and maturities in order to improve their effectiveness. If the main goal is improving the overall RIS quality, medium-technology manufacturing has much more impact than high-tech production because supports the establishment of local synergies by improving University-Industry-Government "stickiness" within a cluster or geographical unit (i.e. such as NUTS II or NUTS III). On the contrary, generally, high-tech manufacturing doesn't provide "structure" to local knowledge contexts, because besides being small scale, is focused on internal, centralized and "globalized" production within multinational corporations, taking place as spinoffs of highly specialized research institutions and involving global markets more than local human capital or knowledge sources. From

annum worldwide. Led by University College Dublin, the research consortium which includes University College Cork, and Dublin Institute of Technology, will use the funding to work with a group of companies to accelerate the development, deployment and adoption of Data Analytics technology. Data Analytics is about the conversion of large amounts of raw data into valuable information through the use of statistical techniques and advanced software. Top-tier multinational and Irish ICT companies will lead the research agenda at the technology centre called CeADAR (The Centre for Applied Data Analytics Research). CeADAR's industry partners include; eBay, Accenture, Dell, Fidelity Investments, Adaptive Mobile, Climote, Cylon, GBR, HP, Moving Media, Nathean Technologies, Nucleus Venture Partners, and Qumas. Research will be focused on developing ways of generating business, profit and ultimately jobs from the high-growth area of data analytics. CeADAR will conduct initial research into technology challenges that have been identified by the industry representatives. Available from: (http://www.ucd.ie/research/news/news/newsarchive2013/news/mainbody,166023,en.html) [Accessed: 22 March 2013]

an industrial organization perspective, medium-tech manufacturing can work as seedbed for high-tech production, because allows maintaining the absorptive capacity, so that knowledge and technologies developed elsewhere can be understood, disseminated more easily and adapted to local circumstances (Doloreux 2003; Doloreux and Parto 2005; Leydesdorff and Fritsch 2006; Pessoa 2010; Teixeira and Fortuna 2010). This view is not opposing to learning regions approach, there is a complementary impact resulting from both views, instead.

The co-substantiated hypotheses regarding RIS configuration and its impact on economic and employment growth could become even more important when EC's Research and Innovation policies consist mainly on transnational research-driven clusters and KICs implementation. What happens is the "Europe 2020 Growth Strategy" is focused on enhancing high-technology production towards industry leadership instead of balancing a mix of several technological features, levels and maturities, such as medium-tech manufacturing or simply improving the availability of high-tech service providers. Besides, Knowledge intensive services are usually decoupled from local economies, but the high-tech services have the capability of shaping the underlying knowledge base configuration. Despite "size" and "location" aspects, if stimulated on a high-tech end, the knowledge intensive services may contribute to improve the absorptive capacity in economically peripheral areas and thus to reduce asymmetries in manufacturing technologies, by spreading and disseminating specialized know-how, across the several regions (Leydesdorff and Fritsch 2006; Teixeira and Fortuna 2010).

Finally, considering all these aspects strongly substantiated and well supported by the literature review, one can ask him/herself if the R&D financial incentives shouldn't be measured, planned and implemented at a regional scope instead of being at EU's level, as a "homogenous macro-conglomerate" location. In other words, the European funding framework shouldn't be adapted to the spatial location, knowledge base maturity, absorptive capacity, technological sophistication, productivity and potential competitive advantages of each region?

2.4. Applications of ANN Methodology to Innovations and Entrepreneurship field

There has been a recent, but steady increase interest in research and studies that recur to the use of ANNs methodology applied to Innovation and Entrepreneurship. The early applications of ANNs in the business context have centered in areas such as accounting and finance, manufacturing, and marketing (Zhang & Huang, 1995; Wong et al., 1997; Wong & Selvi, 1998; Krycha & Wagner, 1999; Vellido, Lisboa, & Vaughan, 1999). In accounting and finance, for example, much of the research has paid attention to bankruptcy risk prediction (Odom & Sharda, 1990; Wilson & Sharda, 1994), insolvency prediction (Baetge & Krause, 1993), and fraud detection (Fanning, Cogger, & Srivastava, 1995). In manufacturing, on the other hand, ANNs have been used successfully for estimating, for instance, software development efforts (Finnie, Wittig, & Desharnais, 1997; Heiat, 2002) and cost estimation problems (Smith & Mason, 1997). Yet, many applications of ANNs in marketing have also been reported, including modelling consumer responses to market stimuli (Curry & Moutinho, 1993; Dasgupta, Dispensa, & Ghose, 1994), evaluating the effect of gender on car buyer satisfaction and loyalty (Moutinho, Davies, & Curry, 1996), predicting consumer choice (West, Brockett, & Golden, 1997), new product development (Thieme, Song, & Calantone, 2000), marketing strategy (Li, 2000), sales forecasting (Kuo, 2001), market segmentation (Boone & Roehm, 2002), and modelling the effect of market orientation on firm performance (Silva, Moutinho, Coelho, & Marques, 2009).

The studies mentioned above have, in general, compared ANNs to more traditional statistical methods (e.g. discriminant analysis and multiple regression) with respect to predictive accuracy, reporting therefore, the superiority of neural networks (e.g. Dasgupta et al., 1994; West et al., 1997) from the comprehension and the prediction of the phenomena. Recent studies have extended this optimism to problems that involve the prediction of continuous criterion, from which nonlinear relationships were expected. In this stream, Somers (2001) and Somers and Casal (2009) used neural networks to examine the relationship between work attitudes and job performance. In both studies, neural networks outperformed linear regression, and several nonlinear relationships that may account for the findings were reported. Likewise, Palocsay and

White (2004) found advantages in using neural networks compared to linear regression for modelling relationships between dimensions of culture and perceptions of organizational justice, and more recently Minbashian et al. (2010) also used ANNs in the domain of research on personality and work performance, presenting results that indicate the higher predictive accuracy of neural network over multiple regression.

The benefits this analytical statistic approach brings over traditional statistical methods (DeTiene et al., 2003), and the increased enthusiasm of researchers in using it for predicting and explaining problems in the management domain, are most remarkable, although it is interesting to note that little is known about ANNs applications in the innovation and entrepreneurship context. Indeed, recent discussions among entrepreneurship and innovation scholars have centered on the domain of entrepreneurship and its place within the management field, suggesting for its progress, the use of sophisticated research design, sampling criteria, data collection methods and analytical techniques (Low & MacMillan, 1988; Aldrich & Baker, 1997; Brush, Duhaime, Gartner, Stewart, Katz, Hitt, Alvarez, Meyer, & Venkataraman, 2003; Dean, Shook, & Payne, 2007), which can turn entrepreneurship and innovation into a respected peer alongside neighboring fields such as organizational behavior, strategic management and policy-making (Short, Ketchen, Combs, & Ireland, 2010). In that sense, one can refer a few examples as the research efforts for using neural networks in entrepreneurship studies were made to some extent by McKelvey (2004) in his research paper called “Toward a complexity science of entrepreneurship” and by Hájková and Hájek (2010) with the introductory research named “Analysis of Regional Innovation Systems by Neural Networks and Cluster Analysis”, which discuss the importance of regional innovation systems, by defining them as the cooperation between companies and institutions in the development and dissemination of knowledge in innovation processes. The input variables proposed included factors related to economy, as Regional GDP per capita, Real growth rate of regional GDP, Employment rate, Long-term unemployment share, R&D and Education and data were analyzed by the model merging neural networks and cluster analysis algorithm with the aim to visualize regional innovation systems in a topological map and to pointing out policy-making to reach economic growth and development. In this context, concepts like Regional Clusters (namely

agriculture, industry, construction, services, transport, storage and communication, financial intermediation services, public administration and education), Regional Innovation Systems, Regional Innovation Networks and Learning Regions were considered to be attributes of successful development of a number of economies. Although the potential of this analytical approach was showed, several limitations were also addresses such as the NUTS II OECD classification[66] system for regional analysis because of the geographical unit of analysis, and on the other hand results of average employment percentage in economic sector for clusters were from 2006, which clears calls for a more complete and updated analysis.

The present research sustains that neural networks can provide entrepreneurship researchers with new insights into intricacy among variables, since they are based on systems of nonstructural and configural relationships, and can also broad the understanding of the range of analytical techniques to be used for addressing research questions in a wide variety of contexts.[67] That is to say, with this shift, one can theorize and study about the dynamics of the interaction in complex phenomena, such as Regional Innovation Systems and Economic and Employment growth, without establishing a priori causal relations between the variables. Entrepreneurship and Innovation systems research, in this sense, moves from post-structural inquiry into connectionist and nonlinear model (McKelvey, 2004), where, as argued previously, the elements interact in dynamic and exploratory way, permitting to provide in depth analysis process and aiming for a broader understanding over the relationships among variables.

[66] A new classification that combines elements from the OECD classification with the new urban-rural typology developed by the Commission was set in 2010 (*Eurostat regional yearbook 2010*, p. 240-253). The new urban-rural typology developed by the Commission takes the OECD approach based on districts and TL3 regions and applies it to population grid cells and to NUTS-3 regions. The OECD's TL3 regions differ from NUTS-3 regions in Belgium, the Netherlands and Greece, where they are NUTS-2 regions, and in Germany, where they are spatial planning regions, which results in a more adequate geographical unit of analysis. The new urban-rural typology developed by the Commission does not include the remoteness dimension. The changes and updates adopted by the OECD include modifications of the road network, data about the road network, population distribution within the regions, or population size and the definition of cities, which of course have an impact on the classification. Available from: (http://epp.eurostat.ec.europa.eu/portal/page/portal/nuts_nomenclature/introduction). Accessed 23 November 2011]. Available from: (http://epp.eurostat.ec.europa.eu/statisticsexplained/index.php/Regional_typologies_overview) [Accessed 23 November 2011].

[67] Complex of contexts include the creation of new ventures, existing corporations, family business, and Regional Innovation Systems.

2.5. Formulation of the Dataset and Methodology

When considering OECD's Regional Statistics Database as initial dataset, covering a total of 231 regionally standardized variables, the geographical scope selected for analysis is the OECD Territorial Level II (TL II) and the sample consisted in 158 regions,[68;69] which make part of 18 European countries[70] and were selected from an original dataset of 396 regions across 34 OECD's countries. The regional variables were collected over a time span between 1998 and 2008[71] in order to maximize series fit with available data. The missing values were completed using different methodologies. Besides, single intermediate values were calculated with an arithmetical mean, considering the two nearest years, or it was estimated a yearly variation-rate matching the previous and the subsequent existent values, in order to fulfil that "gap", when needed. If the value fells near the beginning or the end of the series, a geometric average of the variation-rates between the available values sequence was applied. Due to the existence of missing values in all studied variables, all these procedures were applied for each one of the 231 variables available in OECD's Regional Statistics Database. [72;73]

[68] OECD Regional Statistics Database includes two aggregation levels: Territorial Level II (Large Regions) and Territorial Level III (Small Regions). However, the set of variables available for Territorial Level III is quite different and much smaller than Territorial Level II.

[69] The Regions which make part of the countries included in the sample are less than the Regions made available by OECD, because only the series that have two or more values were included. This procedure is justified by the need of obtaining the yearly variation rates for further estimation of the geometrical average, for each region, over the studied time span.

[70] All of them are members of European Union (EU 27), with exception of Norway. The sample includes all European countries available in OECD Regional Statistics Database. We only included the "European" countries because their regional innovation systems aren't comparable, for instance, with North-American ones (Cooke, 2001), as shown by the emergence of the so called "European Paradox" (Audretsch, Grilo and Thurik, 2012).

[71] This dataset follows the new OECD classification that was set in 2010.

[72] See accepted and submitted research papers: Moutinho, R. and Castro Soeiro, F.,2012. *Regional Innovation Systems: Structure, Subsystems and their impact on employment and economic growth*. Research Policy Journal (Elsevier); Moutinho, R. and Castro Soeiro, F., 2012. *Translating R&D expenditures in to employment and economic growth: policy orientations to overcome the "European Paradox"*. Cambridge Journal of Regions, Economy and Society (Oxford Journals); Moutinho, R. and Castro Soeiro, F, 2012. *What future for Europe 2020 Growth Strategy? The need of a regional, operational and measurable framework for R&D policies*. Regional Studies Journal (Taylor & Francis);

[73] See Table 5 -Themes available on OECD Regional Statistics Database.

Table 5

Themes available on OECD Regional Statistics Database

Variables Segmentation	
Themes available in OECD Database	Number of variables
Economics	44
Demographic Statistics	15
Innovation Indicators	61
Regional Labour Market	101
Social Indicators	10
Total Variables included in Dataset	*231*

Source: Own preparation and OECD Regional Statistics Database

After data collection and missing values estimation procedures, there were calculated the yearly variation-rates and the correspondent geometrical-averages for each region over the ten years time span. In other words, the geometrical averages for the 158 regions, covering the period between 1998 and 2008, are the concrete data series for the 231 variables included in the sample (Moutinho, R. and Castro Soeiro, F., 2012).[74]

Table 6

European Countries covered: Territorial Level and Number of Regions

European countries covered	Territorial Level	No. of Regions
Austria	Level II OECD	7
Belgium	Level II OECD	3
Czech Republic	Level II OECD	8
Finland	Level II OECD	4
France	Level II OECD	21
Germany	Level II OECD	16
Greece	Level II OECD	4
Hungary	Level II OECD	7
Ireland	Level II OECD	2
Italy	Level II OECD	21

[74] See Table 6 -European Countries covered: Territorial Level and Number of Regions.

Netherlands	Level II OECD	4
Norway	Level II OECD	7
Poland	Level II OECD	9
Portugal	Level II OECD	4
Slovakia	Level II OECD	4
Spain	Level II OECD	17
Sweden	Level II OECD	8
United Kingdom	Level II OECD	12
Total number of regions		*158*

Source: Own preparation and OECD Regional Statistics Database

"First Hypothesis": in order to test the "First Hypothesis", that is possible to identify a clear "set of composite variables", which constitutes the input layer of RIS, it was developed a Factorial Analysis. This statistical method allows defining the underlying structure of the data matrix, in order to reduce the original and larger set of variables into a smaller number of factors that could resume the explanatory capacity of the original set. Moreover, this modelling approach would permit visualization mapping on regional innovation systems, namely throughout the use of topological maps.

Then, the main advantage of this analytical statistic method is that the extracted factors are less sensitive to potential data recording errors than single variables would be because the bias effect is dispersed by the whole set of original variables within each factor. On the other hand, the accomplishment of the assumptions of normality, homoscedasticity and linearity are not required or used less restrictive. According to this methodology, multicolinearity, which generally causes serious difficulties in other types of statistical analysis, is desirable in this case, given the fact that the main goal is to identify the series of variables which might be found to be interrelated. Hence, whenever clearly differentiated subgroups of variables emerge within the same variables are highly interrelated, and, on the other hand, those of the different subgroups show no relationships, than the original series of indicators will be able to be simplified to a few factors. This procedure will summarize the information held in common by the several variables included in each factor (Pestana and Gageiro, 2008).

"Second Hypothesis": to test and verify the "Second Hypothesis", regarding the identification of "mediatory variables" and the measurement of their latent impact on the attainment of measurable outcomes at a macro-economic level, it was applied the Artificial Neural Networks (ANNs) econometric approach. Mostly, ANNs modelling have been found to offer various advantages over conventional statistical methods such as regression, and many of these benefits were addressed by DeTienne, and Johsi (2003). The two advantages which are most relevant in this instance are that, in first, neural networks are capable of learning an approximation to any functional form, providing their complexity (in number of hidden nodes) is increased sufficiently (White, 1989). This means that there is no need for the researcher to specify underlying directional paths prior to analysis (Bejou, Wray and Ingram, 1996). And secondly, there is a significant value for scholars in the hidden layer nodes, which can be regarded as "latent or unobserved variables" related to the process, in which, the R&D outlays are converted in to employment and economic growth.

Before computing the ANNs, the RIS components generated through "Factorial Analysis" are assumed as "Independent or Input variables" and "Youth-Unemployment", "Unemployment", "Gross Value Added (GVA)" and "Gross Domestic Product (GDP)" as "Dependent or Output variables". It was made the assumption that remains a group of latent or mediatory variables conceptualized as hidden nodes that entail, at least, one "Intermediate layer" between "Independent variables" and the "Dependent variables". This "Intermediate layer" is expected to determine RIS effectiveness generating significant macro-economical outputs. It is also expected that the application of ANNs modelling allows describing the overall RIS architecture, by reproducing the interactive "nature" of innovative ecosystem, more precisely the non-linear relationships between RIS components and macro-economical outputs, casting some light inside the so called "Innovation's Black-Box" (Rosenberg, 1982; Tappeiner, Hauser and Walde, 2008).

2.6. Independent Economic Policies

The Factorial Analysis[75] started from the original dataset of 231 variables and by means of a process of trial and error only 25 variables have finally been kept,

[75] For further analysis on the necessary validation requisites, procedures and implications of Factorial Analysis, as statistical inference method, see Pestana and Gageiro (2008).

generating 8 factors or underlying dimensions[76] that are linear combinations of the originals. These factors reflect better the core-components of a RIS, than each one of the individual variables could do so, as they not only group together all related variables, but also reflect the interaction between factors, as the model correlates each variable to all factors, not only to the one in which it is included. The communalities (i.e. correlation of each variable with regard to the set of the other variables making up this factor) of the variables are relatively high, most of them over 0.750[77], which indicates a high degree of preservation of their variance and assures the reliability of the findings. Moreover the 8 factors retain nearly 87 per cent of the original variance and there is a scarcely 13 per cent loss of the information contained in the original set.

Table 7

Hypothetical Components: Factorial Weights, Communalities and Theoretical Dimensions

Matrix of Rotated Components	**RIS Hypothetical Components**		
	Components	Communalities	Theoretical Dimensions
1. Corporate R&D Expenditures (% of GDP)	.943	.910	
2. Corporate R&D Expenditures (USD, PPP)	.938	.911	
3. Corporate R&D Employment (Number)	.895	.834	**Corporate R&D**
4. Corporate R&D Employment (% of total employment)	.820	.727*	
5. Corporate R&D Expenditures (USD)	.815	.689*	
6. Population (Number)	.920	.911	
7. Density (Persons per square kilometre)	.914	.909	**Market Potential**
8. Labour Force (Number)	.914	.926	
9. Employment (Number)	.847	.839	
10. GDP per worker (USD)	.914	.899	
11. GDP Per Capita (USD)	.907	.870	**Demand Sophistication**
12. Primary Income per Household (USD)	.890	.908	
13. Disposable Income per Household (USD)	.759	.791	
14. Governmental R&D Expenditures (% GDP)	.960	.955	
15. Governmental R&D Expenditures (USD, PPP)	.957	.988	**Governmental R&D Investment**
16. Governmental R&D Expenditures (USD)	.952	.979	

[76] The 8 Factors and their composition are entirely congruent with theoretical framework already highlighted in literature review and are also compatible with Frascati's Manual (OECD, 2002).

