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ABSTRACT

This paper presents the "IAIF" scoreboard for European regional innovation systems. The heterogeneity of such systems requires the simultaneous use of a broad number of variables. The use of the Factor Analysis Technique allows us to work with a broad number of variables whose information will be reduced and converted to a few non-observable hypothetical variables called factors. Those factors reflect different specific aspects of the innovation system and are used –as sub indexes- to elaborate the overall *IAIF index for European regional innovation systems.* This index measures the innovative level of the regions and permits us not only to compare the technological capabilities of the different European regions but also permits the analysis of this capacity over time. We calculated this scoreboard for the regions of the former EU15 countries.

RESUMEN

Este artículo presenta el "IAIF scoreboard" para los sistemas regionales de innovación en Europa. La heterogeneidad de tales sistemas requiere el uso simultáneo de un amplio número de variables. El uso de la Técnica de Análisis del Factor nos permite trabajar con un extenso número de variables cuya información será reducida y convertida en unas pocas hipotéticas variables no observables. Esos factores muestran diferentes aspectos específicos del sistema de innovación y son utilizados –como subíndices- para elaborar finalmente el *Índice IAIF para los sistemas de innovación regional europeos*. Este índice mide el nivel innovador de las regiones y nos permite no sólo comparar las capacidades tecnológicas de las diferentes regiones europeas sino que también permite el análisis de esa capacidad en el tiempo. Calculamos este marcador para las regiones de los quince estados miembro (EU15).

SECTION "0":

GENERAL INTRODUCTION: FOUR COMPLEMENTARY IAIF WORKING DOCUMENTS

As indicated by Edquist (2005) and shown by the work of Navarro (2007), Pellitero (2008) and Baumert (2006), there are scarcely any empirical research works on regional innovation systems with aggregate data at regional level. This is particularly due to the lack of regionalised statistics and sources. At the present time, there are various scattered sources of information, but there is not just one database collating data of different sorts which is available to the public. In the last few years the Institute of Industrial and Financial Analysis (IAIF) –under the direction of Mikel Buesa y Joost Heijs- carried out several research projects[1] aimed at providing solutions to both shortages. On the one hand, they recollect data from varying sources and of a different nature, to prepare a broad database. Furthermore, a broad group of studies was carried out trying to fill, at least partially, the gaps shown by the literature in the empirical field on regional innovation systems, as well as to promote a clearer understanding of the reality of Spanish and European regions and promote regional "benchmarking".

This publication is part of a set of five working papers that reflect the outcome of these research activities dedicated to the measurement of regional innovation systems and to the novel application of econometrical techniques to carry out empirical analysis on innovation systems.

Five complementary IAIF working documents

- MARTÍNEZ-PELLITERO, M; .BUESA, M.; HEIJS, J; BAUMERT, T. (2008). *A Novel way of measuring regional systems of innovation: Factor analysis as a methodological approach.* Documento de trabajo, Nº 60 (2008).
- MARTÍNEZ-PELLITERO, M; .BUESA, M.; HEIJS, J. (2008). *The IAIF index for European regional innovation systems* Documento de trabajo, Nº 61 (2008). Instituto de Análisis Industrial y Financiero de la Universidad Complutense Madrid.
- BAUMERT, T., BUESA, M., HEIJS, J. (2008). *The production of "ideas" in European regional innovation systems: An econometric approach.* Documento de trabajo, Nº 62 (2008). Instituto de Análisis Industrial y Financiero de la Universidad Complutense Madrid.
- MARTÍNEZ-PELLITERO, M; .BUESA, M.; HEIJS, J. (2008). *Novel Applications of Existing Econometric Instruments to Analyse European Regional Innovation systems: A regional efficiency index.* Documento de trabajo, forthcoming (2008). Instituto de Análisis Industrial y Financiero de la Universidad Complutense Madrid.
- MARTÍNEZ-PELLITERO, M; .BUESA, M.; HEIJS, J. (2008). *Una tipologia de los sistemas regionales de innovación en la Europa ampliada.* Documento de trabajo, forthcoming (2008). Instituto de Análisis Industrial y Financiero de la Universidad Complutense Madrid.

Available on internet:
http://www.ucm.es/BUCM/cee/iaif/

[1] In fact it is the outcome of several complementary projects, of which in particular we can mention the Project: *Indicadores de recursos en investigación e innovación tecnológica de la Comunidad de Madrid (Directed by M*ikel Buesa) and the project: *"Innovación en la Comunidad Autónoma de Madrid y su impacto sobre la competitividad, crecimiento y eficiencia"* led by Mikel Buesa and Joost heijs.

The projects had two complementary parts. The first one consists of the construction of a database related to the regional innovation systems for 15 Countries of the European Union (The former EU-15) and about the 17 Spanish "Comunidades Autonomas". Both databases included respectively around 60 variables about a broad number of aspects of the regional innovation systems and their environment. During the second part of the research project the IAIF carried out the elaboration of empirical studies based on econometric multivariate techniques. Therefore we did a number of complementary studies that deal with different aspects and perspectives of the regional innovation systems. A typology of regional innovation systems (RIS) was created to describe the structure or configuration of the RIS. The IAIF index for RIS was elaborated to summarize this typology and offer the possibility to analyse its development over time. Afterwards an "ideas production function" was estimated to establish the relationship between the "structural aspects" and to reveal the determinants of the creation of knowledge on a regional level. Moreover the Data Envelopment Analysis" was used to evaluate the efficiency of that innovation production process.

The first analysis and publications, of which we can highlight, among others, the following publications, did evaluate the Spanish regional innovation systems:

- BUESA, M., HEIJS, J., MARTÍNEZ PELLITERO, M. y BAUMERT, TH. (2005): "Regional systems of innovation and the knowledge production function: the Spanish case"; *Technovation* (2007).
- BUESA, M.; HEIJS, J.; BAUMERT, T.; MARTÍNEZ-PELLITERO, M. (2007). *Novel Applications of Existing Econometric Instruments to Analyse Regional Innovation systems: The Spanish Case.* In: Suriñach i Caralt, J. (Editor). Knowledge and Regional Economic Development" (Editor: Edward Elgar – ISBN 978 1 84720 120 1)).
- BUESA, M.; HEIJS, J.(2007) (Coordinators) (2007). *Sistemas regionales de innovación: tipología y eficiencia en España y la Unión Europea.* Authors: Mikel Buesa, Joost Heijs, Björn Asheim, Mikel Navarro, Thomas Baumert y Mónica Martínez Pellitero. Editor: Fundación de Cajas de Ahorro (FUNCAS). (ISBN 978-84-89116-32-0)

The European case is reflected partially and synthetically in the book of FUNCAS while broader information about the methodological problems and solutions for the measurement of (regional) innovation systems and about the empirical analysis are offered in the four complementary working papers of IAIF. The first one, -A *Novel way of measuring regional systems of innovation: Factor analysis as a methodological approach.* - is about the problems to measure such a complex phenomena as an innovation system. The heterogeneity of such systems requires the simultaneous use of a broad number of variables which could be synthesised by the use of the "Factor Analysis" technique. Therefore in this first working paper we explain the creation of the regional data base for the EU-15 regions and clarify the use of the Factor Analysis Technique. The factor analysis allows us to work with a broad number of variables whose information will be reduced and converted to a few non-observable hypothetical variables called factors. Each of them includes a set of correlated variables that reflect together some specific aspect of the innovation system. From our point of view these new synthetic variables or factors better reflect the general aspects of the regional innovation systems than could do each of the individual variables included in the factor. In the next three working papers we use those factors or hypothetical variables to carry out empirical studies.

In the second working paper the "factors" are used to elaborate *The IAIF index for European regional innovation systems*- that measures the innovative level of the region and permit us to analyse the development of this technological capacity over time.

The next working paper - *The production of "ideas" in European regional innovation systems: An econometric approach.*- estimates an "ideas production function" to establish the relationship between the "structural aspects" (factors) and to reveal the determinants of the creation of knowledge (patents) on regional level. While the fourth working paper – *Novel Applications of Existing Econometric Instruments to Analyse European Regional Innovation systems: A regional efficiency index*- tries to analyse the efficiency of the "production of ideas". In this fourth document we suggest a first approach to measure the efficiency of the regional innovation system by using the factors -calculated in the first working document- as input variables of the Data Envelopment Analysis to evaluate the efficiency of the R&D and innovation activities.

1.- Introduction

As mentioned by Edquist (2005) and as is shown by the work of Navarro (2007), Pellitero (2008) and Baumert (2006), there are scarcely any empirical research works on regional innovation systems with aggregate data at regional level. This is particularly due to the lack of regionalised statistics and sources. At the present time, there are various scattered sources of information, but there is not just one database collating data of different sorts which is available to the public. The development of using the subnational perspective in the literature on RIS has been delayed due to the lack of empirical indicators or sources of information that permit the existing situation to be studied. This lack of indicators is one of the main biases that can be observed in the existing literature towards theoretical discussions to the detriment of the empirical studies (MacKinnon *et al.* 2002). In fact only a few of the empirical studies carried out in the area of RIS are mainly devoted to case studies, especially those regions considered as success-stories (Doloreux 2004, Howells 2005, Sharpe and Martínez-Fernández 2006). Moreover the existing studies used a static perspective instead of the development of longitudinal studies that use a process more oriented by dynamic approximation (Doloreux y Parto 2004, MacKinnon *et al.* 2002). Malmberg y Maskell (1997) criticised precisely the lack of attention of the RIS literature for the studies that manage aggregate regional data for a large number of regions.

Since several years agothe Institute for Industrial and Financial Analysis (IAIF) of the Complutense University in Madrid has been elaborating and updating a database with regional information for the European regions for a period of 10 years. In this working document we develop a methodology to elaborate a regional innovation index for the former 15 European Union members (EU-15) to analyse the innovative capabilities of the European regions and its development over time. This aspect could be interesting because it permits the dynamic of some specific regions to be analysed, thus giving us some hints for policy making and success stories.

Only a few studies tried to develop an index of the innovation capabilities and almost all of the studies used a National level such as the Technology Achievement Index (UNDP, 2001 and Desai et al. 2002), the Technology Index (WEF, 2001, 2002, 2003); and the Indicator of Technological Capabilities (Archibugi and Coco; 2004)—, Another study for the European countries is the European Innovation Scoreboard (2001, 2002a, 2003a, 2004, 2005, 2006). On a regional level we detected only two research institutes that developed a regional innovation index. On the one hand, the IAIF developed such an index for the case of Spain (Buesa et al, 2002) and Europe (Buesa/Heijs, 2007) and the MERIT Institute in Maastricht establishes, on behalf of the European Commission, the European Innovation Scoreboard for EU regions (European Commission, 2002, 2003, 2006b, 2007).