[77] The only exceptions are Corporate R&D Employment (% of total employment) with 0.727; University R&D Employment (Number) with 0.720 and Corporate R&D Expenditures (USD) with 0.689.

17. High and Medium Technology Employment (% total employment)	.947	.945	**Technological Capacity**
18. High and Medium Technology Employment (Headcount)	.936	.927	
19. High and Medium Technology Manufacturing (% total manufacturing)	.910	.840	
20. Knowledge Intensive Services Employment (% of total employment)	.908	.879	**Knowledge Intensity**
21. Knowledge Intensive Services (% total services)	.905	.884	
22. University R&D Employment (% total employment)	.897	.890	**University R&D Employment**
23. University R&D Employment (Number)	.726	.720*	
24. Governmental R&D Employment (% total employment)	.804	.806	**Governmental R&D**
25. Governmental R&D Employment (Number)	.745	.790	**Employment**

Source: Own Preparation. The asterisks* indicate the communalities values which are less than 0.750

"Quantitative Validation": This is important because of the need to verify validity of all factors from the statistic point of view and from the theoretical stand point.

"Qualitative Validation": Another important dimension for the judgment of the outcomes of Factorial Analysis is the qualitative validation (Manso and Simões, 2009) in which one must take in consideration two important principles:

(1) Parsimony principle: factorial analysis aims to explain the correlations between the original variables, retaining at the same time most of the variability from the initial set, with less factors as possible in order to make theoretical constructs become more interpretable, measurable and operational for policy development purposes. Thus, this criterion makes it possible to resume relevant information in the lower possible number of factors;

(2) Interpretability principle: factorial analysis should be used only if the outcomes are coherent with the theoretical background and with the previous empirical findings within the respective research domains or complementary fields, generating clear but consistent "interpretability gains". Thus, this criterion permits to have interpretable factors when they are related to the original variables.

The result was that 25 original variables were integrated in 8 composite dimensions improving significantly the interpretability of RIS construct with only 13 per cent of variability loss, which is good. In other words, extracted factors are not only

consistent but also interpretable in accordance with the theoretical framework of the research field, in this case, Regional Innovation Systems (RIS). Then, the associated variables belong to the same "subsystem" of the overall RIS, in which, the variables belonging to a certain component are only located in that factor. Therefore, each factor can be labeled and clearly expresses the nature of the whole set of original variables. According to Pestana and Gageiro (2008), it was selected the Factorial Analysis by Principal Components with VARIMAX rotation and KAISER normalization, because it makes possible to obtain more interpretable factors, as well as other advantages of statistical nature, such as, predetermining the angle between axes. In these conditions, the factorial pattern obtained through this specific rotation procedure tends to become more robust than the ones obtained from alternative methods, assuring the maximum orthogonality between factors, which is important for the use of further statistical analysis.[78]

2.7. RIS Architecture and Micro and Macro-economic Dynamics

The recent research of Artificial Neural Networks (ANN) econometric methodology applied to business and economics contexts focusing on areas such as accounting and finance, manufacturing, and marketing permitted to study a number of relevant aspects. For example, the research of bankruptcy risk prediction, in what refers to accounting and finance (Wilson and Sharda, 1994), modelling consumer responses to market stimuli, evaluating the effect of gender on car buyer satisfaction and loyalty (Moutinho et al., 1996), predicting consumer choice (West et al., 1997), in marketing, and modelling the effect of market orientation on firm performance (Silva et al., 2009).

The econometric ANN research approach mentioned above when compared to traditional statistical methods (e.g. multiple regressions) with respect to predictive accuracy, shows a clear superiority of neural networks (West et al., 1997). Besides, recent studies have extended this "optimism" to problems that involve prediction of

[78] All Dependent or Output Variables are part of OECD Regional Statistics Database and are already included in presented dataset.

continuous criterion, from which nonlinear relationships were expected. In this stream, Somers and Casal (2009) used neural networks to examine the relationship between work attitudes and job performance, for instance. Although, Neural Network and Cluster Analysis were used to research Regional Innovation Systems (Hájková and Hájek, 2010) with success, and ANNs modelling approach remains wide and promising, unexpectedly its application to these domains is still unknown or less significant.

The present research extends the knowledge of previous studies by identifying the key-dimensions that shape the overall RIS structure and by mapping the mediatory flows through which innovation is converted into employment and economic growth. Each one of the dimensions which integrate the "Input layer", comprise a specific subgroup of original variables that must have, at least, an "acceptable level of correlation" between them in order to become suitable for further ANNs modelling and analysis. The level of "multicolinearity" within the subgroup is defined as "internal consistency" and is obtained through reliability analysis or Cronbach's Alpha coefficient.[79] The majority of the factors reveal an excellent[80] internal consistency, having Alphas higher than 0.9 with the exception of Knowledge Intensity (0.884) with just a "good" interrelation between items.

Table 8

Variables and underlying factors, Descriptive Statistics and Cronbach's Alpha scores

Original Variables | RIS Core-Dimensions	Mean	S.D	Cronbach's Alpha
1. Corporate R&D			0.922
Corporate R&D Expenditures (% of GDP)	103.172	9.953	
Corporate R&D Expenditures (USD, PPP)	108.757	11.754	
Corporate R&D Employment (Number)	107.151	11.927	
Corporate R&D Employment (% of total employment)	105.682	12.085	
Corporate R&D Expenditures (USD)	108.156	14.956	
2. Market Potential			0.908
Population (Number)	100.382	0.624	
Density (Persons per square kilometre)	100.406	0.635	

[79] Cronbach's Alpha measures the deviation of each factor generated for each of the original variables. Of course, the higher the correlation existent between original variables, lower the deviation reflected in the factor, i.e., alpha is equal to 1.

[80] For details about the assessment scale regarding internal consistency, see George and Mallery (2003).

Labour Force (Number)	101.144	1.051	
Employment (Number)	101.546	1.052	
3. Demand Sophistication			0.915
GDP per worker (USD)	103.832	1.563	
GDP Per Capita (USD)	105.031	1.384	
Primary Income per Household (USD)	104.730	1.335	
Disposable Income per Household (USD)	104.646	1.324	
4. Governmental R&D Investment			0.977
Governmental R&D Expenditures (% GDP)	100.981	10.333	
Governmental R&D Expenditures (USD, PPP)	106.057	13.429	
Governmental R&D Expenditures (USD)	106.323	13.873	
5. Technological Capacity			0.939
High and Medium Technology Employment (% total employment)	99.569	3.392	
High and Medium Technology Employment (Headcount)	101.170	3.794	
High and Medium Technology Manufacturing (% total manufacturing)	101.252	2.528	
6. Knowledge Intensity			0.884
Knowledge Intensive Services Employment (% of total employment)	101.460	0.871	-
Knowledge Intensive Services (% total services)	100.638	0.766	-
7. University R&D Employment			0.286*
University R&D Employment (% total employment)	106.828	20.024	-
University R&D Employment (Number)	103.976	5.400	-
8. Governmental R&D Employment			0.460*
Governmental R&D Employment (% total employment)	104.115	15.762	-
Governmental R&D Employment (Number)	105.336	24.328	-

Source: Own preparation. Asterisks* indicate the Cronbach's Alpha scores which aren't suitable for further ANNs analysis.

Although coherent with the theoretical background the last two factors do not reveal enough consistency for being suitable[81] to further statistical analysis. However, given the importance of the information provided and taking in to account the RIS theoretical framework it was decided to include them, being replaced in the neural model by the most representative item of the respective subgroup, namely University R&D Employment (% total employment) and Governmental R&D Employment (% total employment). As depicted in Table 7, these variables show a higher preservation of their original variability within the retained factors, being considered

[81] When the Cronbach's Alpha (α) is lower than 0.7, the correspondent Factor doesn't reveal an acceptable internal consistency, not being considered suitable for statistical inference purposes. That is the case of *University R&D Employment* (0.286) and *Governmental R&D Employment* (0.460). Hence, these factors were rejected and substituted by the original variables, which are more representative, therefore have a higher communality with the factor that has theoretical importance for the model. As mentioned, there were considered for the econometric ANN model 6 factors and 2 original variables.

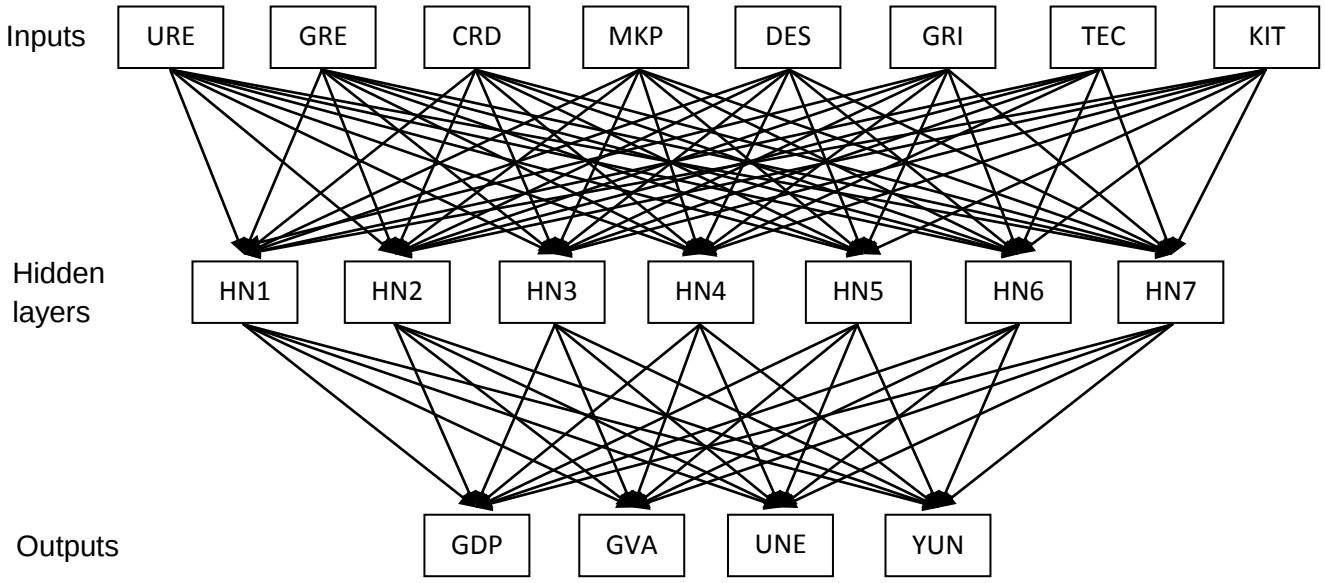
more representative than the alternative ones which keep lower communalities.[82] Therefore, it was considered as "modelling inputs", the two remaining original variables, representing the theoretical factors, more precisely *University R&D Employment* (URE) and *Governmental R&D Employment* (GRE) and the 6 remaining dimensions from Factorial Analysis that revealed an "excellent" or "good" internal consistency namely *Corporate R&D* (CRD), *Market Potential* (MKP), *Demand Sophistication* (DES), *Governmental R&D Investment* (GRI), *Technological Capacity* (TEC) and *Knowledge Intensity* (KIT). As "output variables" it was considered Gross Domestic Product (GDP), Gross Value Added (GVA), Unemployment (UNE) and Youth-Unemployment (YUN). Given the purpose of this study, for mapping the mediatory variables, which influence the impact of RIS inputs on employment and economic growth, it was used the multiple feedforward networks as neural network model selected.

These neural networks use S-shaped functions to find patterns of nonlinearities in data that linear statistical tools such as regression analysis cannot model, and the sigmoid function was employed for the hidden and "output nodes". Besides, it was used "multiple backpropagation" algorithms (MBP) because they perform significantly better than does "backpropagation" (Lopes and Ribeiro, 2003) and are easy to use, highly configurable, permit RMS analysis and graphics during training and test sets, and allows input sensitivity analysis.

In this research the network modelling was conducted through a trial-and-error process, in order to gradually narrow the Root Mean Square Error (RMSE), attempting to minimize the discrepancy between the predicted and observed values. In that way, different architectures were tried and tested, and it was found the optimal fit between inputs and outputs was achieved through a network with a single intermediate layer, integrating 7 hidden nodes (Figure 4). This was thought to be an "interpretable" number of latent variables that could be clearly identified and labeled, and the network did not give significantly better results by increasing the number of nodes comprised in the hidden layer.

[82] Regarding *University R&D Employment*, the "share of total employment" (0.890) keeps a higher communality within its factor when compared with the respective "absolute number" (0.720). A similar situation occurs with *Governmental R&D Employment* with the "share of total employment" (0.806) preserving a higher proportion of the original variance than its "absolute number" (0.790).

Figure 4 - Hypothetical Neural Network Model



Source: Own preparation

This study adopts a "connectionist framework" where the processing elements, which define the "topology of the model", are examined in a structured manner. As showed in Figure 4, the focus is in the interactions between input and output layers. The "input layer" represents the "independent variables" in the study, whereas the "output layer" represents the "dependent variables". The link between independent and dependent variables occurs through an intermediate layer, termed as "hidden layer", where the number of elements is discretionary (Somers and Casal, 2009). This interior layer contains the elements that are not directly observable from the inputs and outputs system. Each "hidden node" is linked to each input node and to each output node, with the network computing values for each processing unit as a weighted sum of the neurons in the preceding layer, according to the connection weights. These nodes are assumed as latent[83] variables, and the neural network can be used to cast light on these variables through their links, identifying communal processes, which are labelled by considering their connections to the input variables (Moutinho et al., 1996, p. 135). In this way, ANNs modelling takes into consideration the non-linear relationships between RIS components and the macro-economical outcomes, reaching a higher explanatory power in comparison with the equivalent linear regression models. The RMSE obtained for the test data was 0.052 and the

[83] See Haykin (2008) for further details about the NNs modelling approach.

goodness-of-fit value (R^2) was estimated to evaluate the performance of the neural model. Moreover, a linear regression was also run for each macro-economical output, using the exact same 8 independent or input variables. As expected, the neural model outperformed linear regression by generating a greater predictive accuracy, which is consistent with the previous studies (e.g. Somers and Casal, 2009).

Table 9

Comparison with linear regression equivalent model

	Output variables			
	1. Youth-Unemployment	**2.** Unemployment	**3.** Gross Value Added	**4.** Gross Domestic Product
Measure:	R^2	R^2	R^2	R^2
ANNs	0.998	0.994	0.966	0.977
Linear regression	0.195	0.143	0.874	0.915

Source: Own preparation

As measured by R^2, a relatively high share of macro-economical variance is explained by the network architecture, assuring the representativeness of the overall neural model and adding value to the current knowledge's state-of-art in this particular research field.

2.8. Interpretation of the Results according to the Literature Framework

The neural network was examined regarding the links between the variables in each layer. The overall contributions of independent variables to hidden-nodes reveal that *Corporate R&D* (5.354) has the major significant contribution followed more closely by *Technological Capacity* (4.932) and *Governmental R&D Employment* (4.091). The independent contributions to Hidden node 1 (HN1) show more positive impacts than negative ones. For instance, the findings show that *Demand Sophistication* (1.306) is by far the most significant contributory weight followed by the much smaller weights from *Knowledge Intensity* (0.230) and *Governmental R&D Investment* (0.189). In the particular case of HN1 inhibitory effects have very low weights and considering all the

remaining contributory and inhibitory contributions this node was labelled as *Internal Demand* due the structuring impact of *Demand Sophistication*. Therefore, it is interesting to note that, in general, *Internal Demand* has a quite meaningful impact on the output layer (6.752). When looking at the individual neuronal outputs the findings reveal that GVA (-1.874) and GDP (-1.091) growth rates are both negatively influenced by *Internal Demand*. This analysis is coherent with Bento (2011) findings regarding economies that are being driven by Domestic Consumption in association with investments increasing, in which the economic tissue tends to become narrowly focused on non-tradable sectors in order to take advantage from the raising *Internal Demand*. What happens is that the non-tradable sectors are protected against external competitors, revealing a tendency for oligopolies' consolidation and thus for empowering, for instance, *utilities'* firms regarding their "pricing-power". When companies don't have relevant competitors for the same market segments they are allowed to increase prices until a certain threshold, without losing a significant level of demand.

Table 10

ANN: Network Layers and Weights

(a) From Input Node	**URE**	**GRE**	**CRD**	**MKP**	**DES**	**GRI**	**TEC**	**KIT**
To Hidden Node:								
Internal Demand (HN1)	0.080	-0.060	0.052	-0.061	1.306	0.189	0.003	0.230
R&D Catching-up (HN2)	0.177	0.049	0.375	0.189	-0.096	0.691	-1.596	-0.090
Innovative Potential (HN3)	-0.099	0.309	0.224	0.387	0.238	-0.193	-2.576	-0.954
Insourcing (HN4)	-0.971	-0.074	0.456	0.112	-0.222	0.173	0.008	-1.147
R&D Intensity (HN5)	-1.332	-1.324	-0.012	-0.023	0.179	-0.157	0.072	-0.206
Absorptive Capacity (HN6)	-0.112	-2.242	-1.713	0.037	0.095	0.079	0.519	-0.083
Economies of Scale (HN7)	-0.017	0.033	-2.520	0.628	0.054	0.357	0.157	-0.043
Total contribute of Input Variables	2.788	4.091	5.354	1.437	2.189	1.839	4.932	2.753
(b) From Hidden Node		**HN1**	**HN2**	**HN3**	**HN4**	**HN5**	**HN6**	**HN7**
To Output:								
GDP		-1.091	0.736	-1.651	-2.002	-0.015	-0.146	-0.653
GVA		-1.874	-2.249	-2.027	-0.928	-0.356	0.250	-0.571
Unemployment		-2.337	-0.965	1.244	-0.072	0.248	-0.807	0.856
Youth-Unemployment		1.450	-0.980	0.626	0.058	0.190	-0.645	0.097
Total contribute of Hidden Node		6.752	4.930	5.548	3.060	0.809	1.848	2.177

Source: Own preparation

In such contexts, companies that are focusing on non-tradable markets tend to increase wages and stockholders yields faster than productivity because it is possible to reflect the additional overhead and financial debt costs into higher prices or “rents” and keeping the profit margins, at the same time. Furthermore, the tendency to labour costs inflation within the non-tradable sectors is extended to the overall labour market leading to a lack of international competitiveness in the tradable industries. Given the raising “gap” between productivity and wages, increasing governmental consumption or investments and thus contracting more public debt is the only way of keeping an artificial level of Domestic Demand, despite the marginal production costs increasing and the further decreasing on exportations.

Hidden node HN1 – Internal Demand:

The HN1 or *Internal Demand* generates additional Youth-Unemployment because “consumption-driven” economies rely mostly on the non-tradable services which are not exposed to international competition for more productive technologies and human capital, generating less qualified jobs when compared with the tradable sectors. The younger segments of the population are, in average, the most qualified human capital and that is the reason why *Internal Demand* leads to a raising Youth-Unemployment (+1.450). Despite the enhancing effect on Youth-Unemployment, *Internal Demand* has a significant and quite meaningful role on reducing Unemployment (-2.337) rate as an all, by creating “mass-market” opportunities for the active population layers with lower qualification standards. In this sense, the non-tradable services have an important and indispensable role on generating job opportunities for the average segments within the overall population, replacing the relocation of manufacturing facilities to countries with lower labour and social costs (Sinn, 2001) and keeping the regional *Market Potential* (Norman, 2002; Friedman, 2005; Pires, 2005). The differential impact of *Internal Demand* on output variables reinforce the idea that innovation policies should be managed in an integrated way and taking into account the downsides and side-effects of each policy. For instance, the *Internal Demand* enhancement policies have a quite meaningful role on employment scale-up through improving the labour market absorptive capacity with less qualified and specialized work supply, but at the same time, significantly increases Youth-Unemployment, by

generating less job opportunities for the most qualified and specialized population's segments.

Hidden node HN2 – R&D Catching-up:

The contributory and inhibitory weights which belong to Hidden node 2 (HN2) illustrate that, in this case, remain more positive than negative effects. Although most effects are positive, the stronger impact is by far inhibitory, more precisely from *Technological Capacity* (-1.596). The negative impact from a weak *Technological Capacity* is balanced with the contribution from *Governmental R&D Investment* (0.691) and that expenditures inflow is associated with a smaller enhancing effect over *Corporate R&D* (0.375). Taking into account, on the one hand, the much stronger effect from a weak *Technological Capacity*, and in the other hand, the responsiveness coming from *Governmental R&D Investment* and followed by *Corporate R&D*, HN2 was labelled as *R&D Catching-up*. Besides, in regional economies with a weak *Technological Capacity*, the governmental investments in R&D play an indispensable role from a policy-making stand point, in creating the necessary conditions, for a medium-technology manufacturing-based development. "R&D public leverage" enhances both employment of qualified personnel and R&D expenditures in corporations, due to the risk sharing and spillover effects between public and private agents (Leydesdorff and Fritsch, 2006; Carlsson, Acs, Audretsch and Braunerhjelm, 2007; Caragliu and Bo, 2011; Hewit-Dundas and Roper, 2011). Moreover, the *R&D Catching-up* has a significant impact (4.930) on the overall output layer materialized on an enhancing effect over GDP (+0.736) growth rates. The *emerging innovator* regions reveal the tendency to increase R&D investments in order to "catch-up" with more developed regions or countries (Furman and Hayes, 2004) and those expenditures leverage GDP and help supporting a sustained demand for qualified human capital, capable of reducing either Youth-Unemployment (-0.980) and Unemployment (-0.965). Despite, the priming effect both on GDP and on mass-market employment, the *R&D Catching-up* approach is adopted precisely for overcoming the lack of *Technological Capacity* (Furman and Hayes, 2004; Pe'er and Vertinsky, 2008; Bento, 2011) that impairs GVA. For this reason, *R&D Catching-up* policy tends to be applied in technologically underdeveloped regions, as clearly expressed by the negative association with GVA (-2.249). In such a context, the GVA

enhancement is vital to leverage an attractive level remuneration for production factors (i.e. capital and labor), leading to FDI attractiveness and, subsequently, to medium technology manufacturing scale-up. On the other hand, the GVA growth is also needed for keeping these sustainable inflows in the medium and long-run (Romer, 1986; Romer, 1990; Norman, 2002; Pires, 2005), eventually, leading to additional regional sources of competitive advantages through differentiation. Eventually, the development of a higher technological degree, embodied in a more complex production and in less replicable technologies and products (Auerswald, 2010), whenever matching firms' absorptive capacity (Harhoff, 2000; Teixeira and Fortuna, 2010) and the increasing on fitting the market needs (Adner and Levinthal, 2001) allows practicing higher prices and thus leads to profit margins increasing without deter the demand levels (Wersching, 2010). In this sense, *R&D Catching-up* must be combined with other policy measures and adapted to regional characteristics to become effective (Pessoa, 2010; Caragliu and Bo, 2011).

Hidden node HN3 – Innovative Potential:

In what concerns to Hidden node 3 (HN3) it shows an equal number of positive and negative contributions, but the most significant impacts are inhibitory, and more precisely *Technological Capacity* (-2.576) and *Knowledge Intensity* (-0.954). These negative weights are balanced by *Market Potential* (0.387), *Governmental R&D Employment* (0.309), *Demand Sophistication* (0.238) and *Corporate R&D* (0.224). The label attributed to HN3 was *Innovative Potential* due the node's overall structure impairment induced by the combined effect from a weak *Technological Capacity* and a low *Knowledge Intensity*. It seems important to point out that *Market Potential*, *Governmental R&D Employment, Demand Sophistication* and *Corporate R&D* are responsive to the much stronger negative impacts provided by *Technological Capacity* and *Knowledge Intensity*. In such a context, the role of *Market Potential* is increasing market size, improving scale economies availability and making each region a more attractive destination for capital investment. These results are congruent with the previous empirical findings of Pires (2005); Acs, Bosma and

Sternberg (2008) and Gilbert, McDougall and Audretsch (2008) reinforcing the idea that *Market Potential* has a double-role:[84]

(1) On the one hand, "assuring demand": generating economies of scale that can assure the necessary levels of demand for goods and services produced, distributed or sold inside region's boundaries, in order to leverage an attractive level of remuneration for production factors (i.e. capital and labor), leading to FDI and, subsequently, to medium technology manufacturing set-up;

(2) In the other hand, "building critical mass": increasing the availability of qualified human capital – embodied in *Technological Capacity* and *Knowledge Intensity* – improves companies absorptive capacity, technological update and the fit with market needs, leading to higher value-added solutions and thus to higher profit margins.

Both empirical background and current results suggest that the lack of *Innovative Potential* empowers *Market Potential* role, mitigating the combined and restrictive impact from a weak *Technological Capacity* and a low *Knowledge Intensity*, on employment and economic growth potential. On the other hand, the lack of knowledge intensive services could be, at some point, replaced by increasing R&D employment in governmental or "public" organizations. Furthermore, those R&D professionals will, potentially, engage a pool of qualified human capital available for providing cheaper and effective services to companies and thus increasing the productivity of production factors (i.e. capital and labour). Moreover, coping capability with economic downturns could be enhanced by improving the flexible access to highly qualified human capital, allowing companies to convert fixed costs in to variables ones, and, thus, decreasing marginal costs of production (Friedman, 2005; Auerswald, 2010). As expected, a lack of *Innovative Potential* has a restricting effect on economic growth (5.548), i.e., the total contribute of the hidden node expressed both on GVA (-2.027) and GDP (-1.651). In addition, contrary to *R&D Catching-up*, *Innovative Potential* is characterized by a quite weak *Technological Capacity* combined with a significant impairment in the knowledge intensive services supply. Regarding Employment issues, this restriction on the qualified services "supply-side" affects more the experienced individuals as expressed by the differential impact of

[84] The findings are also congruent with "pure" NEG (New Economic Geography) Models (e.g. Krugman, 1991).

Innovative Potential on Unemployment (+1.244) that is almost the double when compared with Youth-Unemployment (+0.626). This interpretation is also coherent with the previous *insight* from HN1 or *Internal Demand*, that the services' sector has more impact on Unemployment than on Youth-Unemployment.[85]

Hidden node HN4 - Insourcing:

The hidden node 4 (HN4) showed an equal number of inhibitory weights and contributory ones. Despite the apparently balanced structure, the most relevant effects are negative, more precisely *Knowledge Intensity* (-1.147) and *University R&D Employment* (-0.971), and the more significant positive contribution is provided by *Corporate R&D* (0.456). The most probable and plausible interpretation is that when Regional Innovation Systems don't have the necessary threshold of knowledge, companies tend to "internalize" skills and competences by investing in and integrating additional qualified human capital in their payroll to overcome those knowledge services' gaps. According to previous insights provided by Piore and Sabel (1984), Zenger (1994), Norman (2002), Friedman (2005) and Auerswald (2010), the knowledge intensive services and technological transference scale-up generates business volume growth and competitiveness gains, essentially through:

(1) Flexibility increasing: conversion of structural fixed costs into variable ones, improving companies' coping capability with demand volatility and bullish markets;

(2) Competitiveness improving: production process' optimization supported on the knowledge intensive services' flexibility and on technological know-how availability provided by universities, allowing companies to reduce prices without deter profitability and to improve coping strategies with global pricing competition and a real-time value-chain management.[86]

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[85] The research carried out by Hájková, V. and Hájek, P. (2010). *Analysis of Regional Innovation Systems by Neural Networks and Cluster Analysis*, Communication and Management in Technological Innovation and Academic Globalization (showed RIS in which the selected regions of Austria, France, Belgium, Sweden, Finland, Netherlands and Great Britain the most of the population is employed in the sector of services. Available from: (http://www.wseas.us/e-library/conferences/2010/Tenerife/COMATIA/COMATIA-04.pdf) [Accessed 10 January 2011].

[86] "Real-time processing refers to the capability of a system that can respond immediately at the time a transaction occurs (Ralston et al. 1983). The value chain as described by Porter (1985) can be grouped into activities in the demand value chain, supply value chain, and the support activities for demand and supply. The demand value chain deals with demand generation in marketing and sales, and demand fulfillment in outbound logistics and services. The supply value chain deals with procurement, inbound logistics and operations" (Chan, 2007). Real-time supply chain management encompasses "supply push" versus "demand pull" strategy. Supply push depends on centralized planning of stocks in anticipation of future demand, material availability triggers

The lack of a qualified outsourcing pool of resources and capabilities induces firms to incorporate the necessary know-how, including, sometimes, knowledge that is not "critical" or considered to be outside the core-business. This helps firms to overcome higher outsourcing costs, to full fill the absence of the necessary pool of specialized human capital and know-how, and to create or reinforce sources of competitive advantages.

According to this, the HN4 was labelled as *Insourcing* because when outsourcing' economies of scale are not available within a certain region, firms replace it by incorporating those skills and competences, in order to overcome the "supply-side" deficit. On the contrary, higher availability of knowledge intensive and technological transference services within a certain region creates an incentive for companies using outsourcing as a replacement of non-core regular employment, permitting firms to focus on differentiated and added value activities and capabilities and leading, eventually, to creation of sources of competitive advantages. Additionally, given the availability of economies of scale and researchers' mobility inside regional boundaries, companies tend to increase their level of outsourcing (Friedman, 2005; Leydesdorff and Fritsch, 2006). Moreover, policy-making, macroeconomic and microeconomic measures' implementation reinforcing *Knowledge Intensity* and *University R&D Employment* (i.e. the outsourcing pool) contribute to prices competitiveness and favor firms coping capability within bullish environments, generating more sales and, thus, leading to higher GDP growth rates. At the same time, replacing – on a higher degree – non-core regular employment by flexible service providers allows companies to reduce overhead fixed costs and to improve their profit margins through converting fixed costs into variable ones (Piore and Sabel, 1984, Norman, 2002) leading to further GVA growth. The *Insourcing* overall impact is 3.060 and the discriminated analysis of node's outcomes points out, as expected, an inhibitory effect on competitiveness expressed either on GDP (-2.002) and on GVA (-0.928). However, contrary to expectations, *Insourcing* doesn't

production and demand forecast and central information systems. Demand pull depends on decentralized control of flows in reaction to current demand, customer demand triggers production and customer identification, demand signal, discipline. As described by Porter (2001) the evolution of technologies in business has gone through the overlapping stages of automation of discrete transactions, functional enhancement of activities, cross-activity coordination and integration, and integration of the entire value chain in real-time. Technology is driving this change and more often organizations are able to be agile, predict and respond with instantaneous processing and integration, focusing on real-time management of the value chain, utilizing technologies in e-business, knowledge management and business intelligence. See Chan, J.O. (2007). *Real-Time Value Chain Management* Communications of the IIMA 79 2007 Volume 7 Issue 3.

generate significant employment (-0.072) or youth-employment (0.058) gains. A plausible interpretation for this is that when companies incorporate certain skills and competences they are also enlarging their organizational structures, creating additional overhead costs with no proportional correspondence on sales or profit margins growth. This "forced" conversion of variable costs into "structural" ones seems to impair firms coping capability with market volatility, by increasing operational costs, decreasing *pricing* competitiveness and thus the profit margins, as shown by the negative impact of *Insourcing* on economic growth (i.e. GDP and GVA).[87] In such a scenario, firms create much less jobs than expected because, at some point, *Insourcing* restricts sales potential and added-value growth. Additional explanation for the absence of significant positive contributions to employment and youth-employment could be the relocation of service providers fitting seasonal demand and researchers networks across several regions and countries, which might replace the need of hiring. The mobility of service providers, researchers and scientists could minimize the impact of *Insourcing* on employment and youth-employment, since knowledge intensive services are frequently decoupled from the regional economies, unless they have high-tech focus. On the contrary, if knowledge intensive services are not stimulated by high-tech end environments, the headquarters location of service providers is more influenced by geographical and logistic cost reasons than by the specific RIS characteristics. Besides, high-tech sectors are characterized for having small size and require economies of scope, but no economies of scale, and they could be efficiently enhanced through *University R&D Employment* generating knowledge based spin-offs or start-ups, and the technological upgrade of manufacturing units, gradually matching technological demand with high-tech services supply (Leydesdorff and Fritsch, 2006; Castro Soeiro, 2009; Caragliu and Bo, 2011).

[87] Generally, in these "forced" conversion conditions, firms tend to insource activities and capabilities, which do not contribute to differentiation and added value generation, leading instead to activities with higher cost contribution, decreasing profit margin's value chain, while focusing on managing non-core activities in which aren't as good as potential service providers and suppliers. Qualitative evaluation can be developed by applying VRIO framework, that is focused on resource or capability based approach to determine each resource competitive potential, by answering the four question about Value, Rarity, Imitability (Ease/Difficulty to Imitate), and the question of Organization (ability to exploit the resource or capability), as referred by Barney, J.B. (1991) *VRIO Framework Analysis*. Strategic Management Journal, 5, p. 171-180.

Hidden node HN5 – R&D Intensity:

Hidden neuron 5 (HN5) is submitted to more negative effects and from those the most important weights are *University R&D Employment* (-1.332) and *Governmental R&D Employment* (-1.324). The remaining effects either contributory or inhibitory aren't specially meaningful and responsive. Since *University R&D Employment* and *Governmental R&D Employment* measure the relative prevalence and installed capacity regarding R&D employment in both types of organizations, HN5 was labelled precisely as *R&D Intensity*. A weak *R&D Intensity* both in universities and in governmental organizations, restricts economic development potential (0.809), as expressed in the inhibitory effect over GVA (-0.356) and in a negligible influence on GDP (-0.015). It generates additional Unemployment (+0.248) and Youth-Unemployment (+0.190), at the same time. This means that, reinforcing *R&D Intensity* tends to significantly increase GVA and mass-market employment growth potential. Considering this, policy-makers must be aware that universities and governmental institutions – like for instance research institutes – not always produce economically useful knowledge, leading to the clogging of the "Knowledge Filter" (Carlsson, Acs, Audretsch and Braunerhjelm, 2007). Although industries with a greater share of R&D employment tend to host more new high-growth companies (Eckhardt and Shane, 2011) there are other factors involved in this process such as the "technological competence enhancing capability", which allows firms to translate knowledge accumulation into sustained competitive advantages and sustained growth, especially if leveraged by the initial size of their technological stock endowment (Lee, 2010). In other words, *R&D Intensity* makes the technological opportunity set wider, but for unclogging the "Knowledge Filter", the capability of effectively translating new knowledge and ideas into marketable products and services and effective technology market transfer process is also needed (Audretsch and Keilbach, 2004; Audretsch and Keilbach, 2008; Fritsch, 2008).

Hidden node HN6 – Absorptive Capacity:

Concerning the hidden neuron 6 (HN6), an equal number of "catalytic" and inhibitory effects were found, but the most relevant ones are inhibitory, namely *Governmental R&D Employment* (-2.242) and *Corporate R&D* (-1.713), inducing a significant responsiveness from *Technological Capacity* (0.519). According to the weights

entailing this node's structure, if the engagement to innovation is low at governmental institutions' and market players' levels, then regional economies tend to be increasingly driven by *Technological Capacity*. *Technological Capacity* consists in high or medium technology employment and manufacturing[88] which are variables considered to be linked to *Absorptive Capacity* construct (e.g. Cohen and Levinthal, 1989). The emergence of *Technological Capacity* facing negative impacts resulting from weak R&D intensity has the same mitigation role effect, aiming factors of production, productivity and, consequently, investment attractiveness, that is usually attributed to *Absorptive Capacity* (Pires, 2005; Leydesdorff and Fritsch, 2006; Fritsch, 2008; Fritsch and Mueller, 2008; Pe'er and Vertinsky, 2008; Teixeira and Fortuna, 2010). Having said that, the hidden neuron 6 has an overall impact of 1.848 on economic growth, and given the overlap to the respective theoretical construct was labelled, precisely, as *Absorptive Capacity*. Besides, when it remains a significant gap of R&D intensity, the *Absorptive Capacity* role is empowered, aiming for the knowledge and technologies developed elsewhere can be understood more easily and incorporated in local factors of production, and being applied as seedbed for technological (Leydesdorff and Fritsch, 2006; Tappeiner, Hauser and Walde, 2008) and productivity upgrade (Pe'er and Vertinsky, 2008; Choudhary and Gabriel, 2009). This means that *Absorptive Capacity* is capable of handling an organizational environment averse to innovation, being able to generate added-value, even in such conditions, as expressed in GVA variation rates (+0.250). On the other hand, if human capital development is combined with local R&D efforts, economically peripheral regions are able to improve their ability to identify, valuate, assimilate and benefit from the knowledge that is produced in the most technologically developed ones, promoting inter-regional spillover effects.[89] However, policy-makers must consider this is a *catching-up* process because *Absorptive Capacity* works as an *engine of growth*, mostly for regions characterized by lower industrialization and income level (Krugman and Macedo, 1979; Krugman, 1991; Tappeiner, Hauser and

[88] See the underlying set of original variables from Technological Capacity in Table 3 and/or in Table 4.

[89] The fact that peripheral regions are able to improve their ability to identify, valuate, assimilate and benefit from the knowledge that is produced in other regions technologically more developed, provide support to answer questions like for instance: "Can knowledge creation process be influenced by feedback relations among actors involved in the regional innovation system, including peripheral regions? How can the innovation process of 'lagging' regions be strengthened? What is the role and extent of inter-regional knowledge spillovers?", to further research on the knowledge production function framework and policy-making aiming at upgrading the knowledge creation capacity of European regions, while promoting inter-regional spillover effects, as corroborated by Greunz and Lydia (2005). *Intra- and inter-regional knowledge spillovers: Evidence from European regions*. European Planning Studies, Vol. 13, Issue 3.