In the next section we will briefly revise the problems with the data and the methodological approach of calculating regional and national innovation scoreboards or composite indicators. In section 3 we explain our own methodology based on a Factor Analysis as a previous step to calculating the IAIF index for regional innovation capability. In this section we also carry out this factor analysis. In section four we establish our own IAIF regional innovation index. The last section will discuss the reliability of our work and the new research activities necessary for the future.

2.- Methodological aspects of elaborating innovation scoreboards and composite indexes [2]

2.1.- Availability of statistical data

The main problem to elaborate an innovation index or scoreboard, especially on a regional level is the availability of statistical information. The Innovation System Approach shows us that a large number of aspects influence the R&D and innovation related activities[3]. Not only are the individual aspects vital, even more important are the interaction and synergies generated between those elements. Taking into account that the information about some aspects is already lacking, the data on the interaction between agents of a innovation system is even less difficult to find. However, in the last decade there has been a clear improvement of available data in the case of the European Union and the OECD countries. Especially in the case of data on country level we have currently a large number of variables available. The European Innovation Survey (CIS) offers data on a very broad number of aspects. This survey includes qualitative data on the innovative activities of firms among others on cooperation in innovation, protection mechanisms for intellectual property, objectives of innovation, its regularity, the impact of innovation on sales or exports or barriers for innovation.

The availability of data pushed the European Union to elaborate its successive European Innovation Scoreboards on a National level (EIS) which includes a broad number of variables (see table 1)[4] taking into account a broad number of aspects. The EIS for 2006 had 25 variables

The innovation indicators are assigned to five dimensions and grouped in two main themes: inputs and outputs. Innovation inputs include three dimensions:

- *Innovation drivers* (5 indicators), which measure the structural conditions required for innovation potential. These include indicators on Human Capital (education level, permanent learning and Graduates in S&T) and the penetration of ICTs

- *Knowledge creation* (4 indicators), which measure the investments in R&D activities, considered as key elements for a successful knowledge-based economy and an indicator that measures the public support for R&D and innovation

- *Innovation & entrepreneurship* (6 indicators), which measure the efforts towards innovation at firm level, the availability of seed capital, ICT investments and organisational innovations. This also includes a variable on the cooperation between SMEs.

[2] This section is based directly on the broad number of publications and the related Technical Papers related to the European Innovation Scoreboards (EIS) and its regional versions (RIS). Here we highlight the methodological problems mentioned by those reports especially the 2006 RIS Report and the Technical Paper Number 3 of 2003.
[3] A review of this possible aspects or variables is reviewed in the IAIF working paper number 60 in which we offer a methodological approach to measure innovation systems by using the method of factor analysis
[4] The definitions of the variables can be consulted in European Commission (2005b), Annex XVII. The numbers appearing in the squares are those used in the nomenclature of the European Commission in the respective Tables of Innovation Indicators.

Innovation outputs include two dimensions:

- *Applications* (5 indicators), which measure the performance, expressed in terms of labour and business activities, and their value added in innovative sectors. In fact it measures the output on the one hand, in a direct way (with data on high tech exports by total exports or the % of sales new to the market) and on the other hand in an indirect way, based on the employment in high and medium tech sectors ;

- *Intellectual property* (5 indicators), which measure the results achieved in terms of successful know-how, based on data about patents, models and brand marks.

However, also on this level there are problems to collect all the relevant data. As can be observed it is not easy to maintain stability in the structure (the set of included variables) in the Innovation Scoreboard. The 2001 EIS started with 18 variables, for the period 2003-2005 around 22 to 28 variables were used. In the last one however (2006), the EIS includes 25 variables for the EU25 countries. Moreover only 11 variables were included in all the elaborated scoreboards. If this is already a problem on a national level the regional level is still more problematic.

Table 2.1.- Variables of the Synthetic Index of European innovation

	2001	2003	2004	2005	2006
Number of countries	**15**	**15**	**15**	**15**	**25**
Number of variables included	**18**	**28**	**22**	**26**	**25**
***INPUT* Innovation drivers**					
New graduates with higher degrees in Science and Technology (% age group from 20-29)	1.1	1.1	1.1	1.1	1.1
Population with higher education (% age group from 25-64)	1.2	1.2	1.2	1.2	1.2
Rate of broadband penetration (number of broadband lines per each 100 people)				1.3	1.3
Participations in permanent learning activities (% of age group from 25-64	1.3	1.3	1.3	1.4	1.4
Education level of youth population (% of age group from 20-24 who have at least completed secondary education.				1.5	1.5
INPUT Knowledge creation					
Public expenditure on R&D (% of GDP)	2.1	2.1	2.1	2.1	2.1
Private expenditure on R &D (% of GDP)	2.2	2.2	2.2	2.2	2.2
Proportion of medium-high-tech and hi-tech in R&D (% of industry expenditure on R&D)				2.3	2.3
Proportion of firms receiving public funds for innovation.				2.4	2.4
Expenditure in R%D by the University financed by the business sector				2.5	2.5
***INPUT*-Innovation and business initiative**					
PYMES (Small and medium-sized businesses) with in-house innovation (% of industrial PYMEs)	3.1	3.1.a	3.1	3.1	3.1
PYME cooperation in innovation (% of industrial PYMEs)	3.2	3.2.a	3.2	3.2	3.2
Expenditure in innovation (% industry's total sales)	3.3	3.3.a	3.3	3.3.	3.3.
Seed capital investment (% GDP)		4.2	4.2	3.4	3.4
Expenditure in TIC (% of GDP)	4.5	4.5	4.5	3.5	3.5
PYMEs introducing non-technical changes (% of total PYMEs)			3.4	3.6	3.6
***OUTPUT* Applications**					
Employment in hi-tech services (% total workforce)	1.5	1.5	1.5	4.1	4.1
Exports of hi-tech products compared to total exports				4.2	4.2
New market sales (% of sales)			4.3.1	4.3	4.3
New sales for the firm but not for the market (% of sales)			4.3.2	4.4	4.4
Employment in medium-high-tech industries (% of total workforce)	1.4	1.4	1.4	4.5	4.5
OUTPUT Intellectual property					
Requests for patents to OPEP (for each million inhabitants)		2.4.1	2.4.1	5.1	5.1
Requests for patents to the USPTO (per million inhabitants)		2.4.2	2.4.2	5.2	5.2
Triad patents for each million of population				5.3	5.3
Number of new domestic brands registered (per million inhabitants)				5.4	5.4
Number of new models of domestic appliances registered (per million inhabitants)				5.5	5.5
OTHER INDICATORS (Previous versions)					
Requests for hi-tech patents to OPEP (per each million inhabitants)	2.3.1	2.3.1	2.3.1		
Requests for hi-tech patents to USPTO (per each million inhabitants)	2.3.2	2.3.2	2.3.2		
Venture capital investment in high technology (%GDP)	4.1	4.1	4.1		
New market sales (% of industrial firms' sales)	4.3				
Homes connected to Internet (% of all homes) (In years 2003 and 2004 it also includes firms)	4.4	4.4	4.4		
Percentage of added value in hi-tech sector industries	4.6	4.6	4.6		
Capital obtained in secondary markets plus that obtained by new firms on main Stock markets);	4.2				

The EIS of 2003 included some specific variables related with

- Small and medium sized firms (SME's with in-house investment and the SME volatility rate (of industrial and of services SMEs)
- The service sector (SMEs' cooperation in innovation (% of services SMEs),; Expenditures on innovation by sales in the service sector; New market sales (% of industrial firms' sales); New market sales (% of service firms' sales); New sales for firms but not for market (% of industrial firms' sales); New sales for firms but not for market (% o services firms' sales)

Under the European Commission's "European Trend Chart on Innovation" (Enterprise Directorate-General) three Regional Innovation Scoreboards (RIS) have been published (2002, 2003 and 2006). These RISs used a more limited number of indicators as compared to the *European Innovation Scoreboard*. The 2003 RIS included data for 13 variables of 173 regions of the EU-15 countries while in 2006 the number of regions are 208. However, the disadvantage is that the number of included indicators decreases from 13 to 7 (See table 2 and 3).

In particular the data of the European Innovation Survey are not representing the regional level well. The first editions of the CIS are not designed to take into account the regional dimensions of the innovation systems. CIS4 is expected to provide regional data for more countries. Regional CIS4 results are collected on a voluntary basis but unfortunately not all countries have respected the recommended sample stratification with regard to the regional dimension. CIS4 data are expected to become available in 2007 for 22 countries. However, regional CIS4 data are not expected to be available are Czech Republic, Germany, France, Hungary, Finland and Sweden.

The use of the NUTS classification introduces several problems for analysing the innovative capabilities of regions. First, there are large discrepancies in the size (in terms of population and economic output) of regions, both within and between countries. This can create anomalies, such as a small region doing comparatively well on an indicator because a single innovative firm or public research institute is based there. Second, a few countries have very few regions. This places these countries at a serious disadvantage in analyses of leading regions. A country such as France with 23 regions has a higher probability of showing up with a leading region for one or more indicators than a country such as Belgium with only 3 regions. However, the NUTS level allows specific data to be used because for most countries information is available due to the existence of administrative or political levels.

Table 2.2.- Variables included in the 2006 European Regional Innovation Scoreboard

Indicator	Numerator	Denominator	Interpretation
Variable 1 Human Resources in Science and Technology – Core (% of population)	Number of persons who have successfully completed education at the third level in a S&T field of study and who are employed in a S&T occupation	Total population as defined in the European System of Accounts (ESA 1995)	A rapidly changing economic environment and a growing emphasis on the knowledgebased economy have seen mounting interest in the role and measurement of skills. Meeting the demands of the new economy is a fundamental policy issue and has a strong bearing on the social, environmental and economic well-being of the population. Data on Human Resources in Science and Technology (HRST) can improve our understanding of both the demand for, and supply of, science and technology personnel — an important facet of the new economy.
Variable 2 Participation in life-long learning per 100 population aged 25-64)	Number of persons involved in lifelong learning	Reference population is all age classes between 25 and 64 years inclusive	A central characteristic of a knowledge economy is continual technical development and innovation. Individuals need to continually learn new ideas and skills or to participate in life-long learning. All types of learning of valuable, since it prepares people for "learning to learn". The ability to learn can then be applied to new tasks with social and economic benefits.
Variable 3 Public R&D expenditures (% of GDP)	Difference between GERD (Gross domestic expenditure on R&D) and BERD (Business enterprise expenditure on R&D)	Gross domestic product as defined in the European System of Accounts (ESA 1995)	R&D expenditure represents one of the major drivers of economic growth in a knowledgebased economy. As such, trends in the R&D expenditure indicator provide key indications of the future competitiveness and wealth of the EU. Research and development spending is essential for making the transition to a knowledge-based economy as well as for improving production technologies and stimulating growth.
Variable 4 Business R&D expenditures (% of GDP)	All R&D expenditures in the business sector (BERD)	Gross domestic product as defined in the European System of Accounts (ESA 1995)	The indicator captures the formal creation of new knowledge within firms. It is particularly important in the science-based sector (pharmaceuticals, chemicals and some areas of electronics) where most new knowledge is created in or near R&D laboratories.
Variable 5 Employment in medium-high and high-tech manufacturing (% of total workforce)	Number of employed persons in the medium-high and high-tech manufacturing sectors: chemicals (NACE24), machinery (NACE29), office equipment (NACE30), electrical equipment (NACE31), telecommunications and related equipment (NACE32), precision instruments (NACE33), automobiles (NACE34) aerospace and other transport (NACE35)	Total workforce includes all manufacturing and service sectors	The share of employment in medium-high and high technology manufacturing sectors is an indicator of the manufacturing economy that is based on continual innovation through creative, inventive activity. The use of total employment gives a better indicator than using the share of manufacturing employment alone, since the latter will be affected by the hollowing out of manufacturing in some countries.
Variable 6 Employment in high-tech services (% of total workforce)	Number of employed persons in the high-tech services sectors: Post and telecommunications (NACE64), Information technology including software development (NACE72) R&D services (NACE73)	Total workforce includes all manufacturing and service sectors.	The high technology services both provide services directly to consumers, such as telecom-munications, and provide inputs to the innovative activities of other firms in all sectors of the economy. The latter can increase productivity throughout the economy and support the diffusion of a range of innovations, in particular those based on ICT.
Variable 7 EPO patents per million population	Number of patents applied for at the European Patent Office (EPO), by year of filing. The national distribution of the patent applications is assigned according to the address of the inventor	Total population as defined in the European System of Accounts (ESA 1995)	The capacity of firms to develop new products will determine their competitive advantage. One indicator of the rate of new product innovation is the number of patents. This indicator measures the number of patent applications at the European Patent Office.