Walde, 2008; Teixeira and Fortuna, 2010), as expressed by the negative association with GDP (-0.146), in result of the ANN econometric model. Simultaneously, these regions tend to get increasingly dependent on importations of higher technology machinery and more efficient production equipment to enhance their total factor productivity (Teixeira and Fortuna, 2010) restricting, at the same time, their GDP growth potential (Bento, 2011). Despite that, the medium-technology manufacturing set-up, leveraged through *Absorptive Capacity*, requires "located" facilities (Leydesdorff and Fritsch, 2006) and economies of scope (Norman, 2002), which are associated with factors of production productivity enhancement and thus, with the incorporation of regional human capital, generating clear employment gains, as shown both on Unemployment (-0.807) and on Youth-Unemployment (-0.645). In general terms, the overall results suggest that *Absorptive Capacity* is the most effective short-term policy for overcoming Unemployment and Youth-Unemployment, immediately after *R&D Catching-up* strategy.

Hidden node HN7 – Economies of Scale:

The last node, HN7, has more positive weights than negative ones, although the most important one is inhibitory, in this case, *Corporate R&D* (-2.520). The responsiveness to *Corporate R&D* limitation is assured by *Market Potential* (0.628) and by *Governmental R&D Investment* (0.357). In this sense, a limited R&D installed capacity intensity and investment from economic agents tend to be balanced by population and subsequently by active population growth, combined with the public expenditures to leverage aiming innovation. Considering these aspects, HN7 was labelled as the *Economies of Scale*, which results from market size growth, materialized by the potential consumers and by the overall R&D expenditures of a certain region. In this case the node's overall impact on independent variables (2.177), which reinforces the notion that just by increasing market size and public expenditures scale, aiming economic growth, is not enough to compensate the restrictive effects coming from an economical tissue with low "quality", as expressed on GDP (-0.653) and GVA (-0.571). Such a conjuncture is also characterized by an additional Unemployment (+0.856) and a negligible effect on Youth-Unemployment (+0.097), as in result of the ANN econometric model. A possible explanation for this is that active population growth tends to significantly aggravate Unemployment rate

due the tendency for the jobs demand growing slower and latter than market size. It seems important to point out that R&D labour market is not particularly linked with mass-market employment. As shown in HN1 (i.e. *Internal Demand*) and in HN6 (i.e. *Absorptive Capacity*), the need of new job opportunities directed to the population layers with average qualifications, should be addressed primarily by the services and then by manufacturing sectors, respectively. This is also congruent and consistent with the insights provided by HN2 (i.e. *R&D Catching-up*) that *Governmental R&D Investment* must be coupled with *Corporate R&D* to generate a significant impact facing Unemployment and Youth-Unemployment. Despite that, policy-makers should be aware that additional job opportunities generated by *Governmental R&D Investment* are more suitable for younger and, on average, most qualified segments of population, making the effects of labour market size growth neutral regarding Youth-Unemployment. Thus, te results from *Economies of Scale* demonstrate that economic agents' "quality" couldn't be replaced by the market size and public expenditures growth (e.g. Van Stel and Storey, 2004; Fritsch, 2008), pointing out that "Keynesian policies" are becoming increasingly obsolete in a technologically globalized economy (Sinn, 2001; Friedman, 2005), as in result of the ANN econometric model.

2.9. Final Remarks, Discussion and Policy implications

In first, it is worth to mention that Governmental R&D Investment doesn't have a linear impact on employment and on economic growth, pointing out the need of assessing the trade-offs of policies that could lead to significant expenditure increases and larger time lags. Secondly, translating R&D outlays on employment and on economic growth doesn't work on a simple "input-output" logic. Besides, increasing R&D investment scale, either public or private, is a necessary condition for building sustainable development, but must be combined with other policy measures and adapted to local circumstances, like for instance population density and productivity (Fritsch and Mueller, 2008) to become effective. In fact, Governmental R&D Investment is capable of contributing to GDP and employment growth, even in technologically underdeveloped regions, but must be coupled with Corporate R&D to do so. However, results provide empirical evidence that high or medium technology

employment and manufacturing combined with knowledge intensive services, and also that the presence of a R&D Pool supported by universities and government, are capable of effectively reinforce companies' competiveness, generating additional economic and employment growth, in the scope of the 158 developed regions included in the present sample.

Moreover, in terms of wider policy implications, results reinforce the idea that European Commission Research and Innovation policies should be restructured, shifting from a transnational framework to a more localized, measurable, operational and goal-oriented approach, as already pointed out by Caragliu and Bo (2011). Also, that the emergence of the so called "European Paradox" shows that R&D public investments are not being as effective as possible, and increasing public R&D expenditures scale is not enough to generate employment and sustained economic growth. In other words "throwing money on the problems" policy doesn't seem to be an efficient or effective solution. In such a conjuncture, RIS approach may be a valid alternative, because it improves regions capability for exploiting their differential competitive advantages in order to overcome the unfavorable effects from inputs endowment, spatial location or knowledge base maturity. The overall results of the present research suggest the subsequent groups of instruments as effective guidelines and measures for innovation policy-making:

(1) Corporate R&D or the Economical Agents' "quality" cannot be successfully replaced by "Keynesian policies" focused on enhancing Market Potential, Demand Sophistication and/or Governmental R&D Investments;

(2) High or Medium Technology employment and Manufacturing combined with knowledge Intensive Services, and the presence of a R&D Pool made available by universities and governmental institutions will work as seedbed instead of being a proxy of further Employment and Economic growth;

(3) Governmental R&D Investment could be effective for enhancing GDP growth, even in technologically underdeveloped regions, and also for leveraging Mass-market Employment growth, but only if coupled with Corporate R&D;

(4) The need of Mass-market Job Opportunities directed to the population layers with lower average qualifications, should be addressed primarily by the services and medium-technology manufacturing sectors, respectively;

(5) The R&D Catching-up is the most effective short-term policy for overcoming Unemployment and Youth-Unemployment, immediately before the Absorptive Capacity development strategy;

(6) In general, results suggest that Absorptive Capacity is the most balanced and short-term development (i.e. both Employment and Economic growth) strategy for the regions characterized by an environment averse to innovation and by a lower industrialization and income;

(7) The Innovative Potential reinforcement provides the most stalwart impact, unleashing Economic and Employment growth potential. However, doesn’t produce direct or immediate results, requiring a long-term sustained investment instead.

Chapter 3

RIS and Policy-Making intersection: Implications at Regional, National and Transnational level in Knowledge based Economies

3.1. Abstract

The purpose of this essay is to identify, analyze and provide Policy-Making Recommendations following a regional and local approach, based on the dimensions that shape Regional Innovation Systems (RIS) structure and evaluate empirical model's consequences in the EU context.

After "entering" in the "Knowledge Filter", analyzing and discussing the "Innovation's Black-box", by recurring to a new statistical inference supported by neural networks exploratory approach, which showed RIS subsystems are not homogeneous and can generate positive, null and negative side-effects, it was carried out a strong literature review and a transversal benchmark on macroeconomic and microeconomic measures implemented in the EU context to provide a ground view for Productive Entrepreneurship and Innovation and the role of the State. This essay provides a deeper analysis and discussion about Policy-Making implications and Regional Innovation Systems, aiming to highlight nexus-causality effects with the objective of suggesting new insights regarding the implementation of Policy-Making Recommendations to foster Innovation, Entrepreneurship and, ultimately, Employment and Economic growth in the future, either in short or medium and long-term.

(Keywords: Regional Innovation Systems, European Paradox, Knowledge Triangle, Europe 2020 Growth Strategy, Economic Agglomeration, Knowledge Spillover Theory of Entrepreneurship and Spatial Clusters, knowledge-Based Clusters, Cluster Mapping and Policy-Making)

3.2. Introduction

The State can assume active, passive, or indifferent roles, nevertheless it has a natural role as regulator, through policy-making to foster the adequate contextual economic and business conditions that impact on the development of regional innovation systems and entrepreneurial activities, aiming to employment and economic growth. Historically, this view is supported by the work of Joseph Schumpeter[90] about the role of the State, and by more recent research developed by Kayne (1999)[91] and by Martinelli (2004)[92] whose studies shows that innovation systems and entrepreneurial activity can be increased significantly through improvements, for instance, in the regulatory framework, and by simplification of the administrative process and integration of knowledge-based services. Moreover, administrative barriers are considered by the European authorities as a major hurdle to starting businesses.[93] In Portugal, in an effort to respond to mounting concerns about administrative barriers to entrepreneurship, a one-stop-shop for creating firms was introduced in 2003.[94]

On the other hand, as provider of educational and research-based resources and the authority that regulates educational programs, the State might also have, from that stand point, an important impact on innovation and entrepreneurship activities, as well as on knowledge intensity and insourcing. Research shows,[95;96] that reinforcing innovation and entrepreneurship education programs has positive impact on regional innovation systems, entrepreneurial activity and new businesses set up.[97] In

[90] Ebner, Alexander, Institutions, entrepreneurship and the rationale of government: An outline of Schumpeterian theory of the State.
[91] Kayne, Jay, 1999, from the Kaufmann Center for Entrepreneurial Leadership at the Ewing Marion Kauffman Foundation, Kansas City, Missouri.
92 Martinelli, A 2004. The Social and Institutional context of Entrepreneurship. University of Milan. Book series International in Entrepreneurship.

[93] Communication from the Commission to the Spring European Council, 2008 – Strategic report on the renewed Lisbon strategy for growth and jobs: launching the new cycle (2008-2010) support this conclusion.
[94] Firstly with "Portal do Cidadão" and then with "Empresa na Hora", the time resulted to set up a business has been reduced by as much as 80% compared with the mid-1990s and afterwards to a superior to 50% in 2003, by simplifying procedures and jointing all the formalities about firms registration, business and social security registers at the same time in one place WEB supported.
[95] Amaral, Osvaldo, 2004, O Empreendedorismo e o Papel do IEFP na Região, 2001-2004, support this conclusion.
[96] The Fostering of Entrepreneurship in Portugal, 2001, study completed by Sociedade Portuguesa de Inovação, with the support of Nova Forum, Fundação Luso-Americana para o Desenvolvimento and Banco Português do Investimento, corroborate this.
[97] For example, the "EXIST Programme" in Germany is considered to be an example of best practice, in promoting regional co-operation between universities, technical colleges, the business sector and other partners

summary, since state's policies regarding access to capital, business regulation, and promotion of innovation and entrepreneurial education, among others, have revealed such an important impact on innovation and entrepreneurial activity, it is clear that a better understanding of the types of government policies towards innovation and entrepreneurship and of the nexus causality effect that links such policies to an increase in innovation and entrepreneurship rates and new business creation and growth is a worthwhile inquiry. Moreover, given the impact of innovation and entrepreneurship on economic growth, this represents an opportunity to discuss, guide and monitor a set of policies that foster economic development as a whole.

When it comes to Regional Innovation Systems and Knowledge based Economies one of the main objectives is to understand what policies can be catalogued as best practices for the role of the State in promoting innovation, entrepreneurship and growth. These are relevant research questions, in particular how these policies are being and could be implemented in EU and in each of Member states, which are facing an economic crisis. In addition, there is an opportunity to analyze and discuss possible policy-making referential at both regional/national and transnational, aiming to access to "catalogue" of best practices and to put forward a list of recommendations about the policies that the EU and, eventually the Portuguese State "could" implement to foster innovation, entrepreneurship and, ultimately, employment and economic growth.

The rest of this chapter is organized as follow, section 3.3. reviews literature and general arguments that support the use of State policies towards the promotion of innovation and entrepreneurial activities. Section 3.4. looks at Benchmark findings on the EU environmental Context conditions to Productive Entrepreneurship and Innovation Systems, analyzing how governments intervene in innovation and entrepreneurial activity. Last, but not least, section 3.5. discusses EU context the Policy-Making implications and results for Regional Innovation Systems and provides insights on Guidelines and Recommendations for the future.

with the aim of, jointly, creating a more entrepreneurial mentality in higher educational and research institutions, to foster knowledge spillover and to capitalise on the potential of ideas and entrepreneurs, ultimately, leading to more innovative startups and new jobs.

3.3. Literature Review

First of all the State can assume different roles in the promotion of innovation entrepreneurial activity (active, passive, or indifferent) and it can act in several areas, influencing the access to capital, regulation, education, among other, and direct its efforts through specific policies. On the one hand, it is very important to review the key elements that allow better assessing the preferable role for the State, the most suitable areas of action, and some of the better targeted specific policies, macro and micro-economic measures.

Moreover, it is important starting to review some of the key roles, both positive and negative, that the State can take in the promotion or hindrance of innovation and entrepreneurship.

It is clearly assumed by Baumol's (1990) proposition[98] that the State can take different roles, both promoting and hindering productive entrepreneurship and innovation. For instance, Baumol (1990) says that when State promotes policies that produce positive effects in the productive entrepreneurial activity produces economic growth and increases general welfare.[99] In these conditions, State intervention should be favored, and he defends the role of the State as promoter of entrepreneurial and innovation activities. In the opposite side, Baumol (1990) also says that entrepreneurship can sometimes be unproductive or even destructive, in this case if State intervention promotes, sustain or even allows such kind of entrepreneurship, intervention should be curved, and, most probably, the role of the State put into question. Baumol's (1990) point is that whether entrepreneurial activity becomes productive or unproductive, whether it creates wealth or destroys it, depends heavily on the structure of payoffs in the economy – the rules of the game – established by the State.[100]

[98] Baumol, William J., (1990). *Entrepreneurship: Proactive, Unproductive and Destructive*, Journal of Political Economy.
[99] Baumol, William J., (1990). *Entrepreneurship: Proactive, Unproductive and Destructive*, Journal of Political Economy corroborates this approach.
[100] Baumol William J., (1990). *Entrepreneurship: Proactive, Unproductive and Destructive*, Journal of Political Economy, defends that the "rules of the game" that determine the relative payoffs to different entrepreneurial activities do change dramatically from one time and place to another, which in turn, influences entrepreneurial behavior and changes direction from one economy to another in a manner that corresponds to the variations in those rules. On the other hand, Baumol supports that the allocation of entrepreneurship between productive and unproductive can vary, in high extent, the effects on the innovativeness of the economy, on the degree of dissemination of technological discoveries and the economy's productivity growth.

In addition to Baumol's view on the Productive Entrepreneurship, one of the most discussed proactive positions assumed by the State is defended by the Schumpeterian's model approach. This model clearly points out the idea of Productive Entrepreneurship based in two major supports, sometimes called Mark I and Mark II. In Mark I, Schumpeter argued that the innovation and technological change of a country or a region comes from the "Entrepreneurs", or "Wild Spirits".[101] According to Schumpeter, entrepreneurs are the ones who make things work in the economy of a country or a region. Later on, in Mark II, he asserted that the actors that drive innovation and economy are big companies and corporations which have the resources and capital to invest in research and development. Both arguments might be complementary today.[102;103]

Schumpeter's thought defends that innovations (Schumpeter calls them "the carrying out of new combinations") take various forms besides mere improvements in technology, and that are implemented in a favorable environment and rules' game. This is also the thought in Baumol's theory.[104]

In addition to that, Baumol refers also positions assumed by the State regarding entrepreneurship that have no positive nor negative effects that he calls as Unproductive Entrepreneurship positions.

Last, but not the least, Baumol characterizes a third type of approach by the State that is denominated Destructive Entrepreneurship, which represents the position against the role of the State intervention.[105] This position of the State was further developed by Deasi and Acs,[106] who showed that there are, at least, three main areas of examples to be analyzed, according to the following:

[101] Schumpeter coined the word "Unternehmergeist", german for "entrepreneur-spirit".
[102] Baumol, William J., (1990. *Entrepreneurship: Proactive, Unproductive and Destructive*, Journal of Political Economy, 1990 corroborates the Schumpeterian's model.
[103] Ebner, Alexander, 2006. *Institutions, entrepreneurship and the rationale of government: An outline of Schumpeterian theory of the State* supports this framework.
[104] Baumol, William J. 1990. *Entrepreneurship: Proactive, Unproductive and Destructive*, Journal of Political Economy and several studies and research articles supports this conclusion.
[105] Ebner, Alexander, 2006. *Institutions, entrepreneurship and the rationale of government: An outline of Schumpeterian theory of the State* corroborates this research and conclusion.
[106] Acs and Deasi, 2002. *A Theory of Destructive Entrepreneurship* supports and analyses this topic.

a) Rent seeking and corruption activities

Deasi and Acs (2002) refer to this as “crony capitalism” or “rent-seeking”, or even considering corruption activities as fitting in here. If the formal institutions of a country, or a region, worked well, none of these types of activities could exist. What is also clear is that the opportunities for unproductive entrepreneurship could pull some individuals away from productive entrepreneurship because there is less risk in them;

b) Inadequate regulation and bureaucracy

Djankov et. al. (2002) examined regulation of entry and found high costs of entry in most countries with high standards bureaucracy and regulation of entry have more corruption and larger unofficial and parallel economies;

c) Property right misuse power

De Soto (1990), and later, Acemoglu and Verdier (1998) examined enforcement of contracts between entrepreneurs and the ability of State employees to misuse power for the enforcement of property rights and the findings that it may be optimal to allow some corruption and no enforce property rights fully and also, that some developing economies may choose some combination of strengths of these two institutions.

On the other hand, Murphy et.al. (1993), supported by a theoretical model on the effects of rent seeking on growth, suggests that rent-seeking is indeed so costly to growth because it has natural increasing returns (and thus, becomes increasingly attractive compared to productive activity) and do causes harm to innovative activities more than everyday production activities, besides the allocation of talent effect and its comparative and, in some cases, competitive rewarding, resulting on a trade-off against entrepreneurship. Clearly the trade-off is between entrepreneurship and innovation (starting firms that innovative foster growth) and rent-seeking (redistributing wealth and reducing growth).

Bhagwati (1982) proposes the concept of directly unproductive profit-seeking (DUP) activities, in which the rent-seeking is included as subset, and also analyse the welfare effects of DUP activities, like for example lobbying, tariff evasion and premium seeking for import licenses, and found that these policies affect negatively

entrepreneurial activity's impact in the economy, in terms of innovativeness and productivity.

Hence, depending on the rules of the game, meaning the role and policies carried out by the State, the relative payoffs to different entrepreneurial innovative activities play a key role in determining whether entrepreneurship will be allocated in productive or unproductive directions and that this can significantly influence the vigor of the economy's productivity and innovativeness growth.

This analysis lead to the conclusion that the State should be careful and transparent at always creating the structures and incentive measures that foster Productive Entrepreneurship and not Unproductive or even Destructive ones, and avoiding policies that may carried out to those.

Nevertheless, evaluation of a specific policy or measure on what regards to its respective positive, negative or indifferent impact should not be evaluated by *per se*, but inserted in its context instead, which is dynamic and can suffer interactional effects and produce a significant influence in the final result.

For example, Europe and other industrialized regions of the globe have experienced considerable industrial re-structuring in the last three decades, changing from traditional manufacturing industries towards new and more complex technologies such as electronics, e-business and software, biotechnology and renewal energies. In this context, entrepreneurship and innovative small firms play a particularly important role for two main reasons:

a) the use of new technologies, like software and e-commerce has reduced the importance of scale economies in many sectors (Piore and Sabel, 1984 and Carlsson, 1989);

b) the increasing pace of innovation and the shortening of product and technology life cycles seem to favour new entrants and small firms, which have greater flexibility to deal and time-to-market shortness with radical change than large corporations (Christensen and Rosenbloom, 1995).

In such conditions, it would be expected that high levels of new firm formation should stimulate economic development and employment growth. In 2001, Audretsch and

Thurik discussed the role of new firms in technological development, and concluded that their role is enhanced by a reduction in the importance of scale economies and an increasing degree of uncertainty in the world economy. These latter two phenomena create more room for innovative entry, and benefits new firms, that generate new markets or niches, in a great majority of cases. It was also considered that there are positive supply-side spillovers generated by high levels of new firm formation and those should have a stronger impact on the regions and countries where such formation has occurred.

More recent research (Audretsch et al., 2001) confirms that there is a significant relationship between increased new firm start-up rates and subsequent employment growth, which can lead to net policy-making.

However, later on Audretsch and Fritsch (2002),Van Stel and Storey(2004), and Fritsch and Mueller(2004) suggested there are ambiguous evidence on the relationship between new firm formation and both economic growth and net employment change, which might impact in policy making.[107] The interpretation's analysis is that there are significant time lags for the effects of new firm entry on regional or national employment. With or without time lags, analysis on entrepreneurship's measures show that the first contribution of new firm formation to employment growth is, naturally, the number of jobs directly created as successful new firms enter the market and grow and that, in principle, successful smaller firms have higher growth rates than their larger counterparts, so firm growth is negatively related to firm size and age.[108]

However, net job formation by new entrepreneurial innovative firms might be positive, negative or null, depending or a number of factors:[109]

a) New firms contribute directly only on a very small proportion of the stock of jobs in the economy, because most of new firms merely substitute existing firms, that purely were not able to innovate and being competitive anymore;

[107] Audrestsch's research was followed by studies of Fritsch and Mueller (2004), Rui Baptista, Vítor Escária and Paulo Madruga (2005) where they investigate whether there are significant time lags for the effects of new firm entry on regional and national employment.
[108] These findings have been confirmed in most subsequent studies despite differences in country, industry, time period, and methodology used (see Audretsch et al., 2004 for a review).
[109] As supported by Van Stel and Storey (2004) point out in their research studies.

b) New businesses have a greater probability of failure than old businesses because there is , in general, an increase of business risk that comes from "green field" or innovative activities, either because are testing new technologies, innovative products and services or business models, value propositions and target-markets (segments);
c) New firms, during their set up time, are in the negative side due to return on the investment period until they are in good conditions to expand their business activities, even they operate according to regional clustering models, focusing on common synergies and externalizing non-core activities, while changing fixed into variable costs;
d) New firms that succeed will produce a kind of "substitution" and "regenerative" phenomenon concerning new jobs over the old ones from their larger counterparts, while incrementing differentiation and competitiveness; [110]
e) There are indirect supply-side effects (spillovers) that new firms' entry may generate in the market, by increasing innovation and competition, producing positive or negative net results, depending on market demand curve evolution in a particular industry or sector;[111]
f) New entrants provide a strong incentive for incumbents to behave efficiently and to adopt new technologies and organizational innovations, increasing competiveness, productivity and quality of service of those incumbent firms, and leading to market innovation, fulfilment of costumers' needs and economy dynamics.[112]

As an intermediate conclusion, there is a wave phenomenon,[113] because of the time lags between measures taken with regard to the impact of new firm formation and visible effects on employment growth coming from those in economic terms. On the other hand, there are positive and negative factors, as showed previously. Either

[110] According to Geroski (1995), the survival of most entrants is low and even successful entrants may take more than a decade to gain a size comparable to the average incumbent.
[111] Fritsch and Mueller (2004) developed a survey in which show such effects.
[112] This was supported by Schumpeter, 1934 and by Acs and Audretsch, 1990; Christensen and Rosenbloom, 1995.
[113] This is represented by Figure 7.

way, new firms stimulate and promote the introduction of innovative products and services, leading to patenting activity and sustainable economic growth.[114;115;116]

Such improvements may occur either on the side of newcomers or on the side of incumbents, reacting to the competition from new entrants, resulting in an increasing of industry competitiveness. And current expectation is that all in all entrepreneurial activity generates gains, in the medium and long run, in innovation, net employment and in economic growth.

Focusing on Productive Entrepreneurship Baumol's and Schumpeter's models gave some examples of State's positive intervention and current empirical research seems to support the validity of these policies. Some of the better documented perspectives and examples of State efforts and ground Policy-Making to support an entrepreneurial innovative economy can be considered bellow:[117]

a) States that view entrepreneurs and innovators as a main driving force of economy tend to adopt policies and programs that directly support an entrepreneurial economy;

b) States that take macro-economic tax and regulatory policy-making, e.g. general tax reductions, leading to costs reduction and net profits increasing of entrepreneurial innovative businesses that are moving from the start-up to high-growth stage;

c) States that recognized "capital readiness" of enterprises as a key factor for a firm obtain the capital it needs and match it with the supply of capital throughout public funding and loans programs;

[114] This conclusion was supported by Romer, 1986.
[115] Johnson and Parker (1996) found evidence that growth in firms' births and reduction in firms' deaths significantly lowers unemployment and stimulates economy.
[116] Research done by Van Stel and Storey (2004) showed the relevance of time lags' effects of new firm births on employment, for the regions of UK, finding that rates of growth of regional and local employment are positively shaped by entry occurring in several earlier years. According with their results the amplitude of such effects over time takes an "inverse u" shape, peaking on the effect on employment growth in the current period of start-up activity occurring five years ago, while no significant effects are identified after ten years.
[117] Kayne, Jay, 1999. *Research studies from the Kaufmann Center for Entrepreneurial Leadership* at the Ewing Marion Kauffman Foundation, Kansas City, Missouri, defends this position.

d) States that work with entrepreneurs and innovators, to promote clustering networking environments, namely at regional and international level, and facilitate the access to all industry players, including investors;

e) States that promote measures to implement uniform and reciprocal processes and procedures associated with the regulation of marketable securities, which by having maturities of less than one year are very liquid securities, thus can be converted into cash quickly at reasonable competitive prices;

f) States that invest in education programmes to support entrepreneurship and innovation in order to promote positive influence on having entrepreneurial innovative mindset, risk handling awareness, proactive attitude and failure acceptance;

g) States that recognize the important contribution that universities and technological centres make to an economy that relies on innovation and technology, promoting programs that lead to university-firms linkage and foster applied research and technology market transfer to firms, expanding levels of intellectual infrastructure and propriety, innovation commercialization and increasing knowledge intensity;

h) States that ensures the planning, development, implementation, management and monitoring activities and key performance indicators to strength policy-making of national research and innovation systems;

i) States that recognize the key role of business activity and public-private network collaboration between science–based and enterprises to increase innovation and industry competitiveness level;

j) States that focus on Business R&D expenditures and applied science, focusing on the commercialization of technological knowledge and Patent and Licensing Technology revenues.

Having these general guidelines for the promotion of Productive Entrepreneurship and Innovation Systems in mind as a ground for further analysis and discussion of

Policy-Making applied to Regional Innovation Systems, it should be advisable to review some of the reasons and the most accepted examples of positive cases for State intervention, which leads to a group of benchmark findings, developed in section 3.4.[118]

3.4. Benchmark Findings on Environmental Context conditions to Productive Entrepreneurship and Innovation Systems[119]

EU policy–making review was carried out in twelve different areas of intervention, where macro and micro-economic measures foster productive entrepreneurship, technological innovation and knowledge intensity.

a) Administrative barriers

Policy making that focus on administrative barriers, that is considered to be a major priority to promote entrepreneurship and innovation, as bureaucratic and inefficient processes and procedures are perceived as a hurdle to start and to change a business. In **Portugal** a one-stop-shop for creating a firm is a good example of international benchmark practices. Firstly, with "*Portal do Cidadão"*[120] and then with *"Empresa na Hora",* the time needed to set up a business has been reduced by as much as 80% compared with the mid-1990s. Major improvements were achieved by simplifying procedures and joining all the formalities about firms' registration, business and social security registers in one same place, and by using a WEB supported platform which provided more 700 different services to citizens and firms. Policy-making focusing on flatting and eliminating administrative barriers, namely in what

[118] See European Commission, 2003. *Entrepreneurship in Europe*, green paper.

[119] Castro Soeiro, F. (2009). *Entrepreneurship and the role of the State in Portugal*, MSc. Thesis, Faculdade de Ciências Económicas e Empresariais da Universidade Católica Portuguesa.

[120] "Portal do Cidadão" is an important project to decrease and eliminate bureaucracy of administrative barriers, while increasing quality and easiness of services managed by the State and several public entities to citizens and firms, in result of Portuguese Minsters Council's resolution, from 2002, ("resolução do Conselho de Ministros 135/2002, de 20 de Novembro"), that was given the responsibility to UMIC (Unidade de Missão Inovação e Conhecimento, whose president was Diogo Vasconcelos), of coordinating the development and implementation of the e-Government Action Plan, in which "Portal do Cidadão" was a core project. During 2003 and throughout 2004, this web portal was prepared to manage more than 700 services, in result of the team work of around 120 public and private entities. Filipe Castro Soeiro was one of the participant members of the project, on behalf of Parque Expo '98, S.A., and of the Ministry of Cities, Territorial Planning and Environment. Available from: (http://www.portaldocidadao.pt/PORTAL/participantes/cidades.html) [Accessed 5 January 2009].

regards to firm's creation, shareholders and stockholders' agreements, accounting procedures, industrial and operational licensing, patent registration and IPR, to mention just a few examples, drive to competitiveness increment throughout simplicity, flexibility and administrative processes' cost efficiency decreasing, that generates new dynamics on firms' creation and FDI attractiveness.

b) Risk (sharing) and reward

Policies that help adjusting the incentives toward entrepreneurial activity are also key. For instance, in **Europe,** the risks associated with entrepreneurship and innovation are not adequately offset by the prospect of reward. People might be more willing to

accept the risk of entrepreneurship and innovation if they were compensated by the prospect of reward in the event of success. In the European Union, a recent trend of measures taken by the State is to reduce tax levels on the self employed, startup and small businesses is observed.

On the other hand, there is another relevant barrier, which results from the fact that a failed entrepreneur faces the stigma of failure, sometimes complex debt processes and legal consequences.[121] The point is that such consequences are justified in cases of fraud or dishonesty, but failure is an intrinsic part of economic life and a proportion of entrepreneurs and innovators go bankrupt or loose competitiveness because they cannot compete in the market. Insolvency laws could be reviewed and optimized to reduce barriers to making a fresh start for honest entrepreneurs, while ensuring there are not negative consequences to creditors' interests and to ecosystem's participants.

Belgium, for instance, has adapted its insolvency legislation with a view allowing entrepreneurs to attempt to rescue businesses when facing temporary problems and to liquidate non-viable firms as quickly as possible, and permitting them to make a fresh start in business, developing good conditions for new attempts to start new businesses and promoting a positive mindset to manage with failure, while learned lessons can also be incorporated in future innovative projects, at same time. In addition, stigma

[121] When the Eurobarometer asked Europeans to identify their primary concerns in relation to the risk associated with entrepreneurship, going bankrupt and losing personal property were prevalent. In addition to the social stigma, a personal bankruptcy implies severe legal consequences. Besides, discharge of remaining debts may take years, bankrupt individuals may lose their possessions and be subject to certain restrictions.

failure is also a reflection of culture and education aspects. Thus, educational programmes and initiatives from society that support the sharing of both positive and negative experiences and provide innovative ways of learning can play an important role in order to drive to positive change.

c) Reducing cost of entrepreneurship

Policies taken by the State focused on reducing cost of entrepreneurship, e.g. throughout the implementation of social measures, that contribute to foster a positive entrepreneurial attitude and promote entrepreneurial innovative projects' development.

In **France**, for instance, a social protection system is tailored to the needs of entrepreneurs (reducing social protection taxes for the self-employed) could make entrepreneurship more attractive. This measure is reducing barriers for employees who want to start up company, either independently or with their employer.

d) Fostering capacity and skill

Policies and measures concerning education and training contribute to encouraging entrepreneurship, by fostering the right mindset, awareness of career opportunities as an entrepreneur and skills.[122] Surveys seem to indicate that knowing about how to start a business increases the likelihood of becoming an entrepreneur. In 2003, for instance, GEM survey found that people who are confident about their skills and experience are two to seven times more likely to be involved in starting or running a business. These conclusions was also supported by the British Household Survey (YEAR), where it appears that the main triggers for entrepreneurial attitude and activities are higher education, and having family and friends that were already "self-employed oriented". The education system can provide both skills and exposure as a contribution to fostering entrepreneurship. In addition, a referenced international benchmark practice about this type of measure is taking place in the *Sivitanidios Technical School* in Athens, **Greece**, where the students divide their time between theoretical and practical guidance on preparing business plans and running a virtual enterprise. This programme will be extended to all technical schools due to its very positive results. It is like

[122] The Eurobarometer in 2003 revealed that 37% of Europeans are considering or had considered becoming entrepreneurs, yet 15% turned their aspirations into reality. This number is about 10% at Portugal in 2008.

running a virtual enterprise within the school that covers entrepreneurship theory and practical guidance on preparing business plans. Simultaneously, liaison offices will ensure that students receive advice and support for entrepreneurial career options. Other example, **Ireland** is implementing a strategy for developing high-growth startups with a focused package of support geared to increasing the number and intensity of campus-based ventures. It includes a one-year incubation programme for graduates who wish to start a firm, providing hands-on and management support and, at the last stage, financial support for turning their research results into commercial reality is provided, leading to commercialization of innovation.

e) Making entrepreneurship accessible to all

Policies and measures with particular focus on women, and towards minorities, as a way of making entrepreneurship accessible to all and giving support to obtain a better response to their specific needs, contribute to encouraging entrepreneurship and innovation. The European Commission has facilitated exchanges of good practice on policy to promote entrepreneurship among women trough the “WES network”. There are considerable fewer female than male entrepreneurs in Europe, proportions of self-employed women ranging from 16% in Ireland to 40% in Portugal. *NUTEK*, the Agency in **Sweden** for Economical and Regional Growth, started the Business Consultants for Women Project, under which female consultants provide advice and non-financial assistance to women entrepreneurs.

f) Regulation and Taxes

Measures taken by the State concerning regulation and taxes can induce positive effects on entrepreneurship, by focusing on the needs of the entrepreneurs during the startup stage. In fact, complying with administrative regulations and their related costs remains for the startups firms a significant burden. Access to skilled workers, the degree of flexibility of the labour market and appropriate finance are also constraints on business build up process and performance. In addition, there are still possibilities of implementing measures for helping businesses to make the most of the opportunities offered by Internal Market and to innovate. Regulation is not generally differentiated according to firm size, and therefore often disproportionately affects smaller

firms, particularly SMEs and startups. If public policy considers direct and indirect effects of new business formation on regional employment growth over time (Audretsch, Fritsch, Van Stel, Storey and Mueller, 2004), then should giving priority to "think small first", keeping regulation as simple and appropriate as possible, reducing SMEs and startups' administrative burdens, incrementing provision of information and support, which can help obtaining positive effects on entrepreneurship and innovation. At European Community, **Denmark** has introduced a new system for handling salaries. By signing up for *"EasyPay"* which is voluntary and free of charge, employers can provide information about salaries and employees to one place. *"EasyPay"* is part of "e-administration initiative", which also includes www.indberetning.dk, where all forms from public authorities relevant for businesses are collected electronically and *Webreg* which enables new limited liability companies to register completely online (including digital signature). It is simplification and virtualization that reduces the burden of administrative procedures. **Austria**, for instance, introduced website (www.help-business.gv.at) offering entrepreneurial innovators concise information on administrative procedures.[123] European Commission estimated that €50 billion could be saved with better quality of legislation and point out as objective that all States members develop an Action Plan to achieve relevant improvements for regulation, minimum standards for consultation on new policies and a systematic approach to impact assessment. Appropriate tax measures, for instance, can contribute to development, growth and survival firms. The structures of the tax system, including income and corporate tax, payroll tax and VAT, definitely influence the ability of firms to expand. The complexity of tax systems is in itself an administrative burden for entrepreneurs. Besides, the tax complexity usually drives to additional bureaucracy, running costs and loss of fiscal revenues to the State. The European Commission has identified a number of tax obstacles to cross-border activities in the Internal Market. As marginal income tax rates increase, entrepreneurs tend to expand their business more slowly, to invest less and to hire fewer staff. Moreover, the level

[123] All procedures which can be accomplished on-line are accessible via one administrative tool (@mtsweg online), so that entrepreneurs can fill in their municipal tax returns using a tool called HELP, which sends the data to the competent authority. The website also provides extensive information on various aspects of running a business, from "registering staff" to "annual leave".

of payroll tax likewise affects firms' decision to hire fewer staff. In alignment with European Commission recommendation, diagnosis and some remedies can be highlighted or suggested. Tax reforms in recent years have contributed towards a clear trend in reducing the tax burden on labour in EU, although labour taxes in a number of Member States remain high and more recently, austerity programs in EU Members States are increasing those taxes even more, taxes, which is generating negative impact on growth and employment.

g) Access to skilled labour

Policy-making concerning access to skilled labour contribute to promote innovation and entrepreneurship, by creating labour conditions to development and growth of skills of workers, as well as mobility conditions to human resources. In fact, bottlenecks in labour market create barriers to growth and efforts to develop skills of workers need to be intensified in order to reach significant improvements. Mobility of human resources can also be seen as a source of competitive advantage for a region. Issues like life-long learning, flexibility and mobility of labour market should be addressed in an integrative way because they act as "anchor" for the development and competitiveness' increasing of "Learning Regions" models. Recent findings shows **UK** government provides incentives to help small higher-risk companies to recruit and retain the employees they need, helping them to achieve their growth potential. The UK tax scheme enables companies to give share options to key employees under attractive fiscal conditions.

h) Access to capital

Actions coming from State intervention concerning firms' access to capital promote innovation and entrepreneurship, by offering to startups and SMEs financial loan programmes, in adequate and less risk conditions. It is notorious that access to finance is indispensable for growth, but many startups and SMEs have difficulties, either as the risk capital market is underdeveloped, namely networks of venture capitals and business angels, and banks increasingly avoid risky lending, especially to businesses in early stage with high uncertainty and that didn't fully proven yet in the market. In 2008 about 20% of small enterprises in **Portugal** reported problems accessing long-term finance and this trend has been increasing in the last years. Access to micro-

loans throughout funding and loan programs[124] is one of the recommended measures to be reinforced, providing regional networking and international focus is considered, because that is a key factor for the business growth and international expansion stages. Nevertheless, the State should not focus on policy-making to foster public capital investment, which tend to "pre-define and shape the rules of the capital investment game" of the industry with public money, and not necessarily leading to industry competitiveness increasing.[125] Most probably best benchmarking regarding this matter is coming from **Finland** with Finnvera, the public SME finance institution that run a micro-loan programme for existing and new micro-enterprises, which has financed co-investments, working capital and business development for 2741 entrepreneurs amounting to 45.5 million in 2001. It finances up to 75% of the total financing requirement and loans are between 3.400 and 35.000 €. Innovative feature of this fund is that it combines State and EU regional fund guarantees against losses and includes a business assessment tool aiming to promote a high survival rate among the innovative entrepreneurs.

i) Helping firms within a specific industry to exploit knowledge and international opportunities

Policies carried out by the State focused on helping firms within specific industries to exploit international opportunities, promote new entrepreneurial businesses and existing businesses' growth and expansion to foreign markets, by promoting contextual conditions to foster clustering, universities-linkages and synergies among firms, which compete and cooperate, at the same time. Contextual factors as capital resources, human resources and knowledge resources are key sources of competitive advantages for such a regional development, as these types of clusters are economically powerful in themselves, the kind of niche market still attractive to global investment despite the economic recession. The economic landscape in **Italy** is characterized by the presence of a multitude of specialized industrial districts (clusters), which are agglomerations of small firms specialized in a single

[124] Government of Portugal is going in this direction with funding and loan programs like FINICIA and QREN, managed by IAPMEI, "Garantia Mútua", runned by SPGM – Sociedade de Investimento, SA.