Table 2.3.- A comparison of the 2002 and 2003 RIS and the 2006 RIS

Table 1. A comparison of the 2002 and 2003 RIS and the 2006 RIS

	2002 RIS	2003 RIS	2006 RIS	Source (Eurostat)
Countries	EU15	EU15	EU25	
Number of regions	148	173	208	
Number of indicators	7	13	7	
Population with tertiary education (% of 25 – 64 years age class)	Yes: 2001 data or most recent	Yes: 2002 data or most recent	No	Labour Force Survey
Human Resources in Science and Technology – Core (% of population)	No	No	Yes: 2004 data	Labour Force Survey
Participation in life-long learning (% of 25 – 64 years age class)	Yes: 2001 data or most recent	Yes: 2002 data or most recent	Yes: 2004 data	Labour Force Survey
Employment in medium-high and high-tech manufacturing (% of total workforce)	Yes: 2000 data or most recent	Yes: 2002 data or most recent	Yes: 2004 data	Labour Force Survey
Employment in high-tech services (% of total workforce)	Yes: 2000 data or most recent	Yes: 2002 data or most recent	Yes: 2004 data	Labour Force Survey
Public R&D expenditures (GERD – BERD) (% of GDP)	Yes: 1999 data or most recent	Yes: 2001 data or most recent	Yes: 2002 data or most recent	R&D statistics
Business expenditures on R&D (BERD) (% of GDP)	Yes: 1999 data or most recent	Yes: 2001 data or most recent	Yes: 2002 data or most recent	R&D statistics
EPO high-tech patent applications (per million population)	Yes: 1999 data or most recent	Yes: 2001 data or most recent	No	Patent statistics
EPO patent applications (per million population)	No	Yes: 2001 data or most recent	Yes: 2002 data	Patent statistics
Share of innovative enterprises (% of all manufacturing enterprises)	No	Yes: 1996 data	No	2nd Community Innovation Survey
Share of innovative enterprises (% of all services enterprises)	No	Yes: 1996 data	No	2nd Community Innovation Survey
Innovation expenditures (% of all turnover in manufacturing)	No	Yes: 1996 data	No	2nd Community Innovation Survey
Innovation expenditures (% of all turnover in services)	No	Yes: 1996 data	No	2nd Community Innovation Survey
Sales of 'new to the firm but not new to the market' products (% of all turnover in manufacturing)	No	Yes: 1996 data	No	2nd Community Innovation Survey

[1] The 2002 report is available from http://trendchart.cordis.lu/scoreboards/Scoreboard2002/download_area.cfı
The 2003 report is available from http://trendchart.cordis.lu/scoreboards/scoreboard2003/scoreboard_papers.cfm

2.2.2.-Methodology used to construct the European Regional Innovation Scoreboard[5]

In this section we reflect the methodological discussion about the construction of a regional innovation scoreboard based on composite indexes. The 2003 RIS used a composite indicator - the Revealed Regional Summary Innovation Index (RRSII) - to locate *local* leaders by taking into account both the region's relative performance within the EU and the region's relative performance within the country. Building upon the methodology used in the 2003 RIS, two indexes are calculated of which a weighted mean is taken for the Revealed Regional Summary Innovation Index (RRSII):

• RNSII (Regional National Summary Innovation Index) - The average of the re-scaled relative to the country mean indicator values:

$$RNSII_{jkt} = \frac{1}{m}\sum_{j=1}^{m} x_{ijkt}^{n}\text{, where } x_{ijkt}^{n} = \frac{\sqrt[p]{\left(\frac{X_{ijkt}}{X_{ikt}}\right)} - \sqrt[p]{\underset{\forall k,\forall t}{Min}\left(\frac{X_{ijkt}}{X_{ikt}}\right)}}{\sqrt[p]{\underset{\forall k,\forall t}{Max}\left(\frac{X_{ijkt}}{X_{ikt}}\right)} - \sqrt[p]{\underset{\forall k,\forall t}{Min}\left(\frac{X_{ijkt}}{X_{ikt}}\right)}}$$

• REUSII (Regional European Summary Innovation Index - The average of the re-scaled relative to the EU25 mean indicator values:

$$REUSII_{jkt} = \frac{1}{m}\sum_{j=1}^{m} x_{ijkt}^{eu}\text{, where } x_{ijkt}^{eu} = \frac{\sqrt[p]{\left(\frac{X_{ijkt}}{X_{iEU25t}}\right)} - \sqrt[p]{\underset{\forall k,\forall t}{Min}\left(\frac{X_{ijkt}}{X_{iEU25t}}\right)}}{\sqrt[p]{\underset{\forall k,\forall t}{Max}\left(\frac{X_{ijkt}}{X_{iEU25t}}\right)} - \sqrt[p]{\underset{\forall k,\forall t}{Min}\left(\frac{X_{ijkt}}{X_{iEU25t}}\right)}}$$

where *Xijkt* is the value of indicator *i* for region *j* in country *k* and time *t* and *m* is the number of indicators for which regional data are available, *Xikt* is the country average for indicator *i* for country *k* at time *t*, and *XiEU* 25*t* is the EU25 average for indicator *i* at time *t*. The maximum and minimum values for each indicator are determined over the full 5 year period. In the re-scaling process a power-root transformation has been applied to correct for possible problems of outliers and skewed data distributions. For Human resources, public R&D, business R&D, medium/high-tech manufacturing employment and high-tech services employment a square-root transformation has been used (with *p* equal to 2 in the formulas above). For life-long learning and EPO patents a double-square-root transformation has been used (with *p* equal to 4 in the formulas above). Both composite indicators are only calculated when data are available for at least 6 indicators.

[5] The text of this section is taken directly from the Report of the 2006 European regional Innovation Scoreboard (2006 RIS) (European Union, Revised Version, January 4, 2007).

Both RNSII and REUSII are re-scaled to fit the [0,1] range for each year before entering the RRSII calculation:

$$\overline{RNSII}_{jkt} = \frac{(RNSII_{jkt} - \underset{\forall k}{Min}(RNSII_{jkt}))}{(\underset{\forall k}{Max}(RNSII_{jkt}) - \underset{\forall k}{Min}(RNSII_{jkt}))}$$

$$\overline{REUSII}_{jkt} = \frac{(REUSII_{jkt} - \underset{\forall k}{Min}(REUSII_{jkt}))}{(\underset{\forall k}{Max}(RNEUSII_{jkt}) - \underset{\forall k}{Min}(REUSII_{jkt}))}$$

The RRSII is then calculated as the weighted average of the re-scaled values for RNSII and REUSII:

$$RRSII_{jkt} = \tfrac{3}{4} * \overline{REUSII}_{jkt} + \tfrac{1}{4} * \overline{RNSII}_{jkt}$$

Identifying local leaders reduces the influence of those indicators for which a country has an above average performance. Peaks for indicators for which the country performs well above the EU mean are thus adjusted downwards; peaks for indicators for which the country performs well below the EU mean are thus adjusted upwards. The RRSII will thus increase the composite indicator value for leading regions in lagging countries: local leaders become more visible.

Between 2002 and 2006, the methodology of calculating the composite innovation index has changed. Table 6 summarizes these changes. The 2002 RIS used the most ‘simple’ methodology, data were neither transformed nor re-scaled and both the national and European component received an equal weights. The 2003 RIS introduced the re-scaling of the indicators and also included 5 indicators from the 2nd Community Innovation Survey (CIS). The 2006 RIS introduces the transformation of the data, with a square root transformation for 5 indicators and a double-square root transformation for 2 indicators. The 2006 RIS uses a smaller weight for the national component of ¼ only. Another change has been the division by the country average respectively the EU25 average in the calculation of the national respectively European component. Due to these changes in the methodology of calculating the RRSII, one needs to be careful comparing the results between the 2002, 2003 and 2006 RIS. For example, a region’s rank can change significantly over time due to these changes. Two cases are highlighted, Noord-Brabant and Comunidad de Madrid. Noord-Brabant is showing a large drop in rank, from 3 in 2002 and 4 in 2003 to 20 in 2006. Comunidad de Madrid shows a drop from 9 in 2002, to 13 and 2003 and 31 in 2006.