[125] Policies that lead to capital co-investment are showed positive results, namely the Finnvera funding in Finland and other funding program in the Netherlands and in Portugal.

sector.[126] This type of firms' rearrangement combines both competition and cooperation among firms to boost their overall performance. To enhance their quality and effectiveness a significant number of districts associate with the distinct aim of developing a network with Italian and foreign peers to exchange information about markets, promote access to research and promote conditions to establish linkages between public-private.

j) Intrapreneurship mindset

Policies that promote intrapreneurship provide effective means of developing entrepreneurial ventures that would otherwise be left unexploited. Intrapreneurial attitude means to use entrepreneurial innovative mindset and skills practiced by employees within established organizations to generate new business opportunities and trigger innovative business models' changes. Results from R&D or innovation in large firms (or even with SMEs and startups), universities or research institutes, which they do not want to exploit themselves, can be commercialized through "spin-offs" and managed by (former) employees: a practice known as intrapreneurship. For example, in **the Netherlands** almost a quarter of larger firms have helped employees to set up their own business in the past 5 years and in US there are being developed in the last 5 to 10 years major examples of intrapreneurship measures leading to innovative products and services, human resources capabilities and market competitiveness increasing.

k) Regional networks to foster entrepreneurship

State's initiative that contribute to the reinforcement of regional networks to foster entrepreneurship, namely on education and training, by inducing co-operation and linkages between universities, technological centres and

[126] Examples high value-added and knowledge-intensive industry regional clusters are located e.g. at Silicon Valley (US) for ICT, electronics, biotechnology and renewable energies industries; Emilia-Romagna (Italy) for automotive, industrial machinery, agricultural machinery, engines, biomedical and precision mechanics, shipbuilding, construction, agro-food and design-fashion industries (world-leading brands in the automotive industry, such as Ferrari, Ducati, Lamborghini and Maserati are located in Emilia-Romagna region); Badden-Wurttenberg (Germany) for the automotive industry (world-leading brands in the automotive industry like Audi, Mercedes-Benz and Porsche are very good examples); Cambridge (UK) for the biotech, ICT and cleantech sectors; Zhongda, located near the PRD-Pearl River Delta (China), which faces strong local competition from other regions, such as Beijing-Hebei-Metropolis and the Yangtze Delta Region, including Shanghai, has progressively aim at economic restructuring from labor-intensive manufacturing towards knowledge-intensive and service-oriented industries, namely at the Zhongda textile cluster in Guangzhou, which is adding value and increasing competitiveness to the textile manufacturing and trading sector, re-establishing its role in the city, but it has even proven possible to conduct the restructuring process *in situ* in a densely-populated and completely built-up area, influencing both economic and spatial development; and BMS region in Singapure for pharmaceuticals, biotechnology, medical devices and food and agribiotechnology, sea, ICT and electronic sectors.

companies, has as consequence the creation of a share of knowledge's basis. In **Germany** was launched by the Government the "*EXIST Programme*" (Federal Ministry of Education and Research) to promote regional co-operation between universities, technical colleges, the business sector and other partners with the aim of, jointly, creating a more entrepreneurial innovative mentality in higher educational and research institutions, to foster knowledge spillover and to capitalize on the potential of ideas and entrepreneurs, ultimately, leading to more innovative startups, jobs creation and regional growth. The role of geographical proximity is fundamental to develop and reinforce interdependency among the different stakeholders, including partners, suppliers, customers and competitors, and. of course, between startups and incumbent organizations investing in the creation and sharing of new knowledge, synergies and sources of competitive advantages (Audretsch, Keilbach and Lehmann, 2006; Audretsch, 2005).

l) Towards an entrepreneurial society

Policies that build and promote an entrepreneurial society and attitude, involving everyone, contribute to encouraging entrepreneurial and innovation initiative, and mitigating the stigma of failure, are very positive. Showcasing entrepreneurship, recurring to prizes to reward successful business projects are one of the measures that is being taken and introduced by **Luxembourg**. Supported by the European Commission, Luxembourg's *Chambre des Métiers* awards prizes to young entrepreneurs. The Ministry in charge of gender equality awards prizes for successful businesses run by women. A high-profile prize for innovative business ventures attracts considerable attention amongst the target audience of industry representatives and young researchers. This is very relevant in terms of getting an entrepreneurial innovative culture and behavior change.

This section looks especially at how does EU Members States intervene in innovation and entrepreneurial activity. It summarizes some of the most accepted State European benchmark practices oriented towards structuring the conditions, which can influence propitious environments to implement direct policies to favor a positive ground to Productive Entrepreneurship and Innovation, but does not discuss the Policy-Making implications in terms of Regional Innovation Systems, neither the

question that economic policies may be more effective, in some instances, if having to take the spatial or territorial dimensions into account, also called "placed-based policies"[127], instead of following a transnational approach, in order to maximise aggregate growth, employment and welfare. Thus, that is the purpose of the next section.

3.5. EU context, the Policy-Making implications for Regional Innovation Systems, Discussion and Recommendations

In 2013, despite some structural reforms with the Economic Adjustment Programme, the Policy-making macro referential is relatively the same, following transnational policies approach and EU economy continues to suffer from the impact of both the Great Recession of 2008-09 and the European sovereign-debt crisis, and is still undergoing a period of output contraction. The oil-price increases, the slowing global output growth, and the loss of confidence in an increasing European sovereign-debt crisis have impacted heavily negative on the EU economy. In resume, the output is shrinking, unemployment is rising and consumer-price inflation is above long-term averages. Although, during 2012 and 2013, the decline in economic activity has been mild, essentially due to a) the array of important policy decisions, b) advances in the institutional set-up, c) additional structural reforms, and d) unconventional monetary support,[128] the EU environmental context is still fragile, as the output declined by 0.2% in the first three months of 2013 from its level late last year, the sixth consecutive quarter of a recession that started in late 2011.

In 2013, GDP rose by just 0.1% in Germany, the biggest economy in the euro area and declined by 0.2% in France, the second biggest. Falls in southern Europe were much bigger, with GDP declining by 0.5% in Italy and Spain and 1.3% in Cyprus. Forecasts from the European Commission in early May showed annual euro-zone

[127] See Garcilazo, J., Oliveira Martins, J. and Tompson, W., (2010). *Why policies may need to be place-based in order to be people-centred*, Vox, Research-based policy analysis and commentary from leading economists. Available from: (http://www.voxeu.org/article/why-policies-may-need-be-place-based-order-be-people-centred) [Accessed 1 January 2011].

[128] See *European Economic Forecast*, Spring 2012 and Spring 2013, European Commission.

GDP shrinking by 0.4% in 2013, following a contraction of 0.6% in 2012. On the other hand, the economic reverse has a greater impact on the periphery than in its core, affecting with high intensity EU Member States like Cyprus, which will take over from Greece as the worst performer this year as its GDP shrinks by 8.7%. Somehow, this contrasts with the Baltic States. Estonia, for instance will increase GDP by 3% in 2013, and, within the 27-EU Member States, Latvia which is expected to join the euro next January will be the star performer, with its GDP increasing by 3.8%. In spite of that the overall GDP at EU is shrinking by 0,4% in 2013.

In addition, the disparity between core and periphery is particularly severe in labour markets. Unemployment in Germany was just 5.4% of the workforce in March 2013, whereas in Greece and Spain it was around 27%, and Portugal 17.6%. The gap is even bigger for Youth Unemployment. In Germany the youth jobless rate was 7.6% in March whereas it was 56% in Spain and reached 64% in Greece in February.

Most probably, these figures may exceed real measurement of Youth Unemployment because many young people are in full-time education and so do not count as part of the labour force (the denominator of the Unemployment Rate). But they highlight also the disjuncture between northern and southern within the EU.

Nevertheless, there are signs of slow recovery, e.g. Portugal's deficit has shrunk from 12.6% of GDP in 2008 to 1.5% in 2012; Greece's has fallen from 15% to 3%, over the same period Primary budget balances (ie, excluding interest payments) - a crucial measure in determining the sustainability of public finances - are also recovering. Greece's is expected to reach zero in 2013 – an extraordinary swing from its deficit of 10.5% of GDP in 2009. Indeed the highest primary deficit in the EU this year will be run by Britain (of 3.9% of GDP)[129]. Overall, some EU Member States have proven to be more resilient having contributed in a much more expressive way to GDP growth in the EU during the upturn, in particular Germany, the UK, Poland and France, still with macro-economic cross-country differences persisting.

Despite these improvements, government debt levels are of the most concern, especially at the peripheral EU Member States. In fact, Despite a bond buyback late last year and the financial securities of over half of privately held debt in March 2012,

[129] European economy guide, *Taking Europe's pulse*, Jul, 18th, 2013,The Economist.

Greek debt will reach 175% of GDP by the end of this year, Italy's debt burden continues to rise, to 131% of GDP this year, and debt in Ireland and Portugal is forecast to reach 123% in 2013. With no doubt, interest deferral and maturity extension along with very low interest rates, and further restructuring will be needed.

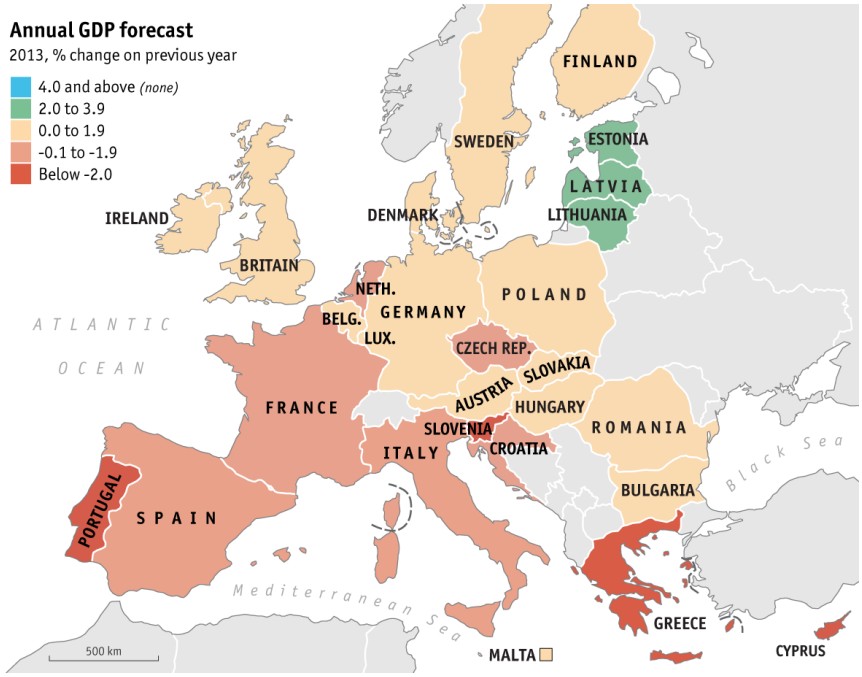


Figure 5 - EU Annual GDP forecast

Source: European Commission

In this context of very slow economic recovery, there is still a gap in terms of return of confidence which is not yet providing an increasingly sustained impact on private domestic demand, in spite of the positive effects, following 0.1 (2011), - 0.3 (2012) and 0.7 (forecast 2013),[130] in result of measures taken on second half of 2012, avoiding sharp decline in economic activity, and permitting a gradual return of confidence to consumers and investors, as well as regarding to private consumption, currently restrained by weak disposable incomes.[131] Increased economic confidence and higher real disposable incomes are expected to be the driving forces behind the rebound in private consumption. A key motive for weak consumption growth is the large squeeze on real gross disposable incomes explained by the low growth in compensations alongside high inflation and there is slow increase on net exports.

[130] See *European Economic Forecast*, Spring 2012, European Economy.
[131] See *European Economic Forecast*, Spring 2012, European Economy.

On the other hand, the improved outlook for demand and increased investor confidence would also push equipment investment and innovative projects investment, which have been delayed because of the elevated uncertainty and, of course, companies have lowered their production expectations in line with falling capacity utilization (Figure 6).

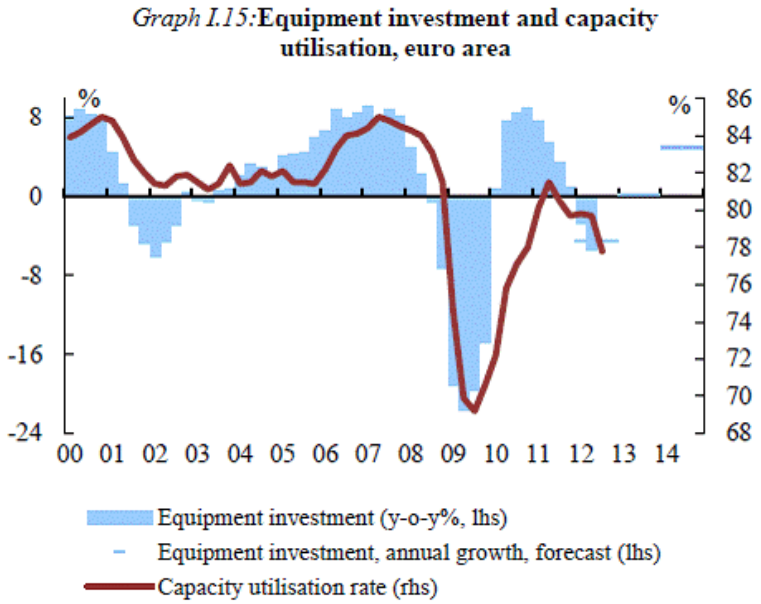


Figure 6 - Equipment Investment and Capacity Utilization, Euro area (2000-2014 Forecast)

Source: European Commission

Moreover, following a sharp decline during the downturn in 2008-09, Gross Fixed Capital Formation had been shrinking, as slowing activity has contributed to put higher pressure on profits and have reduced margins, which origins lower GDP and Labour Costs, and now start recovering gradually. Overall the variation for Gross Fixed Capital Formation was (1.3) in 2011, (-0.9) in 2011 and (2.2) forecast 2013.[132] In addition, in several Member States equipment investment is highly influenced by hard financing conditions and firms' deleveraging, which impact negatively on innovation and economic growth.

In the EU context it is clear that the transnational economic and people-centered policy approach is, in one hand, deferring Economic Growth, Market Potential, Demand Sophistication, R&D and Equipment Investment, and, on the other hand,

[132] See *European Economic Forecast*, Spring 2012, European Economy.

delaying Unemployment and Youth-Unemployment to stop increasing. But when one analyze the RIS empirical model it is notorious that variables like R&D Catching-up and Absorptive Capacity development strategy is the most effective short-term policy for overcoming Unemployment and Youth-Unemployment.

Besides, the discussion based on dichotomies like place-based vs. people-centred policies is a false debate. There is no question about all good economic policies should be “people-centred”, in the sense that they should maximise welfare. Having said that, in the light of Regional Innovation Systems’ comprehension, there is room to analyze and argue on ways to maximise aggregate growth and welfare, economic policies may in some instances have to take the spatial or territorial dimensions into account. This is what should be meant by "place-based policies".[133] Firstly, the dynamics of clusters emergence indicate that there are common paths of evolution, in their development and impact based on the relative importance of both spatial and relational proximity. In fact, clusters formation following bottom-up process (Atherton, A. and Johnston, A., 2008) refers three types of patterns in clusters emergence, e.g. a) arising through physical proximity between firms to benefit from agglomeration economies, or arising from location factors which imply sources of competitive advantages, both contributing to the reduction of transactions costs and logistics costs among the interacting firms, for instance between customers and suppliers; b) arising from transactional proximity, in result of intense trading, competition and cooperation; c) arising out of relational proximity, e.g. in result of the closeness of firms regarding to culture, i.e. through networks of knowledge creation and dissemination that share and transfer know-how that can be exploited to generate new economic activity and increasing regional economic attractiveness. For example, “the region’s distance from the production possibility frontier could indicate an unrealised growth potential (OECD 2009), and the evidence suggests that this is indeed the case in many lagging or under-performing regions in the OECD area” (Garcilazo, J., Oliveira Martins and J., Tompson, W., 2010).

Besides, the fact that regions of similar type (i.e. urban, intermediate and rural) originate heterogeneous growth performance suggests the idea that opportunities for

[133] See Garcilazo, J., Oliveira Martins, J., Tompson, W. (2010). *Why policies may need to be place-based in order to be people-centred*, OECD.

growth in each of these three types undoubtedly exist and policy-making and regional innovation systems are fundamental to economic performance.

Secondly, recognizing the importance of place-based policies implication does not imply opposition to the potential value of agglomeration economies. As mentioned by (Garcilazo, J., Oliveira Martins and J., Tompson, W., 2010) a “large body of economic literature points to the potential benefits of agglomeration, and some recent OECD (2010b) work has encouraged countries to revise policies that appear to be impeding concentration and integration”. Besides, the analytical focus of agglomeration economics is exactly on the relationship between industrial clusters, cities and innovation and because of that value generated results from a variety of aspects regarding, e.g. returns to scale and externalities from economics, with innovation, social and management, science and technology, regional planning, economic geography and policy making (McCann, 2008).

Moreover OECD (2009) provides evidence support that regions’ growth is driven mainly by endogenous factors, namely the level and quality of human capital, human resources’ flexibility and mobility, infrastructure, innovation, the functioning of labour markets, agglomeration forces, among others. Besides, “these factors are present in all regions – not only large urban centres. Moreover, the contributions to growth of large urban hubs, while significant, are not the main driver of aggregate growth” (Garcilazo and Oliveira Martins 2010).

Thirdly, a focus on the potential role of place-based policies need not imply a neglect of the need for economy-wide (spatially-blind) improvements to institutions, on the contrary, a balance between place-based and wide-based approaches is key regarding “the provision of essential public services and balanced regulation of land, labour, and product markets" (Garcilazo and Oliveira Martins 2010). This balanced vision should be ensured, as the efficient provision of essential public services requires a place-based approach due either to specific locational factors, or because physical infrastructure conditions; and also spatially blind approach may actually imply excessive costs in some cases, especially when policy- making is applied indifferently to urban and rural areas, and in many other examples whereas economic spatial distortions exist.

Hence, OECD has promoted a new approach to regional policy, which aims at mobilising regions' endogenous assets and resources, shifting strategies, objectives, actors and implementation processes involved in place-based polices. The objective is to reach a point beyond the use of fiscal transfers to "level up" lagging regions approach, which has drawbacks, but rather to address the endogenous factors that may prevent a region from approaching its production possibility frontier, providing the opportunity of fine tuning the right policies. In light to this, instead of a zero-sum game of taxing high-wealth areas to subsidise activities in low-wealth regions, the emphasis is rather on the positive-sum game notably by encouraging innovative business practices, focusing on the overall objective growth-enhancement, not compensation.

In view to innovation, entrepreneurship and knowledge spillovers literature review refers several examples of theories, which can be considered to be at crossroad, such as the Jaffe-Feldman-Varga model (1989), later extended by Acs and Audretsch, who developed the knowledge spillover theory of entrepreneurship, which focus on research questions like “What is the conduit by which knowledge spillovers occur?” or “Where do innovation and entrepreneurial opportunities come from?” and lead to the commonly accepted assumption that the technology opportunity set is endogenously created by investments in new knowledge.[134]

Besides, the new growth theory, formalized by Romer (1986), establishes that firms exist exogenously and then engage in the pursuit of new economic knowledge as input into the process of generating endogenous growth. In that sense, technological change plays a central role in the explanation of economic growth, since on the economic steady state growth path the rate of per capita GDP growth equals the rate of technological change.[135] However, as demonstrated by the ANN econometric model in the chapter 2, knowledge is not only input-variable to contribute to technological change, it also creates opportunities to third-party firms, including entrepreneurial ventures and startups (Shane, 2001), through knowledge spillovers.

[134] See Acs, Zoltan J. (2010). *Innovation, entrepreneurship and the search for knowledge spillovers*, Handbook of Research on Innovation and Entrepreneurship, edited by David B. Audretsch, Olivier Falck, Stephan Heblich and Adam Lederer, 2011, Edward Elgar Publishing Limited.

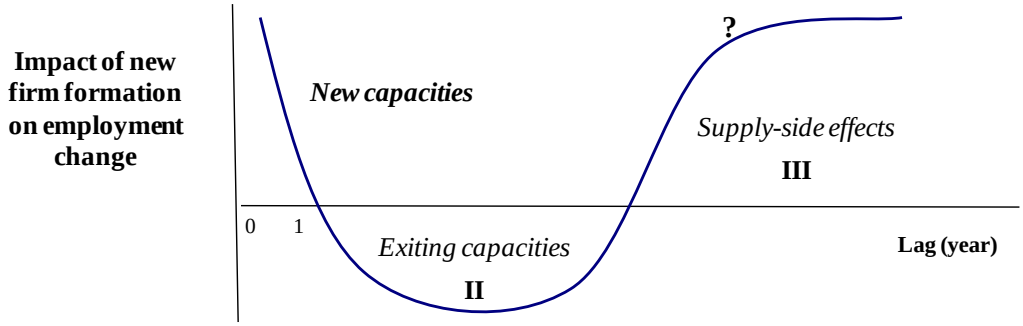
[135] The steady state economy is an entirely physical concept. Any non-physical components of an economy (e.g., knowledge) can grow indefinitely. But the physical components (e.g. supplies of natural resources, human populations, and stocks of human-built capital) are constrained and endogenously given. An economy could reach a steady state after a period of growth or after a period of downsizing or degrowth (GDP decreasing).

Hence, entrepreneurial innovative opportunities do not involve simply the arbitrage of opportunities (Kirzner, 1973), but also as the result of the exploitation of new opportunities not appropriated by incumbent organizations (Hellmann, 2007). In spite of entrepreneurship literature considers opportunity to exist exogenously, in the new economic growth literature, opportunities are endogenously created through investment in new knowledge.

This theoretical shift and the present RIS empirical model represent an important improvement concerning the microeconomic foundations of Endogenous Growth theory (Acs et al., 2009) view because it revokes two unrealistic assumptions of the Exogenous Growth theory. The first is that knowledge is readily equated with economic knowledge, which is not, as it is different from the traditional factors of production (Arrow, 1062), originating in a gap between knowledge (K) and economic knowledge (Kc); and the second refers to spillover of knowledge, which fully yields endogenous growth. Hence, in the Knowledge Spillover theory of Entrepreneurship, institutions tend to impose a filter between new knowledge and economic knowledge ($0<Kc/K<1$), decreasing in a lower level of knowledge spillovers, where innovations come either from incumbents or from entrepreneurial startups and firms (Schumpeter, 1934) and (Baumol, 2004), and produces time lags in what refers to direct and indirect effects of new business formation on regional employment growth over time.

Productive Entrepreneurship (Audretsch, Fritsch, Van Stel, Storey and Mueller, 2004), that leads to direct and indirect effects of new business formation on regional employment growth over time, which follows a wave phenomenon because of the time lags between measures taken with regard to the impact of new firm formation and visible effects on employment growth, in economic terms and because there are positive and negative factors. Either way, new firms stimulate and promote the introduction of innovative products and services into the market, leading to patenting activity and sustainable economic growth. Nevertheless, improvements may occur either on the side of newcomers or on the side of incumbents reacting to the competition from new entrants and the bottom line is that, in principle, all entrepreneurial activity generates gains, in the medium and long run, either in net employment or in economic growth, as shown in Figure 7.

Figure 7 - Direct and Indirect Effects of New Business Formation on Regional Employment Growth over Time



Source: Audretsch, Fritsch, Van Stel, Storey and Mueller, 2004

According to this model, net job formation by new firms might be positive, negative or null, depending on a number of factors.

The “positive effects” are due to the following reasons:

1. New firms contribute directly on a small proportion of the stock of jobs in the economy because most of them merely substitute existing firms that were not able to innovate and being competitive anymore;
2. New entrants provide a strong incentive for incumbents to behave efficiently and to adopt new technologies and organizational innovations (blue ocean strategies), increasing competiveness, and quality of service, and leading to market innovation and to fulfillment of costumers’ needs, new markets and niches;
3. There are indirect supply-side effects (spillovers) that new firms’ entry may generate in the market, by increasing innovation and competition, producing positive net results.

The “null effects” is when new firms that succeed will produce a kind of “substitution” and “regenerative” phenomenon concerning new jobs over the old ones from their larger counterparts.

On the contrary, the “negative effects” have the following nexus-causality reasons:

1. New businesses have a greater probability of failure than old businesses because there is an increase of business risk that comes from “green field” or innovative activities and business models;

2. New firms, during their set up time, are in the negative side due to return on the investment period until they are in good conditions to expand;
3. There are indirect supply-side effects (spillovers) that new firms' entry may generate in the market, producing negative net results, depending on market demand curve evolution in a sector.

This leads to the assumption that most probably incumbent firms tend to rely more on the flow of the knowledge to generate incremental innovation, i.e. product and service improvements (Acs and Audretsch, 1988), while entrepreneurial innovative startups, that have access to knowledge spillovers from the "stock of knowledge", and develop radical innovation processes, which leads to new industries or complete replace existing products (Acs et al., 1994).[136]

The RIS empirical model also shows the need of Mass-market Job Opportunities directed to the population layers with lower average qualifications to fulfilled the services and medium-technology manufacturing sectors, respectively;

Complementary, literature research (Acemoglu et al., 2004) supports the explanation of entrepreneurial innovative startups (E) creation as a function (Y) of the difference between forecast profits (π^*) multiplied by economic knowledge (Kc) and wages:

$$E= Y(\pi^*(Kc) –w)/\beta$$

where β is contextual, institutional and individual barriers and constraints to entrepreneurship, such as culture, education and access to knowledge, regulatory and legal restrictions, financial constraints, risk aversion, initiative spirit, failure stigma, etc. (Acemoglu et al., 2004), which might explain why economic agents sometimes choose not to enter into entrepreneurship, even when confronted with knowledge capable of generating profitable opportunities. Hence, an increase on the stock of knowledge influences higher levels of entrepreneurship and innovation; the more efficient incumbents and market leaders are at exploiting knowledge flows the smaller the effect of new knowledge on entrepreneurship and innovation to new comers; and entrepreneurial innovative activities decrease in the face of high barriers

[136] Industries like the software, semiconductors, biotechnology (Zucker et al., 1998) and the information and communications technologies (Jorgenson, 2001) are following radical innovation. Radical innovation is especially important at the early stages of the life cycles when technology is still fluid.

as for instance regulations barriers, legal constraints, administrative and bureaucratic barriers and governmental market intervention, as explained in section 3.4.

To focus on technological change and macroeconomic growth explanation one has to extent the previous theory to Economic Agglomeration (Varga, 2006), which is usually considered as the last frontier because agglomeration explains the dynamic effects of the spatial structure of R&D on macroeconomic growth (Baldwin and Forslid, 2000; Fujita and Thisse, 2002; Baldwin et al., 2003), namely when spatial proximity and concentration of the system of innovation occurs, generating sources of positive externalities, as centrifugal forces in R&D location, reducing costs of innovation and leading to additional regional strengths and spatial economic structure.[137;138] Moreover, within the JFV framework (Varga, 2000 and 2001) that estimates the magnitude of agglomeration effects, contributing to dynamics of agglomeration's study, it was found that spatial concentration of high-tech production and business services has a positive relationship with the intensity of local academic knowledge transfers, increasing returns resulting from the spatial concentration of economic activities. The understanding of the process of economic development and growth based on, among others factors, technical and technological change through innovation as the key "driving force" to generate long term stable economic growth, is leading Policy-Making. Nevertheless, that begs the question, "What causes innovation in a region or economy?" (Acs and Sanders, 2007).

Hence, knowledge creation is a *sine qua non* condition, although insufficient, for innovation and growth, and creation without implementation and monitoring is

[137] However, agglomeration effects can be negative as well, for instance, when increasing housing costs, travelling time and transport costs, which can lead to a more expensive and less competitive innovation, and ultimately might motivate labs do delocalized and move out of the spatial region. In fact, there are centrifugal and centripetal forces and it is the balance between them that determines the geographical structure of the system of innovation, while the level of spillovers also influences the change in technological knowledge, in result of R&D, the rate of technological progress and, most possibly, the macroeconomic growth rate.

[138] The clustering in space versus dispersing over space was researched by Polenske (2004), hypothesizing on how two types of economies of scale may enhance regional economic growth: "Agglomeration Economies" and "Dispersion Economies". In both cases economies and diseconomies of scale are researched by analyzing and studying the relationships between Average Cost and Quantity. "Agglomeration Economies" may occur if cost saving/cost increases result when similar firms locate in one and take advantage of the various resources and facilities of the region, including suppliers, intermediate agents in the value chain, universities, trade associations, training institutes, incubators, etc., decreasing transactional and logistic costs; or increasing costs in result of high traffic level creation, leading to congestion, increasing the time to ship inputs and outputs.
"Dispersion Economies" may occur if cost savings/cost increases are originated when firms disperse their activities away from the home office along regional or global supply chains. Cost-saving effects may come from the reduction on inventories when suppliers and customers of a firm are spatial distributed along the supply chain. Also, new information and communication technologies promote the dispersion of firms over space, allowing cost reduction and decreasing the importance of economies of scale.

undoubtedly a waste of resources and efficiency. The most advisable is to identify first the main "bottlenecks" in the innovative process that are linked to impact of regional level, before addressing higher impact public policies and committing large amounts of public money to knowledge generation process.[139]

As the knowledge spillovers that drive economy growth are likely to be regionalized, then regional policy-making, macro and microeconomic measures, which focus on ensuring sufficient resources to both knowledge creation and knowledge commercialization, on entrepreneurial talent and attitude, on geographical labour mobility, on cost efficiency of transport and communication should beneficial spillovers. In addition to these conditions attention should be taken to avoid and eliminate legal impediments, such as non-competitive clauses in labor contracts, to eliminate legal and administrative barriers and constraints to firms, to improve physical and communication infrastructures, to stimulate knowledge dissemination and exchange, to incentive the entrance of new players and competitors, which can contribute to regional innovation system, enhancing economic growth and regional cluster competitiveness, and to provide public and private R&D support as long as that does not reduce the necessary incentives to create or commercialize new knowledge, throughout patent registration and IPR, Technology market transfer and technology licensing, and commercialization of innovative products and services. Besides, a closer look at RIS empirical model shows that combination of Technology and Manufacturing, with Knowledge Intensive Services and University R&D promote a role of seedbed to Innovation, Employment and Economic Growth, which is an important aim of this research.

Moreover, JFV model and extended studies provided by Acs and Audtresch, and ANN model developed in the present piece of research[140] have important place-based policy implications at Aggregate and Regional level, as well as explanatory mechanisms by which Knowledge Spillovers operate and interact with Regional Innovation Systems.

[139] See the Portuguese studies provided by IAPMEI – Instituto de Apoio às Pequenas e Médias Empresas e Internacionalização: "Observatório da Criação de Empresas, that analysed a sampe of approximately 300.000 SMEs and by CFE - Rede Nacional de Centros de Formalidades das Empresas, which studied and analyzed a sample with 891 enterprises and 1518 businessman and entrepreneurs; (Report of 2007).

[140] ANN model developed in chapter 2.

The bottom line is that the relevance of this research focus is enormous because transnational integrative policies are not generating sustained impact in terms of Innovation, Employment, Economic Growth and Welfare, struggling to make economies to converge. On the other hand there is an enormous opportunity of maximizing innovation regional systems for the medium and small-sized regions, which contributes to around two thirds of EU aggregate growth, the so called one-third two-thirds rule.[141] In spite of that, the contribution of the few big hubs to aggregate growth has increased lately, as has the cumulated contribution of the many regions in the "tail" of the distribution, which might be expected, given the heterogeneity of OECD regions in terms of size, value, growth rate and regional dynamism, and the possibility of reinforcing local and regional public policies, leading to Innovation and Economic Growth.

In conclusion, there are clearly policy implications and risks[142] in result to this analysis:

a) Performance of the big regional hubs, when fails it represents a high negative impact on aggregate performance, thus specific regional policy-making should be considered;
b) As many of the fastest-growing regions are second-tier cities and intermediate small-sized regions policies that helped the great mass of regions in the tail of the distribution to improve their performance would generate a large impact on growth;
c) It is meaningless to consider the notion of an "average region" because such is either statistically useless, as there is no concentration around average values in the distribution, or analysis of the determinants of growth at the regional level indicates that the constraints on growth that confront the leading regions are different to those confronting the rest;
d) In spite of most of the main growth drivers are resulting from large urban areas, there is a significant number of relatively big cities that make little or

[141] The contribution of 335 (even not 396 used in this research study) OECD regions over the period 1995-2007 follows an approximate one-third two-thirds rule, thus big regional hubs (around 4% of the total number of regions) contribute approximately to one-third of aggregate growth in the OECD area, and two-thirds come from the remaining regions, OECD Regional Outlook (2011). *Building Resilient Regions for Stronger Economies*, OECD.
[142] See Executive Summary, OECD Regional Outlook (2011). *Building Resilient Regions for Stronger Economies*, OECD.

insignificant to aggregate growth, which in turn, with the implementation of diverse policies, could generate good impact on national performance.

Hence, in the EU conjuncture, Regional Innovation System empirical approach may be a valid alternative, because it improves regions capability for exploiting their differential competitive advantages in order to overcome the unfavorable effects from inputs endowment, spatial location or knowledge base maturity.

The overall results of the present research suggest the subsequent groups of instruments as effective Guidelines and Recommendations for Innovation Policy-Making can be resumed as follows, described in chapter 2:

(1) RIS effectiveness translating R&D investments into economic growth depends on policies that increases the consumption of goods and services at a regional level, while focusing on the income levels of households (i.e. Demand Sophistication) needed to absorb and leverage Local growth and to increase its Market Potential, by attracting high qualified human capital and bi increasing the remuneration of factors of production. Besides, Policy-making enhancing Market Potential has a double positive impact because it permits generating economies of scale and the necessary levels of demand for goods and services produced, distributed or commercialized for a specific region and it contributes for the increasing of regional economic attractiveness;

(2) High or Medium Technology employment and Manufacturing if combined with knowledge Intensive Services, and with university R&D will work as seedbed instead of being a proxy of further Employment and Economic growth, playing an important role in medium and long-term from the innovation stand point. This policy should encompass the focus on the linkages between firms and universities to stimuli in novelty, patent registration and commercialization of innovation;

(3) Governmental and University R&D Investment can be relatively effective for enhancing GDP growth (although with less impact than Demand Sophistication and Market Potential), even in technologically underdeveloped regions, and also for leveraging Mass-market Employment growth, but only if coupled with Corporate R&D, as it can contribute to create knowledge intensity structures to cooperate with entrepreneurial innovative firms, especially under “learning regions” context,

increasing GVA and Mass-market employment growth potential. However, the fact that universities and governmental institutions, e.g. research centres do not always produce economically useful knowledge, should be taken in consideration leading to applied research that can be readily converted into innovation and additional sources of competitive advantages;

(4) The need of Mass-market Job Opportunities directed to the population layers with lower average qualifications, should be addressed primarily by the services and medium-technology manufacturing sectors, readily transferring added value activities and contributing to Unemployment and Youth-Unemployment decrease in the short-term;

(5) The R&D Catching-up is the most effective short-term policy for overcoming Unemployment and Youth-Unemployment, immediately before the Absorptive Capacity development strategy, leveraging GDP and Employment and help supporting a sustained demand for qualified human capital;

(6) In general, results suggest that Absorptive Capacity is the most balanced and short-term development (i.e. both Employment and Economic growth) strategy for the regions characterized by an environment averse to innovation and by a lower industrialization and income, which evidently can be of the most importance and impact at a sectoral level for a specific region;

(7) The Innovative Potential reinforcement provides the most stalwart impact, unleashing Economic and Employment growth potential in the medium and long-term.

Conclusions, Limitations and Next Steps

Policy making and Regional Innovation Systems (RIS) are being researched with aim of improving R&D and Innovation Investments into economic and employment growth under a transitional context from an economy based on natural resources and physical inputs to one based on knowledge and intellectual assets[143]. The GDP growth is dependent on production factors, i.e. capital, labor, resources and productivity which are influenced by knowledge intensity and innovation. The use of knowledge technologies, such as knowledge engineering and knowledge management to produce economic benefits as well as job creation is one of the core aspects of analysis and discussion within the Regional Innovation Systems' optimization. Patents have become one of the adequate measures of stocks of knowledge, but technology market transfer processes, as well as commercialization and production of innovation are also relevant determinant variables for the efficiency of RIS. The fact that there are several core dimensions, that composes RIS with mutual influence due to multiple effects, impacts on economic growth and employment and makes that substantive measurement and optimization of knowledge Economy and Regional Innovation Systems remains unsolved.