	2002 RIS	2003 RIS	2006 RIS
Transformation of the data	No	No	Square root transformation for 5 indicators, double-square root transformation for 2 indicators
Re-scaling of the data	No	'MinMax'	'MinMax'
Indicator weights	Equal	0.5 for CIS indicators, 1 for other indicators	Equal
RNSII	$\left(\frac{100}{m}\right)*\sum_{i}^{m}\frac{X_{ijk}}{\overline{X_{ik}}}$	$\sum_{j=1}^{m} x_{ijk}^{n}$ where $x_{ijk}^{n}=\frac{X_{ijk}-Min(X_{ijk})}{Max(X_{ijk})-Min(X_{ijk})}$	$\sum_{j=1}^{m} x_{ijk}^{n}$ where $x_{ijk}^{n}=\frac{\sqrt[p]{\left(\frac{X_{ijk}}{X_{ik}}\right)}-\sqrt[p]{Min_{\forall k}\left(\frac{X_{ijk}}{X_{ik}}\right)}}{\sqrt[p]{Max_{\forall k}\left(\frac{X_{ijk}}{X_{ik}}\right)}-\sqrt[p]{Min_{\forall k}\left(\frac{X_{ijk}}{X_{ik}}\right)}}$
REUSII	$\left(\frac{100}{m}\right)*\sum_{i}^{m}\frac{X_{ij}}{\overline{EU_{i}}}$	$\sum_{j=1}^{m} x_{ijk}^{eu}$ where $x_{ijk}^{eu}=\frac{X_{ijk}-Min(X_{ij})}{Max(X_{ij})-Min(X_{ij})}$	$\sum_{j=1}^{m} x_{ijk}^{eu}$ where $x_{ijk}^{eu}=\frac{\sqrt[p]{\left(\frac{X_{ijk}}{X_{i,EU25}}\right)}-\sqrt[p]{Min_{\forall k}\left(\frac{X_{ijk}}{X_{i,EU25}}\right)}}{\sqrt[p]{Max_{\forall k}\left(\frac{X_{ijk}}{X_{i,EU25}}\right)}-\sqrt[p]{Min_{\forall k}\left(\frac{X_{ijk}}{X_{i,EU25}}\right)}}$
Weight of national component (φ)	½	½	¼

Where X_{ijk} is the value of indicator i for region j in country k, $\overline{X}_{ik}$ is the value of indicator i for country k, $\overline{X}_{i,EU25}$ is the value of indicator i for the EU and m is the number of indicators for which regional data are available.

2.3.- Main problems or questions related to the methodology of composite indicators

The deficiency of most of these studies lies in the small number of variables used —especially at the regional level—and in determining *a priori*, relying on theoretical proposals. For example, some of them calculate three sub-indexes: creation of technology, technology transfer, and human capital. As we point out in the text, by doing so they intentionally leave aside two major methodological problems: First, it is necessary to calibrate and generate the sub-indexes, conveniently weighting the included variables. Second, the adequate aggregation of those partial indexes in a single, weighted index has to be found. All studies mentioned before, use subjective criteria in doing so, considering that each sub-index has the same importance or just assigning in a discretionary way, a certain weight to each of them. As has been conveniently pointed out by Grupp (2003), these subjective criteria are not always disinterested, as they seem to be in some cases "country friendly", optimising the results of a certain country or region by what he calls "country-tuning". See also Grupp and Mogee (2004). For a further discussion on this topic, see European Commission (2005).

Hollander et al (2006) points out that the future research to improve the methodology of the Regional Innovation Scoreboard should focus on the following research questions:

- With improved data availability, is the RIS able to duplicate the EIS innovation dimensions Will it be possible to calculate a composite indicator for each innovation dimension?
- Should the indicators be weighted? E.g. either directly or indirectly through the use of the composite indicators for each innovation dimension.
- Should the data be transformed when data are distributed asymmetrical and which transformation scheme should be applied?
- What is the most appropriate technique to re-scale the indicator data so that all re-scaled indicators will use the same unit of measurement?
- Could one apply the "benefit of the doubt" method where, simply said, each region receives it "best" composite indicator score? And finally, both as a word of warning and as a suggestion to improve the use of the RIS:
- Do not focus too much on individual composite indicator scores, but focus on groups of regions and shifts over time of regions between groups

Section 3 The IAIF *Index of Regional Innovation Capacity: An methodological approach* **[6]**

3.1.- Introduction

The evolutionary theory underpins the heterogeneity of the innovative performance, which has to be considered as a multidimensional activity. The literature emphasizes the difficulty and the weakness of the use of individual indicators to measure the global concept of innovation, as well as patents, R&D expenditures, percentage of sales related to new products, etc. Each of those indicators –although highly correlated- gives a different view of apparently the same subject.[7] It is worthwhile treating the concept and the different elements of an innovation system as something which is not directly observable[8]. In this case by means of a multivariate methodology[9] and despite the statistical limitations always to be found in these topics, in this paper we elaborate and describe a series of hypothetical variables registering the most important relationships related to technological change. For the creation of "combined" indicators that reflect the different aspects of the regional innovation systems we used *factor analysis.* This technique, from a set of quantitative variables, allows us to reduce the set of existing variables to a lower set of non-observable hypothetical variables, called factors, which summarise practically all the information contained in the original set.

From our point of view these new synthetic variables or factors better reflect the general aspects of the regional innovation systems than could do each of the individual variables included in the factor.

3.2.- The data set

In this section we describe briefly the way we will construct the so called IAIF *Index of Regional Innovation Capacity* for the EU-15 regions. Therefore we will employ a data base that include initially 60 variables related to the regional innovation system in a broad sense taking into account a broad number of aspects of the innovation systems and its determinants. The exact geographical level of that regional data can be observed in table 3.1. In which we can observe that for 5 regions we use NUTS level 1 (33 Regions) while for another 11 countries NUTS level 2 (113 Regions). So we use data for a total of 146 European regions.

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[6] In this section we explain briefly the method to estimate the IAIF Index for Regional Innovation Capacity. The creation of the data base and the methodological details of the used Factor Analysis Technique is explained in: MARTÍNEZ-PELLITERO, M; .BUESA, M. HEIJS, BAUMERT, T. (2008). *A Novel way of measuring regional systems of innovation: Factor analysis as a methodological approach.* Documento de trabajo, Nº 60 (2008).

[7] For example the technological level of Spain (in 2001 in comparison to the European Union=100) is 45 percent, taking into account the R&D expenditures by GNP and 62 percent in the case of employment in R&D by total employment. However if we use the number of patents per capita as an indicator this level is only 15 percent.

[8] Buesa, Martínez Pellitero , Baumert and Heijs (2007)

[9] In Hollestein (1996) the improvements deriving from working with compound indicators when studying the innovating profile of firms from the multivariate technique of factorial analysis, instead of using individual variables, are shown. Other works dealing with the topic of compound indicators are Grupp and Mogee (2004) and Archibugui and Coco (2005).

Table 3.1. Correspondence between countries and NUTS level

Status analysed	**NUTS level**	**Nº of regions**
Belgium	NUTS 1	3
Denmark	NUTS 2/3	1
Germany	NUTS 1	16
Greece	NUTS 2	13
Spain	NUTS 2	17
France	NUTS 2	22
Ireland	NUTS 1	1
Italy	NUTS 2	20
Luxembourg	NUTS 1/2/3	1
Low Countries	NUTS 2	12
Austria	NUTS 2	9
Portugal	NUTS 2	5
Finland	NUTS 2	6
Sweden	NUTS 2	8
United Kingdom	NUTS 1	12
European Union		*146*

Source: own preparation

The total number of variables composing the IAIF-RIS (EU) database is 60 for a total of 146 regions, and the time span included the period from 1995 to 2001. With regard to the variables handled, it has to be said that they can be included in three categories or subgroups. *innovating firms, public administration and scientific infrastructure,* and *regional and national innovation environment.* These three groups are found to be related and have a not very clear frontier, facts that are already indicated by the selfsame innovation systems approach[10]. So a large number of aspects of the innovation system is included, though, though for some elements we did not find any publicly available information. Especially the case of the scientific and technological infrastructure there are almost no data found. The database includes data on universities but about the technology centres, technology transfer centres we did not find homogeneous data available for all 15 countries. The same is the case for the regional data for innovation policies.

[10] The approach of the innovation systems includes different institutions and organisations-and their relationships as well- which are linked directly or indirectly to the innovation processes from their initial phases till their diffusion. However, the terms registered by the approach present open definitions, so setting up subgroups of elements has to be viewed more as a way of simplifying the analysis than setting up real frontiers.

Table 3.2.- The variables used in the final analysis

INNOVATING FIRMS

1.- Inout or innovative efforts of the production sector (firms)

- Firms' expenditure on R&D (%of GDP)Firms' expenditure on R&D (%of GDP) EUROSTAT-REGIO
- Staff engaged in R&D in firms (number of people) (%of total employment) *EUROSTAT-REGIO*
- Staff in R&D in PAs (full time equivalent (% of total employment) *EUROSTAT-REGIO*

2. Results and accumulated knowledge

- Patents (with regard to each million of population) *EUROSTAT-REGIO*
- Patents (with regard to each million of working population) *EUROSTAT-REGIO*
- Hi-tech patents, requests (with regard to each million of population) *EUROSTAT-REGIO*
- Hi-tech patents, requests (with regard to each million of working population) *EUROSTAT-REGIO*

PUBLIC ADMINISTRATION INCLUDING THE INFRASTRUCTURE

1. Resources in the Public Administration (PA)

- Expenditure in R&D of the PAs (% of GDP) *EUROSTAT-REGIO*
- Staff in R&D in the PAs (number of persons) (% of total employment) *EUROSTAT-REGIO*
- Staff in R&D in PAs (full time equivalent (% of total employment) *EUROSTAT-REGIO*

2. University results and resources

- Expenditure in R&D of PAs (% of GDP) *EUROSTAT-REGIO*
- Staff in R&D in the University (number of persons) (% of total employment) *EUROSTAT-REGIO*
- Staff in R&D in the University (full time equivalent) (%of total employment) *EUROSTAT-REGIO*
- Number of students in third cycle (% of population) *EUROSTAT-REGIO*

REGIONAL AND NATIONAL INNOVATION ENVIRONMENT

1. Market size and productive activity

- Gross Added Value (millions of €, base 1995) *EUROSTAT-REGIO*
- Gross Fixed Capital Formation (millions of €, base 1995) *EUROSTAT-REGIO*
- Wage remuneration (millions of €, base 1995) *EUROSTAT-REGIO*
- GDP per capita (€ per inhabitant) *EUROSTAT-REGIO*
- GDP per worker (€ per worker) *EUROSTAT-REGIO*
- Number of people employed *EUROSTAT-REGIO*
- Gross Domestic Product (millions of € , base 1995) *EUROSTAT-REGIO*
- Average annual population (thousands of inhabitants)

2. National indicators

- Index of economic freedom *THE HERITAGE FOUNDATION/WALL STREET JOURNAL*
- ICT penetration *INFOSTATES*
- Seed and start up capital (% of GDP) *EUROSTAT-NEW CRONOS*

3. Human Capital (Human resources in Science and Technology)

- Human resources in S&T in high technology (total)*EUROSTAT-REGIO*
- Human resources in S&T in services (total) *EUROSTAT-REGIO*
- Human Resources in Science and Technology in knowledge-intensive services Human resources in S&T in intensive knowledge services (total) *EUROSTAT-REGIO*

After the preliminary analysis of the sixty variables we eliminated those ones that had a high level of correlation (over 90%). In Table 3.2 the variables and indicators –a total of twenty-nine –with which the work has been done-, are shown, as is the primary statistical source from which they have been obtained[11]**.** Below a synthesis is made of the information recorded by the variables used in this study in accordance with the subgroups defined.