The first part of this research permitted to identify, analyze and discuss the dimensions that shape RIS structure and evaluate if the underlying RIS subsystems exert any statistically significant effect on employment and economic growth. Empirical evidence showed that Innovation could be effectively managed at regional scope, due to the localized nature of sources of competitive advantages, technological transference, new business formation and innovation processes. In the other hand, there are "subsystems" that influence and shape the overall Innovation System at regional level, which can be adapted to all European regions, despite their

[143] See Powell, W.W. and Kaisa Snellman, (K., 2004). *The Knowledge Economy*.School of Education and Department of Sociology, Stanford University, Stanford. Annu. Rev. Sociol. 2004.30:199-220. Available from: (arjournals.annualreviews.org) by Stanford University. Robert Crown law Lib., 2006.

differences and idiosyncrasies. Results reinforce the idea that European Commission's Research and Innovation policies aren't effective as they should, and could be restructured, by shifting from a expenditure increase paradigm and from a transnational approach, to a localized, operational and measurable framework, in order to effectively translate R&D investments into Employment and Economic Growth. There are empirical evidence that should lead to policy-making changes from the European Commission based on the RIS variables' net cause-effect. For example, the relationships between RIS core-dimensions and the attainment of measurable outcomes at macro-economic level show that Governmental R&D Investment doesn't have statistically significant impact on Unemployment or Youth-Unemployment. Governmental R&D Investment is a necessary condition for sustainable development (Carlsson et al. 2007; Ejermo et al. 2011), but is not a core factor for the economic growth. For instance, increasing Governmental R&D Investment contributes to higher GVA and GDP growth rates, but not necessarily promotes efficiently Regional Innovation Systems. In the other hand, the relative scale of Governmental R&D Investment has less impact on GVA and on GDP growth rates than Demand Sophistication and Market Potential. This means that RIS effectiveness translating R&D investments into Economic Growth relies on the creation of the conditions for increasing the level of consumption of goods and services at a regional scope.

The income levels of households (i.e. Demand Sophistication) is necessary to absorb and leverage growth of local supply and also affects the capability of a specific region to grow or to increase its Market Potential (i.e. Size, Value and Growth Rate), by attracting skilled, qualified, creative and productive human capital that can develop, design produce and commercialize more and better products and services, at competitive prices, adding value to consumers. Thus, there is a nexus-causality effect on additional creation of sources of competitive advantages at regional level, leading hybrid advantages based on differentiation and cost leadership. The empirical evidences are congruent with previous empirical findings of Pires (2005); Acs, Bosma and Sternberg (2008) and Gilbert, McDougall and Audretsch (2008), reinforcing the idea that Market Potential has a double-role. In one hand, the role in generating economies of scale that can assure the necessary levels of demand for goods and services produced, distributed or commercialized inside region's

boundaries, contributing for the increasing of its economic attractiveness and consequently leveraging an attractive level of remuneration for production factors (i.e. capital and labor) and leading to FDI and medium technology manufacturing acquisition. On the other hand the role of increasing the availability of qualified human capital – embodied in Technological Capacity and Knowledge Intensity – and improving companies' absorptive capacity, technological update innovation breakthrough, ultimately leading to the fulfillment of market needs, and higher value-added to all key stakeholders, by generating higher potential profit margins and knowledge economy.

The fact that medium technology manufacturing is key for Absorptive Capacity at regional level and to the development of higher technological levels in medium and long-term, embodies in a more complex production processes and in less replicable technologies and products (Auerswald, 2010), leading to optimal clusters modelling at regional scope.

In fact, the conditions within which clusters emerge and generate synergies and value added are influenced and shaped by relational, as well as locational proximity, reflecting a focus on transaction and interaction as place and space, in globalizing phenomena and increasingly interconnected regions (Amin, 2002; 2004). On the other hand, the localization of competitive advantages, through clusters formation, can be symptomatic of the "globalization of competition" (Enright, 2000)[144] and should be researched, depending on place and space, as well as, on the type of industry, which is leading to new perspectives on RIS modelling and Regional Cluster Mapping.[145] In the last decade, Porter[146] analysis concluded that the distribution of

[144] To access knowledge, locational proximity is important. Thus, a paradox if globalization is that it has geographic proximity and location as being more important, not in spite of a globalizing economy, but because of it (Audretsch and Aldridge, 2009). Literature also sustains a second impact of globalization on the organization of economic activity, which involves the enterprise. While early analysis showed large corporations were endowed with a competitive advantages in accessing, producing and commercializing knowledge, recent studies have indicated a very different organizational form that is the entrepreneurial firm, which has the competitive knowledge in the knowledge-based global economy.

[145] A research program is being carried out (Castro Soeiro, F. and Moutinho, R.) focusing on Knowledge Spillover Theory of Entrepreneurship, Cluster Mapping (Data Analytics), Knowledge Economy, Economic and Industrial Clusters Modelling and Policy-Making, over core global sectors and a candidature was submitted to FCT (Science Technology Foundation) under the Ref. PTDC/IIM-GES/5044/2012, *Optimization Model and Public Policy to support the Development of Entrepreneurship and Innovation throughout the European, National and Local scope*.

[146] Excerpted and adapted from Porter, M.E. (2003). *The Economic Performance of Regions*, Regional Studies Volume 37, Numbers 6-7, August-October 2003. The distribution of economic activity by industry over geography reveals there are three different broad types of industries, with very different patterns of spatial competition and locational drivers. "The first type of industry in regional economies is local industries. In these industries,

economic activity by industry over geography reveals three different broad types of industries, with very different patterns of spatial competition and locational drivers, namely the local industries, the resource dependent industries and the traded industries that are not resource dependent.

This research reached also to the conclusion that Regional market size and income growth encourage firms to move away from centralized operations and to adopt multi-location strategies and operations, leading to FDI and to medium technology manufacturing attraction (Norman, 2002). It was also shown the complexity of this phenomena mostly influenced by various factors, which led to integrative explanatory models. For instance, the critical importance of Market Potential and Demand Sophistication demonstrates the need of managing innovation in an integrated way, instead of focusing narrowly on increasing R&D expenditures.

Besides, the analysis of core-variables on RIS led the conclusion that there negative, null and positive side effects, i.e., there are value-drivers which increase wealth and can also reduce welfare, at the same time, as is the case of Knowledge Intensity and Governmental R&D Employment. For example, higher availability of knowledge intensive services within a specific region leads to higher creation of incentives for companies to use outsourcing as replacement of regular employment. On other hand, the increase of economies of scale and mobility of service providers inside regional boundaries produce effects on companies, which tend to enhance their level of outsourcing, that lead to additional Unemployment (Friedman, 2005). Simultaneously, the replacement on higher degree of non-core regular employment by specialized service providers allows companies to reduce general costs and improves their competitiveness by converting fixed costs in to variable ones (Piore and Sabel, 1984), while focusing on their core competences and sources of

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employment is evenly distributed across all regions — that is, employment is roughly proportional to regional population. Local industries provide goods and services primarily to the local market, or the region in which the employment is located. Such industries compete in only a limited way with other regions. Most are services including local health services, most utilities, retailing, and many types of construction. A few goods producing industries are revealed as local, including bottled and canned soft drinks, newspapers, concrete products, and ready-mixed concrete. A second type of industry is resource dependent industries. Employment in these industries is located primarily where the needed natural resources are found, but these industries compete with other domestic and international locations. Examples of such industries include uranium ore, logging, beet sugar, and freight transportation on the Great Lakes. The third type of industries in regional economies is traded industries that are not resource dependent. These industries sell products and services across regions and often to other countries. They locate in a particular region based not on resources but on broader competitive considerations, and employment concentration varies markedly by region. Examples of traded industries include aircraft engines and engine parts, motion picture and videotape production, and automobile assembly."

competitive advantages and being able to generate potentially higher value chain's profit margins, increasing the competitiveness among the different players in the industry and value to all key stakeholders, while weighted average cost of capital (WACC) decreases and, of course, shareholders' profitability increases. The conclusion is that Knowledge Intensity contributes to prices flexibility and to firms coping capability with competitive market environments, generating more sales and thus leading to higher GVA and GDP growth rates.

On the other hand, Governmental R&D Investment can have the opposite effect because, although is important for reducing Youth-Unemployment, has a negative impact on competitiveness, both in GVA and in GDP, at the same time. Increasing R&D investments, public and private, are necessary conditions for building sustainable development, but should be combined with other policy measures to become effective.

These multiple effects of specific RIS subsystems are the reason why it turns out very complex to operationalize the Model for Policy-Making purposes as pointed out by Uyarra (2010). Empirical evidences demonstrate that RIS subsystems are not homogenous, generating, as mentioned, positive, null and negative side-effects, hence they should be managed effectively both for improving welfare and for achieving wealth, if they are planned, implemented and measured in an integrated way, in order to balance specific trade-offs and RIS quality improvement. For example, Governmental R&D Investment and Technological Capacity enhancing policies seem to be connected with GVA growth, showing that managing innovation in a regional scope can increase wealth in an effective and measurable way. Moreover, the increase of absorptive capacity and effective technology[147] market transfer processes, embodied in complex production in less replicable technologies, increases value and differentiation to firms, allowing them to practice higher prices and thus increasing the profit margins without decreasing the demand levels.

[147] In principle the average contributions either to job creation is differentiated when High Technology or Medium Technology investment is considered within a particular region, e.g. high technology is generally centered in multinational companies that tend to "centralize" innovation processes (aircrafts, biotechnology and pharmaceuticals industries) and Medium Technology investments (automotive, moulds, industrial machinery, textile and ICT industries) are more likely to create jobs.

Ultimately, it increases level of competitiveness among firms and maximize benefits to consumers.[148]

It was also found that Governmental R&D Investment and Knowledge Intensity have a significant positive impact on GDP growth-rates and that knowledge intensive services' scale-up generates competitiveness gains and business volume growth through "Flexibility Increasing effect" due to conversion of fixed into variable costs, which improves companies' coping capability with demand volatility; and through "Competitiveness Improvement effect" due to production optimization supported by knowledge intensive services, which allows companies to reduce prices without deter profitability and improves their capacity on coping strategies with bullish conjunctures and intensive pricing competition.

Moreover, Corporate R&D also provides an enhancing environment for achieving higher growth-rates, which seems to impact both on GVA and on GDP model estimative. Despite the positive impact on economic growth, Corporate R&D is not directly connected with Employment or Youth-Employment generation.

Increasing Governmental R&D Investment can have a positive contribution to economic growth but increasing R&D spending may be ineffective if not combined with Demand Sophistication and with Market Potential enhancement policies. Besides, Government R&D Investment doesn't have any impact on Employment, which points out the need of assessing policy trade-offs that could avoid significant expenditure increases. Additionally, the replacement of Governmental R&D Employment by University R&D Employment can be an effective policy for promoting both Employment and Youth-Employment without consuming public resources inefficiently. Thus, translating R&D outlays in Employment and in Economic Growth doesn't work on a simple "input-output" logic process. Increasing R&D investment scale, either public or private, is a necessary condition for building sustainable development, but must be combined with other policy measures to become effective, namely with Demand Sophistication and Market Potential instruments, in order to reach impact on GVA and GDP.

[148] See Castro Soeiro, F., 2009. *Entrepreneurship and the role of the State in Portugal*. MSc. thesis. Católica Lisbon School of Business and Economics.

The bottom line is that there is an opportunity for European Union to restructure Innovation Policies, shifting from a transnational to Regional and Placed-based framework.

The emergence of the so called “European Paradox” shows that R&D Public investments are not being as effective as possible and increasing public R&D expenditures scale is not enough to generate Employment and sustained Economic Growth. In other words “throwing money on the problems” policy is not an efficient and effective solution. In such conjuncture of economic recession, although recovery is on the horizon from the point “where we are now”, it will be like “rolling a long and stony road” before EU economy reaches sustained growth, as the situation remains extraordinarily fragile. Instead of “calling for help”, this is an opportunity to focus on policies and measures to underpin the strength of the expected recovery and growth potential, so RIS integrative empirical model is valid alternative because it can improve regions’ capability for exploiting their differential sources of competitive advantages in order to overcome the unfavorable effects from inputs endowment, spatial location or knowledge base maturity, by enhancing the integration mapping of local market players and partnerships, coping the divide between the corporate and the university; by creating, within the same macro environment context, customized policies and measures with local focus, which can be adjusted and fine tuned to the specific technological endowment and maturity levels of each regional’s knowledge base and sources of competitive advantages; by diversifying innovation expenditures and benefits over a wider set of networks, involving more players and research institutions, hedging the risk and leveraging investments with local, regional and transnational communities; by decreasing the expenditure scale and the investment risk, throughout risk sharing mechanisms run by local, regional and transnational institutions, recurring to co-investment funding, mobility of resources and knowledge sharing programmes; by providing operational and integrated ways of managing innovation policies and assess the respective trade-offs and downsides, in order to ensure the necessary conditions to continuously generate improvement approaches; and by providing reliable monitoring and accurate follow-up measures and key Performance Indicators (KPIs), concerning R&D Investment effectiveness, generating Employment and Economic Growth, in accordance with objectives defined.

Moreover, the inside Innovation's Black-Box analysis throughout the use of neural network architecture and techniques permitted to discuss Innovation's influence on Employment and Economic growth, with very positive results. The aim in analyzing and discussing inside the complexity of the innovation model, by describing Regional Innovation Systems (RIS) architecture and by reducing uncertainty over Governmental R&D Investments' effectiveness, was achieved because of the high potential in analytical and modeling terms Artificial Neural Networks (ANNs) has.

The neural network study of RIS structure turned out possible to identify the "hidden" mediatory variables of RIS, which could establish a relationship between inputs and outputs and influence their overall impact on Employment and Economic Growth.

Empirical evidences demonstrated that underlying RIS subsystems are not homogenous and most of them have positive, null and/or negative side-effects. The results suggest there is mutual influence concerning the different variables and the focus on regional and place-based policies is positive and more effective than merely "Keynesian policies".

In resume, ANN's approach suggested the focus on a set of areas and instruments, as effective measures to foster innovation Policy and RIS optimization, which can be prioritized and listed as the following: Policies that lead to Corporate R&D investment should be aligned (not merely substituted) with "Keynesian policies" focused on enhancing Market Potential, Demand Sophistication and/or Governmental R&D Investment to generate Employment and Economic Growth; Policies to stimulate high and/or Medium Technology Employment and Manufacturing, if combined with Knowledge Intensive services bridged by universities and governmental institutions work as seedbed to Innovation, Employment and Economic Growth; Policies focusing on Governmental R&D Investment, when coupled with Corporate R&D can be effective for enhancing GDP growth, even in technologically underdeveloped regions, and also for leveraging Mass-market Employment growth; The need of Mass-market job opportunities targeted to population segments with average qualifications, should be addressed primarily by the Services and Medium-technology Manufacturing sectors, respectively; Applied R&D catching-up and the Technology Market Transfer processes are the most effective short-term policy focus for overcoming Unemployment and Youth-Unemployment, immediately before the

Absorptive Capacity; Results suggested that Absorptive Capacity is the most balanced and short-term development (i.e. both Employment and Economic growth) strategy for the regions characterized by an environment averse to innovation and by a lower industrialization and income; the Innovative Potential reinforcement provides the most stalwart impact, unleashing Economic and Employment Growth potential in the long run.

Finally, one can conclude Neural Network Research and study of Regional Innovative Structure lighten up the innovation's black box, identifying the referred "Hidden" Mediatory Layer and respective Variables of RIS, which permitted to understand how RIS could be optimized and influence the overall impact on Employment and Economic growth, if managed in an integrative way. Last, but not least, the present dissertation leads to further research contributions on the theme of Regional Innovation Systems and Policy-Making Knowledge to enlarge the scope and the in-depth of the present research analysis and to overcome limitations linked for example to the adaptation of the model to each region, for implementation, management and monitoring purposes.

These types of limitations would be overcome with the design and implementation of three more steps.

In first, if it possible to convert findings in a Statistical Database with a real-time Graphical Interface that allows the integration of Competitive Intelligence framework capable of generating KPIs over the current structure of innovation networks and research-driven clusters at EU 27, considering both country and regional levels, and locally within each country (NUTS II and NUTS III). Further methodology would necessarily include Factorial Analysis, Sensitivity Analysis, Cluster Analysis and Conjoint Analysis. In this step, Structural Equations and a Neural Mapping Systems would be developed, hence by using statistical inference it would be possible to measure, in real time, the impact of R&D on GDP and on Employment variations. These types of KPIs would also be available in disaggregated measures for each country, region, industry sectors and technology market. With EU Cluster Mapping (Data Analytics) Interface would be possible to benchmark and innovate over the

Cluster Mapping Project, which is currently being developed by the Institute for Strategy and Competitiveness, from Harvard University by Porter.[149;150]

Secondly, a next step could be developed in accordance to the design and development of web-based digital platform that allows Entrepreneurs and Innovators, from all over EU 27, to register online and present any type of innovative business project. All projects would be assessed according to regional economic and business criteria, and the most feasible ones would be provided technical support concerning technology features assessment, market validation and certification, Intellectual Property Rights (IPR), management and financial evaluation, project planning and forecasting. Furthermore, the business plans would be defended, tested and incubated, coached and managed within a network of companies, Business Angels (BAs) and Venture Capitalists (VCs), and other key stakeholders, whenever projects need seed capital investments, production in scale and / or retail commercialization to enter or reinforce the market.

A third and last step would involve the interface with Entrepreneurship Monitor that allows delivering statistically validated questionnaires to entrepreneurs ant thus, assessing barriers to entry, competitiveness degree, jobs creation and tracking new businesses growth and survival rates. In this sense, Entrepreneurship Monitor would work as follow-up database to study and develop improved Innovation and Entrepreneurship KPIs at EU 27 landscape.

As whole, this would represent a major opportunity to provide a strategic, analytical and operational integrative instrument to define, test, simulate and validate and monitor further Policy-Making recommendations and Regional Innovation Systems at EU, Country, Regional at local levels, in favour of Innovation, Employment and Economic growth.

[149] See the Research Project nominated as Defining Clusters of Related Industries: A Methodological Note, February 2013, Mercedes Delgado, Temple University and ISC, Michael E Porter, Harvard University, Scott Stern, MIT and NBER. Additional details on the methodology to be available at Delgado, M., M.E. Porter, and S. Stern (2013), *Defining Clusters of Related Industries*. This project is supported by the Economic Development Administration, U.S. Department of Commerce.

[150] See Maps of Top Regional Clusters by Employment Specialization and Share: *Defining Clusters of Related Industries*, Mercedes Delgado, Michael E. Porter, and Scott Stern, 2013 (Enhanced Cluster Definitions, February 2013 Beta Version). Available from: (http://www.isc.hbs.edu/pdf/ECD_maps_vBeta_Feb2013_2013-0307c.pdf) [Accessed 7 March 2013].

These steps follow the present framework of research that discusses new ways of empirical modellization, by recurring to artificial neural networks, with the aim of optimize Regional Innovation Systems and provide new Policy-Making guidelines for Innovation and Economic growth in the EU, and are part of the research programme already defined that the author has planned to develop within the next years.

Appendix

Artificial Neural Network Empirical Model applied to Regional Innovation Systems and Policy-Making.

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