Innovating firms

1.- Input or innovative efforts of the production sector (firms)

The business sector is defined from Frascati's Manual[12] as a group of firms and institutions whose main activity is the production of goods and services for sale to the public in the market and in general, at a price linked to the economic reality of the time. As has been stressed in the review of the literature firms and even more those linked to Research and Development processes[13] are key elements in the regional Innovation systems since they have the capacity to generate knowledge and materialised results both in products and processes[14]. What is more, it can be stated that they are the components connecting the production and innovation systems. On these lines it has been considered essential to include indicators on innovatory effort which are therefore linked to business R&D. Work has been carried out both with monetary and staff resources –in absolute terms (*head count)* and in the equivalent to full time work (*full time equivalent)*[15] devoted to these activities[16].

The final variables we have worked with are: R&D expenditure by firms in % with regard to GDP, staff of firms in R&D in absolute terms as % of total employment and staff of firms in R&D with the full time equivalent as % of total employment.

2. Results and accumulated knowledge

Given the importance of knowledge in innovation systems, its aggregation is a way of quantifying the results of the processes taking place there. In this context, the indicators worked with here are those related to patents. The term patent refers to an industrial property right or invention in the technological field. It may be granted to physical persons or legally designated ones, who will have to meet a series of requirements: "the invention must be brand new, represent a breakthrough not evident to specialists and have an industrial application[17] .The

[11] The variables expressed in monetary terms present as base year 1995-the first year of the IAIF-RIS (EU) base-and the *implicit GDP deflator* is used in its standardisation, obtained from the EUROSTAT CRONOS database.
[12] OECD (2002b-pp54-62)
[13] Frascati's Manual denominates Research and Development (R&D) as a set of creative tasks which begin to develop systematically and whose aim is to increase the amount of knowledge of man, culture and society so that its use can enable new applications to be developed. This term encompasses three activities: Basic Research, Applied Research and experimental Development (OECD 2002b, p.30). This very same manual classifies information according to four agents: Business sector, Higher Education (University), Public Administration and non-profit-making private Institutions (OECD 2002b, p.55). In this research work has only been carried out with the first three groups, since the fourth was practically devoid of regionalised information. In general, the definitions used related to R&D which are explained in this section for the business case-expenditure on R&D and staff-are the same as those subsequently used when reference is made to Public Administration and the University.
[1414] The important role played by firms in innovation-linked processes within the approach dealt with here has been studied, among others, by Meeus *et al,* (1999), Coriat and Weinstein (2002), Agrawal and Cockburn (2003) and Lazonic (2005. The matter of small and medium-sized firms can be seen in Asheim ***et al*,** (2003
[15] For a more detailed analysis on these terms, see OECD (2002b), specifically chapter 5
[16] R&D expenditure includes current R&D related costs, as well as capital costs. A more accurate analysis on this aspect can be consulted in OECD (2002b) specifically chapter 6.
[17] European convention on patents, October 5, 1973, Art 52(1). Taken from Baumert (2006) p. 90.

patents must be considered as an *output* of technological activity. Its use involves a series of advantages among which the outstanding ones are: regular availability of data and with long time series: a degree of international comparison; the reflection of obtaining new technologies and incremental innovations as well as the detail from agents and technological fields. Nonetheless, there also exist limitations in their use among which it is worth mentioning the almost total exclusion of the findings from research of a scientific nature, which do not reflect technological success or impact and the differences in the individual quality of each patent[18].

In this research the work has been carried out with the data regarding patents requested in the European Patents Office (EPO) and registered in the REGIO database. The main advantage of working with EPO data is the so-called “headquarters” effect with the patents allocated to the inventor’s place of residence[19]. is avoided The indicators used are: Patents per each million population, Patents with regard to each million working population and Hi-tech patents with regard to each million working population.[20]

Public administration and scientific infrastructure

The term *Scientific infrastructure* refers to the group of agents and actions which impinge on the development of regional innovatory and scientific activity. This infrastructure is closely linked to the human resources available to the region in scientific and technological areas. There are two areas included in this section: *Public Administration Resources and Resources and results of the Universities.*

- *Public Administration Resources*

Frascati’s Manual defines the Public Administration (abbreviated to PA) as the group of ministries, offices and other bodies supplying –for free or at fixed rates-public services and goods which otherwise would not be profitable in the market, whilst administering public services and developing social and economic policy[21] . In developing innovation systems the PAs play a significant role[22] in the scientific field, and proof of this is found in the centres of specialised research[23]. Just as in the business case, another of the factors or determinants in the regional innovation systems is the resources used by the PAs, which serve as support for their scientific and technological development. In the research an attempt has been made to introduce these aspects by means of the following indicators: R&D expenditure by the PAs as a % with regard to GDP, PA staff in R&D in absolute terms as % of total employment and PA staff in R&D in the full time equivalent as % of the total employment.

[18] For a more detailed analysis of patents see among others, Griliches (1990), Trajtenberg (1990),OECD (1994b and 2004),Buesa, Molero, Navarro, Aranguren and Olarte (2001), Baumert and Heijs (2002), Baumert (2006), Buesa, Navarro and Heijs (2007).
[19] The patents are thus allocated on the basis of where inventors live and regardless of where the titular owner of its rights lives.
[20] For a more detailed analysis, as well as the comparative findings of 161 countries analysed here see Miles *et al* (2004).
[21] OECD (2002b), p. 62
[22] The importance of the Public Administration in the context of innovation is dealt with among others, in OECD (2003) and Guellec and van Pottelsberg (2003).
[23] Outstanding here are the Centres of agrarian, health and aerospace research.

- *University resources and results*

In Frascati's Manual Higher Education[24] is defined (henceforth University) as the group of Universities-faculties, higher technical schools and university schools-technological institutes and other postsecondary bodies, regardless of the source of their financial resources and legal status. In the definition are included research institutes, experimental stations and clinics under the direct control of Higher Education units, whether administered by them or whether they are associated with them. Given that Universities are a key agent in the region's scientific infrastructure[25] , the available indicators on the topic must be introduced. Here specifically work has been carried out with four: University R&D expenditure as a % with regard to GDP, University staff in R&D in absolute terms as a % of total employment, University staff in R&D as a full time equivalent as a % of total employment and the number of students in the third cycle (postgraduate) as a % of the region's population[26]

Regional and national innovation environment

The *regional and national innovation Environment* is a broad concept that includes different elements impinging indirectly on the region's own capacity in scientific, technological and innovation matters. Three aspects have been considered in this study: *market size and productive activity, human capital* and *national indicators*

- *Market size and productive activity*

Market size and *productive activity* may be considered as one of the fundamental supports of the environment and therefore of regional innovation systems. Since important differences of size exist in the regions studied -either in population or production terms- it is important to reflect them because they may have effects on the extent of the development of systems and their working[27]. The variables used to represent this aspect are: Gross Domestic Product, Gross Added Value, Gross fixed capital Formation, Salaries, per capita GDP, GDP per worker (productivity), the number of workers or employees and the annual mean population.

- *Human Capital (resources in Science and Technology)*

As well as staff linked to R&D it is important to add human resources in Science and Technology, since this is a key axis in the innovation-backing infrastructure[28].

The information provided by EUROSTAT is based on the definitions of human Resources made by Manuel Canberra, and implies the following conditions for them to be considered as such[29]:

- o Having finished third level studies-in Spain it would be the second level, that is graduate or equivalent-in a scientific-technological field[30].

[24] OECD (2002b), p.68. A more detailed description is found in OECD (2002), pp.68-72.
[25] The matter of the importance of the Universities as agents linked to innovation processes is dealt with among others by Etzkowitz and Leydersdorff (2000), Kossonen (2002) and Mowery and Sampat (2005.
[26] The importance of including indicators deriving from Education Statistics in innovation studies is stressed by authors such as Jacobson and Oskarsson (1995).
[27] It is to be noted that from the innovation systems approach market size is going to be an important element, since it will have effects on the processes of generating and spreading knowledge.
[28] The outstanding role played by human Resources in innovation systems has been analysed among others by Amable, Barré and Boyer (1997) and Amable and Petit (2001).
[29] OECD (1995), p. 16.

- o Being employed in a technological-scientific field without meeting the previous condition, which is normally required.
- o A third measurement is given by those people who have completed third level studies and are employed in the scientific-technological field.
- o Finally, the fourth measurement is given by the total of those people who meet one requirement or another[31]

In this research the work has been carried out with the fourth type of indicator, specifically with human resources in Hi-tech Science and Technology, human Resources in Science and Technology in services and knowledge-intensive human Resources in Science and Technology[32].

- *National indicators*

On various occasions it has been pointed out that the approach of regional innovation systems is not exclusive of the national environment itself. From this viewpoint and since the work has been done here with fifteen countries-which have their own characteristics in their territorial organisation and economic development-it would appear logical and necessary to include variables showing the aspects of the national innovation systems themselves, where the regions are situated. The included variables in question are:

1. *Index of economic freedom:* This index, prepared by the *Heritage Foundation* and *the Wall Street Journal,* shows economic freedom in various countries via 50 independent variables subdivided into 10 general factors. These factors charged with reflecting the degree of economic freedom are: Trade policy, Government tax levy, Government intervention in the economy, Monetary policy, Foreign capital inflows and investments, banking and financial activity. Wages and prices. Property rights and informal Market. Low marks in this indicator are the most convenient, since the higher the mark in the factor, the greater the level of interference by the Government in a country's economy, and the systemic analysis of these factors shows that States with high levels of economic freedom have the highest standards of living.

2. *Penetration of TICs[33] (Infostates Index)* The new information and communication technologies are elements of what are called knowledge-based societies. The *Infostates[34]*index is drawn up by Orbicom[35] and is calculated from two partial indices, *Infodensity* –which includes all TIC stocks of capital and labour-and by *Info-use*-which measures the consumption of TICs by periods- with the aim of differentiating their degree of penetration by countries.

3. *Variables related with venture capital.* In the present context of innovation, increasing importance is given to the venture capital market since it is considered to be a necessary agent in the promotion of new innovatory firms[36]. Under the heading of venture capital are included firms

[30] The academic areas considered as scientific technological are: Exact and Natural Sciences, Engineering and Technology, Experimental and Health Sciences, Agrarian and Social Sciences. Thus Humanities-related disciplines are excluded.
[31] These variables in the database have been given the denomination of *total.*
[32] The importance of knowledge-intensive services within innovation systems has been analysed by, among others, Muller and Zenker (2001).
[33] Information and Communication Technologies
[34] A detailed description can be consulted in Sciadas (2003).
[35] International network of professorial chairs Communication UNESCO.
[36] COTEC (1998), pp.99-103. An analysis on the relationships between financing and innovation can be seen in Lamorreaux and Sokoloff (2004) and O'Sullivan (2005). Also, for the state of the venture capital market in Spain see Martí Pellón.

not quoted on the Stock Market, including those made by bodies administering their own capital or that of private investors and outside institutions, and/or informal investors or *business agents.*[37]. In this research two variables have been used: seed capital and start up as a% of GDP and development investment capital as % of GDP.

Finally, in concluding this section it must be pointed out that the research attempted to record those indicators highlighted by the innovation systems approach and those for which regionalised information is available. Nonetheless, there are still weaknesses in statistical sources which have not made it possible for other aspects to be included such as those related to cooperation between agents, R&D Policies, or the very same sectorial characteristics of the area. In this way, it is hoped that they might be included in similar works.

[37] On the EUROSTAT NEW CRONOS database it is called "*early stage*" and "*expansion and replacement*". N

3.2.- The application of the factor analysis technique

3.2.1.- Methodological remarks

The factorial analysis[38] is a multivariate statistical technique which from a group of quantitative variables enables a clearly smaller group of hypothetical or non-observable variables to be determined, and these summarise practically the whole of the information to be found in the original group. These hypothetical variables receive the name of factors, and among their characteristics of particular significance is the fact that they are unrelated among each other[39].

Factorial analysis makes it possible, given a sample of observations or cases in a group of quantitative variables, for them to be represented in a small area, known as factorial space, enabling the relations among them to be interpreted[40]. Specifically, this type of factorial analysis, which manages to reduce the variables to others of a theoretical or hypothetical nature-factors-, as well as identifying the structures by means of a data summary, receives the name of factorial analysis R[41].

It is important to point out that one of the advantages possessed by this technique, compared to others, is that from the statistical viewpoint, the accomplishment of assumptions of normality, homoscedasticity and linearity are not required or applied less restrictive. That is, the basic assumptions implicit in the method are more conceptual than statistical in nature. In this way, the multicolinearity –which usually causes serious problems in another type of multivariate analysis- in this case is desirable, given that the aim is to identify series of variables which might be found to be interrelated[42]. Moreover, whenever certain clearly differentiated subgroups of variables can be determined in which on the one hand, within each of them the same ones are highly interrelated, and, on the other, those of the different subgroups show no relationships, the original series of indicators will be able to be simplified to another one of factors. The latter will summarise the information held in common by the several variables belonging to the same subgroup[43]

Once the analysis has been carried out, the factors obtained will have the same character and nature as the original data, but they will be fewer in quantity and will enable the components of the European regional innovation systems to be better understood, and to be used in subsequent analyses. It can be highlighted that the factor analysis we will present in this paper grouped the variables without any restriction. That is we did not assign a priori the variables to a "factor", though it is the automatic procedure of factor analysis that grouped the variables to each other in

[38] For the methodological aspects dealt with in this section basically the previous work by Martínez Pellitero (2002) is followed.
[39] The procedures applied have made it possible to obtain unrelated factors, even though it will subsequently be seen that this is not always the case.
[40] Ferrán (2001) ,p. 340
[41] There is also what is called factorial analysis Q where the grouping instead of variables is of cases. Nevertheless, for this purpose another multivariate technique known as *cluster* analysis is normally used. Hair *et al* (2001), pp. 83-84. For a description of the main aspects of the *cluster* analysis the reader is recommended to consult Chapter 5.
[42] Hair *et al*, (2001), p.88.
[43] Ferrán (2001), p. 340

the factors. This is important because, as will be seen, the variables included in each factor belong to the same component o sub-system of the overall regional innovation system. This can be considered as a success because it should not be forgotten that one of the main criteria to revise a factor analysis, besides the statistical requirements being fulfilled, is that the factors –or hypothetical non-observable variables- include a set of variables that can be adequately interpreted from a practical point of view and within the theoretical framework.

For the European case (146 EU-15 regions and initially 60 variables) we found six "unobservable variables" or factors that are homogeneous in their consistency and are clearly interpretable in terms of the theory on innovation systems (1.- regional and productive environment; 2.- the innovating enterprises; 3.- Higher Education system and University research; 4.- National innovation environment; 5.- Role of Public Administration and risk capital and 6.- the role of and degree of sophistication of the demand). We consider that those six factors —which are no more than a combination of a set of different highly related variables—reflect better the different components of the innovation system than each of the individual variables would have done. The results of these analyses not only can be interpreted correctly from the perspective of the evolutionary theory of innovations and technological change, they can also be considered as stable and consistent[44].

The results of the *factor analysis* by themselves are not the principal objective of this paper. Rather our main aim is their use in follow-up studies. Once we have the factors, for each region "*standardised factor values*" will be assigned which will be used for to elaborate the IAIF index for regional innovation capacity.

Although in the factorial analysis it is not necessary to prove the classical statistical assumptions- normality homoscedasticity and linearity- it is convenient to carry out some type of test to reinforce the idea that using this technique is relevant[45]. After applying the required analysis we found that we should diminish the number of variables included in the data base

The factorial analysis method which has been used to determine the factors of the European regional innovation systems is the one known as main components[46]. The aim of this technique is to form linear combinations of the independent variables observed, that is, to obtain new hypothetical variables-factors-uncorrelated from real or observable variables which are correlated[47]. In graphic terms, the factors will therefore be orthogonal. The first factor will thus have the maximum variance and successive factors will explain increasingly smaller proportions

[44] The use of factors not only better reflects the different elements of the innovation system as we will show in the paper, they do avoid, in a certain way, the problem of important irregular fluctuations in time of the values of the individual variables often based on statistical effects due to exceptional or ……. like those caused by changes in the law or application norms that delay the assignment of subsidies or patents.

[45] Therefore we analysed the correlation and the partial correlation matrixes, applied a *Kaiser-Meyer-Olkin Sample Adaptation measurement (KMO) and a Barlett's sphericity test. (For details see footnote 6).* The final variables worked with are those related to Table 2.2. The choice of these variables of the database has been carried out by means of a process of *trial and error* which allows better results in terms of variance, as well as better interpretation of the findings to be obtained. .

[46] There also exists the so-called *common factorial analysis* technique. However, the complications involved in carrying out this analysis have led to the generalised use of the main components analysis, and more so in cases where the aim is to reduce the number of existing variables. What is more, although there are still experts who continue to argue as to which factorial model is the most suitable one, empirical research has shown an important similarity in results on many occasions. For a more detailed analysis on the subject see Hair *et al,* (2001), pp. 89-92.

[47] Ferrán (2001), p.341

of the variance, with no correlation [48]existing between them. Therefore we can use the factors in further analysis with the advantage that they are totally independent variables which assure the absence of the multicolinearity problem.

Taking into account the aspects mentioned, in the choice of factors and variables to work with several criteria have been used in combined form:

1. The factors extracted will have to be consistent and interpretable in accordance with the theory of regional innovation systems, since it is one of the aims of the factorial analysis in this research.

2. In determining the number of factors two criteria have been used. The first of these is the one called *Kaiser's criterion or that of the latent root.* In accordance with this a set of factors will be extracted the auto values of which will be greater than 1. Here the best situation or model arises when the chosen factors have high *auto values* and present a reduced number in comparison with the original variables. The second criterion is the retained variance of the model. The outcome of the factor analysis is satisfactory if it retains a high percentage of the total variance of the sample high, that it should be more than 75%.

3. As already mentioned in section 3.2.1 the selection of the variables start with the control of their correlation and partial correlation. Because several variables were combinations or transformations of other variables of the data-base ***…… of the sixty*** variables were already excluded in the first stage of the analysis due to the high level of correlation (over 90%).

4. Once the high correlated variables are excluded we started with the elaboration of the factor analysis. This analysis is based on a large number of *trial and error* attempts, starting with the inclusion of all the variables and including and excluding different variables[49]. An important selection criterion of the variables is the value of the *communalities*. It has been taken into account that if small *communalities* exist it is reasonable to increase the number of factors, or eliminate the variable, since this may not add a significant value to the model. Also in this case it must be remembered that many of the indicators which were not chosen are combinations or transformations of those that have been included. In this way we excluded other …. variables.

5. The third reason to exclude some variables is their powers to assure a clear unequivocal and unambiguous interpretation of the factors. If some of the factors include variables statistically related to each other, even though conceptually totally different, we could not interpret the factor and its use makes no sense.

3.3.-The factor model

The application of the statistical requirements and the need of an unequivocal interpretation of the factors brought us to a model of six factors that include 29 variables. Although one could think that some variables reflect very similar concepts the statistical tests confirm that the data

[48] From the *p*-dimensional space, the attempt will be to find a *k*-dimensional subspace so that *k* is small with regard to *p* but with a small loss of the initial variability. Ferrán (2001), pp...341.
[49] This is not only important for selecting the included variables and the factors, it is also useful to assure the consistency, reliability and robustness of the final result.

are sufficient unequal and identify different fine points of the same global factor[50]. Given that we are working with an important heterogeneity of regions it can be stated that there will exist cases in which these differences will be significant and therefore, it is not a good idea to eliminate them provided that their use can be statistically justified[51]. What is more, it must also be pointed out that in this case the number of variables-twenty-nine- is not high. Bearing in mind that we are not attempting to perform a predictive-type analysis, but rather a descriptive one, it is understood that it will be enriched by the use of a larger number of indicators.

In table 3.3 we show the final outcome of our factor analysis[52] were we can observe six clearly defined groups of variables that can be interpret well from a innovation system approach. For this interpretation we organised them (in table 3.4) relating them with the aspects of the innovation system were they belong to.

In Table 3.5 the *communalities* of the initial variables and later the extraction of the six factors according to the main components method are registered. As can be understood, the *communalities* are high, which guarantees the reliability of the results and, furthermore, many of them are close to the unit, indicating the high degree of preservation in their variances. Only four variables present a *communality* below 80% - *Risk capital, Risk seed capital, Expenditure on R&D by the University* and *Third cycle students*- though their elimination does not generate a significant improvement in the model. Given the importance of the information provided by the approach in the innovation system it was decided to include them in the model. Moreover, it can be stated that this communalities will be used to elaborate the IAIF index for regional innovation capabilities.

Another important aspect of the Factor Analysis is the retained variance or variability. The solution with six factors-as shown in Table 3.6.-preserves 88.92% of the variance, which is important because it assures that the six factors or new hypothetical non observable variables preserve almost all the information included in the initial set of 29 variables.

As will seen in the next section the communalities of each of the variables and the retained variability will be important elements to construct the pounded IAIF index for regional innovation capabilities.

[50] By way of an example, we point out that the *Gross National Product* and the *Gross Domestic Product* have been included. From the economic point of view the quoted macro magnitudes that present a high correlation reflect clearly different concepts however. Moreover in some cases the differences, especially at regional levels are important, as in the case of the Irish regions
[51] In this sense it is once more worth remembering that the variability of the chosen indicators is well represented and that the factorial analysis shows consistent results.
[52] As already mentioned for details see the IAIF working paper number 60 mentioned in section “0”.

Table 3.3.Rotated components matrix

	Components					
Number of people employed	0,980					
Average annual population (thousands of inhabitants)	0,973					
Gross Domestic Product (millions € base 1995)	0,972					
Gross Added Value (millions € base 1995)	0,970					
Gross Fixed Capital formation(millions € base 1995)	0,967					
Human resources in Sc and T services (total)	0,966					
Wages(millions € base 1995)	0,964					
Human resources in Sc and T in knowledge-intensive services (total)	0,946					
Human resources in Sc and T in high technology (total)	0,926					
Hi-tech patents (with regard to each million working population)		0,913				
Hi-tech patents (with regard to each million population)		0,907				
Patents per each million of population)		0,875				
Patents per each million of population activa)		0,862				
Firms' expenditure on R&D (%of GDP)		0,822				
Firms' staff in R&D (number of people) as ‰ of employment		0,805				
Staff in R&D in (full time equivalent) % of employment.		0,788				
Staff in R&D in the University (number of people) % of employment.			0,877			
Staff in R&D in the University (full time equivalent) as % of employment			0,857			
University expenditure on R&D (% of GDP)			0,835			
Number of third cycle students (‰ of population)			0,773			
Capital investment development (% of GDP)				0,902		
Economic Freedom Index				0,830		
Penetration of TICs				0,735		
Seed and start up investment capital (% of GDP)				0,710		
Staff in R&D in PAs (full time equivalent) % of employment					0,940	
Staff in R&D in PAs (number of people) %of employment					0,938	
PA expenditure on R&D (%of GDP)					0,915	
GDP per worker (€ per worker)						0,866
GDP per capita (€ per worker)						0,783

Method of extraction. Analysis of main components
Method of rotation: Varimax with Kaiser Normalisation.
The rotation converged after 6 iterations

Table 3.4. Factorial analysis years 1998, 1999 and 2000.

REGIONAL PRODUCTIVE ECONOMIC ENVIRONMENT (30, 61%)

1. ***Size and productive activity of the market***
   - Number of people employed (0,980)
   - Average annual population (thousands of inhabitants) (0,973)
   - Gross Domestic Product (millions € base 1995) (0,972)
   - Gross Added Value (millions € base 1995) (0,970)
   - Gross Fixed Capital formation(millions € base 1995) (0,967)
   - Wages(millions € base 1995) (0,964)
2. ***Human resources in Science and Technology***
   - Human resources in Science and Technology in services (0,966)
   - Human Resources in Science and Technology in knowledge-intensive services (0,946)
   - Human Resources in Hi-tech Science and Technology(0,926)

INNOVATING FIRMS(21, 01%)

1. ***Resources of innovatory firms***
   - Firms' expenditure on R&D (%of GDP) (0,822)
   - Staff in R&D in firms (number of people) % of employment (0,805)
   - Staff in R&D in (full time equivalent) % of employment. (0,788)
2. ***Results of innovative firms***
   - Hi-tech patents (with regard to each million working population) (0,913)
   - Hi-tech patents (with regard to each million population) (0,907)
   - Patents per each million of population) (0,875)
   - Patents per each million of working population (0,872)

UNIVERSITY (10,21%)

1. Universityresources
- Staff in R&D in the University (number of people) % of employment. (0,877)
- Staff in R&D in the University (full time equivalent) % of employment (0,857)
- University expenditure on R&D (% of GDP) (0,835)

2. University results
- Number of third cycle students as % of population(0,773)

NATIONAL INNOVATION ENVIRONMENT(9,96%)
- Capital investment development (% of GDP) (0,902)
- Economic Freedom Index (0,830)
- Penetration of TICs (0,735)
- Seed and start up investment capital (% of GDP) (0,710)

PUBLIC ADMINISTRATION(9, 56%)
- Staff in R&D in PAs (full time equivalent) % of employment (0,940)
- PA staff in R&D (number of people) as % of employment(0,938)
- PA expenditure on R&D (%of GDP) (0,915)

DEGREE OF SOPHISTICATION OF DEMAND(7,49%)
- GDP per worker (€ per worker) (0,866)
- GDP per worker(0,783)

Source :own preparation.

Table 3.5. Communalities

	Initial	Extraction
Average annual population (thousands of inhabitants)	1	0,951
Patents (with regard to each million population)	1	0,917
Patents (with regard to each million working population)	1	0,911
Hi-tech patents (with regard to each million population)	1	0,885
Hi-tech patents (with regard to each million working population)	1	0,892
Human resources in Sc and T in high technology (total)	1	0,940
Human resources in Sc and T services (total)	1	0,985
Human resources in Sc and T in knowledge-intensive services (total)	1	0,955
Gross Domestic Product (millions € base 1995)	1	0,990
Gross fixed Capital Formation (millions € base 1995)	1	0,965
Wages (millions € base 1995)	1	0,986
Gross Added Value (millions € base 1995)	1	0,988
Number of people employed	1	0,976
Firms' expenditure on R&D (%of GDP)	1	0,830
PA expenditure on R&D (%of GDP)	1	0,868
University expenditure on R&D (% of GDP)	1	0,762
Staff in R&D in firms (number of people) % of employment	1	0,870
Staff in R&D in (full time equivalent) % of employment.	1	0,883
Staff in R&D in PAs (number of people) %of employment	1	0,932
Staff in R&D in PAs (full time equivalent) % of employment	1	0,963
Staff in R&D in the University (number of people) % of employment.	1	0,863
Staff in R&D in the University (full time equivalent) % of employment	1	0,869
GDP per worker (€ per worker)	1	0,920
GDP per capita (€ per worker)	1	0,909
Seed and start up investment capital (% of GDP)	1	0,662
Capital investment development (% of GDP)	1	0,843
Penetration of TICs	1	0,849
Number of third-cycle students (% of population)	1	0,649
Economic Freedom Index	1	0,777

Method of extraction. Analysis of main components

Table 3.6. Variance explained by the model

Component	Initial autovalues			Sums of the saturations to the extraction square			Sum of the saturations to the rotation square		
	Total	% of the variance	% acumulate	Total	% of the variance	% acumulate	Total	% of the variance	% acumulate
1	11,902	41,041	41,041	11,902	41,041	41,041	8,878	30,614	30,614
2	5,392	18,594	59,634	5,392	18,594	59,634	6,095	21,019	51,633
3	3,083	10,630	70,264	3,083	10,630	70,264	2,976	10,261	61,894
4	2,345	8,085	78,349	2,345	8,085	78,349	2,891	9,969	71,863
5	1,808	6,235	84,584	1,808	6,235	84,584	2,775	9,569	81,432
6	1,260	4,344	88,928	1,260	4,344	88,928	2,174	7,497	88,928
7	0,687	2,371	91,299						
8	0,545	1,881	93,180						
9	0,474	1,634	94,814						

Method of extraction. Analysis of main components

Short description of the factors (see also table 3.4)

Factor 1: ***Regional productive economic environment:*** This factorial axis -which records a 30.61% of the total variability of the total variability of the 29 variables included in the factor analysis- contains those indicators which determine the productive economic environment of innovation. Two blocks can be identified: *Size and productive activity of the market* and *Human resources in Science and Technology* .

This factor or hypothetical non observable variable is based on variables expressed in absolute figures. This can be justified to incorporate somehow the concepts of critical mass and scale advantages related to R&D systems. I.e. smaller regions or regions with small innovation systems have specific problems to assure the benefits of innovation related activities. The small number of innovating agents and the low demand of innovative products or service impede the necessary regional based labour division of the innovation process between firms, technology centres, consultancy offices, specialised providers, etc…. Therefore we could conclude that regions with a larger innovation systems has a more developed and differentiated system with more dynamic mutual reinforcing agents, effects and spillovers.

Factor 2: ***Innovating firms:*** This factor which registers 21.01% of the total variability. This factor is made up of indicators that determine the resources and results of firms with a more innovatory behaviour. This block includes the *Resources of innovatory firms* and *Results or output of innovative firms* T

Factor 3: ***University:*** This factorial axis retained 10.21% of the total variance of the 29 variables included in the factor analysis contains those indicators relating to University resources and results. The University forms part of the region's scientific infrastructure and therefore is an important part of innovation systems. The included variables can be differentiated in university resources and results

Factor 4: ***National innovation environment:*** This factor retained a 9.96% of the total variability and is made up of variables which represent some of the characteristics inherent to the Nation-State to which each region belongs. Note that the starting point is a group of countries with significant differences in the geographical, economic and political aspects, so indicators are needed to express their heterogeneity. The variables of the national environment are: capital investment development (% of GDP); seed capital investment (% of GDP); economic freedom index; and the penetration of TICs

Factor 5: ***Public administration:*** This factor, which records 9.56% of the variance of the 29 variables included in the factor analysis, shows the resources used by the Public Administration in areas of Research and Development and also forms part of the regions' scientific apparatus .The variables composing it are:

Factor 6: ***Degree of sophistication of demand:*** This factor has been called *degree of sophistication of demand*, and explains 7.49% of demand development in the regions, from two key economic indicators, which relate the production of the country to its population and number of employees. Living standard (Per capita GDP) and productivity (GDP per worker)

In Table 3.6. there is a synthesis of this information with the intention of making it easier to visualise. In brackets the existing correlations between the factors and the variables of the research are included.

3.4. Concluding

From a battery of indicators available for different European regions in the period 1998-2000, the multivariate technique of factorial analysis of the main components is used. As already argued, the factorial analysis is a technique which determines on a set of variables a smaller set of hypothetical indicators by merging the variables which are highly correlated in one sole combined indicator. The latter, which take the name of factors, summarise practically all the information to be found in the original set of variables and among their characteristics that of being uncorrelated is the outstanding one. The technique thus makes it possible, given a sample of observations or cases or a set of quantitative variables, for them to be represented in a small space-a factorial space- where the relationships between them can be interpret[53].

The new hypothetical or "non observable" variables are: *Regional productive and economic environment, Innovatory firms, University, national innovation environment, Public Administration and Degree of sophistication in that of demand*. Given the methodology employed, these 6 factors will practically summarise all the information of a primary set of 29 variables, and will show, better than individual-type indicators, the components of the regional systems of European innovation.

It can be highlighted that the factor analysis presented in this paper grouped the variables without any restriction. I.e. the statistical programme classified or assigned the variables to each in groups or so called factors without previous indications or influence of the authors of this paper. This is important because, as will be seen, the variables included in each factor belong to the same component or sub-system of the overall regional innovation system. This can be considered as an important achievement because it should not be forgotten that one of the main criteria to judge the correctness of a factor analysis is , besides that the statistical requirements are fulfilled, that the factors –or hypothetical non-observable variables- can be correctly interpreted from a practical point of view and fit properly within the theoretical framework of the innovation system approach. So, the variables assigned to a factor have to be somehow interrelated and reflect different aspects of the same overall concept and on the other.

On the one hand the variables included in each of the factors can be interpreted easily. Moreover, the appropriateness of our variables and factors to measure the framework of the national innovation systems can be observed once we compare them with the main descriptions in the literature of national and regional innovation systems. Revising some literature[54] on national and regional innovation systems we argue that our "factors" -and the variables synthesised in them- include most of the aspects mentioned by those authors, although some aspects are not in our database and factors[55].

However we have to admit that some important aspects of the RIS and its components are missing. Especially there is a lack of information or data about the interaction between the agents of an innovation system such as data about cooperation and technology transfer. Moreover we did not find any homogeneous regionalised data on the public support for R&D. Maybe some of such data are available in the European Innovation Survey (EIS) although the first editions were

[53] Ferrán (2001), p.340
[54] Lundvall (1992a); Edquist y Johnson (1997); Edquist (2005); Nelson (1993; Patel y Pavitt (1998); Radosevic (2004)and Koschatzky (1997/2001)
[55] This analysis is carried out with detail in IAIF working paper number 60.

not representative on a regional level[56], while for the most recent ones we are not sure for which countries they are representative on a regional level. Moreover we worked with data in a longer period while the EIS is carried out only in some specific years. To overcome the lack of information on some of the important aspects missing in this paper we propose to work with a smaller number of countries for which we can find homogeneous data on some specific variables like scientific publications or inter-firm relationships

Concluding, although there is more and more information available on the R&D and innovation related activities, it is still difficult to recollect aggregated homogeneous data for a large number of regions or even countries. Therefore, our approach is just a step forwards in this kind of studies. Its main advantage is the creation of the so called hypothetical non observable variables. Which is nothing less than a reduction of a larger number (29) variables into six factors that reflect, from our point of view, better the reality of a RIS than each or a few of the individual variables.

[56] In fact for the case of Spain we used those data: see Buesa et al 2005, 2007 (in English) and Buesa and Heijs (Coordinators) in Spanish.

4.- The construction of a synthetic index for the innovation systems of the European regions

4.1.- Introduction

The construction of a synthetic index for European regions has the aim of quantifying the elements going to make up the regional innovation systems and to make feasible greater or lesser capacity when engaged in innovation. It thus becomes an important practical exercise not just of great economic, but also of political and social value. In the building of the IAIF Index of European Regional Innovation (also called IAIF Index), as well as in the various partial indices of which it consists, four stages have been followed[57].

1. Creation of the IAIF data base for the EU-15 regions (Section 3.2)
2. Identification of the factors making up the innovation systems (section 3.2)
3. Calculation of the weightings or weight of the factors and variables. (Section 4)
4. Standardisation or normalisation and calculation of partial and final indices. (section 4)

Once the factors have been specified we went on to quantify the extent of innovatory capacity in European regions by means of the construction of what is known as the IAIF index of regional innovation[58]. This index, calculated from the results obtained in the previous stage-factorial analysis-, establishes a ranking of regions according to the extent to which their systems are developed .In the same way, an order can be set from each of the factors detected- *Regional productive and economic environment, Innovatory firms, University ,National innovation environment, Public administration and degree of sophistication of demand*-, which correspond here with the subindexes making up the general indicator. Given the nature of this index, the relative weight of the factors, as well as the variables comprising them have been calculated from the findings produced by the multivariate analysis. The idea is to weight the variables and the six partial indices in accordance with their real participation in the innovation systems bearing statistical criteria in mind.

In the former section the main methodological aspects on the factorial analysis technique of main components have been shortly explained. Its use generated six hypothetical variables that identify synthetically the European regional innovation systems: *Regional productive-economic environment, Innovating firms, University, National innovation environment, Public Administration and Degree of sophistication of demand.* We will use each of these six factors – which register 88.92% of the total variance- to construct partial indices. And in a last step they will be combined to one solely index: the IAIF index for regional innovation capability.

4.2.- Calculation of the weightings

Given the character of this index-a measurement of the innovation capacity of the regions from the most objective viewpoint possible-the relative weight of the factors, as well as of the variables of which they are composed, has been calculated from the results thrown up by the multivariate analysis .The idea is to weight the variables and the partial indices, in accordance with their real participation within the innovation System, and not in a random way or merely influenced by theoretical considerations, that is, subjectively.

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[57] See footnote 6.

[58] The IAIF index of regional innovation has been applied to the study of Spanish regional innovation systems in Martínez Pellitero and Baumert (2003) Buesa, Heijs, Baumert and Martínez Pellitero (2003a and 2003b). Buesa, Heijs, Baumert, Martínez Pellitero et *al* (2007). In the latter findings for European regions are also included.

In the case of the partial indices, their weighting within the final index will be determined by the total variability (divided by the number of included variables) recorded by the factor in the model with regard to total variability. From the total variance explained by the model (See section 3 ,Table 3.6.) and the one corresponding to each factor is obtained as a percentage of the relative weight of each partial factor—within the IAIF Index. This implies that the variables and factors with most variability have a stronger influence or weight than those variables that reflect a more homogeneous distribution between regions.

Regarding the variables, their weighting within the partial indices- *Regional productive-economic environment, Innovating firms, National innovation environment, Public Administration* and *Degree of sophistication of demand*- has been calculated from the *Matrix of coefficients for calculating marks in the components*[59] (Table 3.5.). Bearing in mind that each variable is assigned to just one factor on the basis of its greater degree of correlation with it, the relative weight is calculated as a percentage from the correlations between the factor and each variable, and of the correlation of the factor with all the variables.

In table 4.1. an explanation is given of the composition of the IAIF Index of European Regional Innovation for the years 1998 ,1999 and 2000. The partial index with a greater weight on the total, namely, 34.43% corresponds to the *Regional productive-economic environment,* with no very notable differences existing among the variables of which it is composed. The second most important partial index is the one relating to *Innovatory firms* with 23.64%, and here the outstanding point is that of the variables relating to the patents, particularly the hi-tech one. The third index, with an 11.54% weighting, is the one linked to the *University.* In the fourth partial index, the *National innovation environment,* with an 11.20% weighting, the capital investment development variable stands out. The fifth index, with a 10.76% weighting, is associated with the *Public administration,* where the variables of which it is made up have practically equal *weight.* Finally, the last partial index, made up of two variables, has an 8.43% weight on the end, with the importance of productivity being greater in what has come to be called the *degree of sophistication of demand.*

Standardisation and calculation of partial and final index

Finally, in the last stage of the construction of the index the variables were standardised in order to oscillate within established margins, and in this way become comparable. The way in which it was done is based on the use of maximum and minimum values of each year in each variable so that the standardised results are to be found within a range of zero to a hundred, that is:

$$x^{*}_{r,j} = \frac{x_{r,j} - x^{\min}_{j}}{x^{Max}_{j} - x^{Min}_{j}} \times 100$$

where: $x^{*}_{r,j}$: value standardised region r, year j

$x_{r,j}$: value observed in the region r, year j

x^{Max}_{j} : maximum value observed, year j

x^{Min}_{j} : minimum value observed, year j

[59] This matrix also is called the *matrix of component transformation.*

The sum of the standardised variables thus obtained, weighted by the corresponding factor and multiplied by a hundred gives rise to the value of each of the partial indices, which will oscillate between zero and a hundred. Likewise, from the weighted sum of the IAIF Index of European regional innovation is obtained, and this will similarly vary between zero and a hundred.

Table 4.1. Structure IAIF Index of Regional Innovation (1998, 1999and 2000)

	VARIABLES	**Weight of each variable**	**Weight of each factor or subindex**
1. Regional productive economic environment	Average annual population (thousands of inhabitants)	12,09%	*34,43%*
	Number of people employed	11,83%	
	Gross Fixed Capital formation (millions € 1995)	11,09%	
	Human resources in Sc and T services (total)	11,08%	
	Gross Domestic Product (millions € 1995)	11,06%	
	Gross Added Value (millions € base 1995)	11,03%	
	Wages (millions € 1995)	10,94%	
	Human resources in Sc and T in knowledge-intensive services (total)	10,78%	
	Human resources in Sc and T in high technology (total)	10,09%	
2. Innovating firms	Hi-tech patents regard to each million population	19,51%	*23,64%*
	Hi-tech patents regard to each million working population	19,48%	
	Patents per each million of population)	14,45%	
	Patents with regard to each million working population	13,83%	
	Firms' expenditure on R&D (%of GDP)	12,84%	
	Staff in R&D in firms (number of people) % of employment	10,35%	
	Staff in R&D in (full time equivalent) % of employment.	9,54%	
3. University	University expenditure on R&D (% of GDP)	26,41%	*11,54%*.
	Staff in R&D in the University (number of people) % of employment.	25,31%	
	Staff in R&D in the University (full time equivalent) % of employment	24,54%	
	Number of third cycle students (‰ of population)	23,74%	
4. National innovation	Risk Capital for development (% of GDP)	32,45%	*11,20%*
	Economic Freedom Index	26,87%	
	Seed and start up investment capital (% of GDP)	20,67%	
	Penetration of TICs	20,01%	
5. Public administration	PA expenditure on R&D (%of GDP)	33,38%	*10,76%*
	Staff in R&D in PAs (number of people) %of employment	33,36%	
	Staff in R&D in PAs (full time equivalent) % of employment	33,26%	
6. Degree of sophistication of demand	GDP per worker (€ per worker)	54,57%	*8,43%*
	GDP per capita (€ per worker)	45,43%	

*With regard to each million of population; **With regard to each million of working population
NP: Number of people; EDP: Equivalent to full time

4.3. RESULTS OF THE IAIF INDEX OF REGIONAL INNOVATION

When interpreting the results from the above-mentioned method it is worthwhile taking several aspects into account:

Firstly, a reminder must be given once again that the indices measure the relative position of a region compared to the rang of a one-year sample, and the value adopted can be between zero (minimum) and a hundred (maximum)

Secondly, it must be taken into account that the results of a region in the IAIF Index will depend on those obtained in the six partial indices, which also have a different weight. In this context, the role of the factor *Regional productive-economic environment* is the one that most impinges on the final index. This corresponds to the importance of market size for the development of the economy in general and innovation in particular, as has been stressed in the literature, both theoretical and empirical[60]. This factor or hypothetical non observable variable is based on variables expressed in absolute figures. Its inclusion in the IAIF index of Regional Innovation Capabilities can be justified to incorporate somehow the concepts of critical mass and scale advantages related to R&D systems. I.e. smaller regions or regions with small innovation systems have specific problems to assure the benefits of innovation related activities. The small number of innovating agents and the low demand of innovative products or service impede the necessary regional based labour division of the innovation process between firms, technology centres, consultancy offices, specialised providers, etc…. Therefore we could conclude that regions with a larger innovation systems has a more developed and differentiated system with more dynamic mutual reinforcing agents, effects and spillovers.

As is observed, the European region possessing the highest mark in the IAIF Index is the French one from *Île de France (fr1).* Nonetheless, this region does not obtain more than 57 points in any of the three years, which indicates that it does not show high marks in each of the six partial indices. In general, many European regions present important asymmetries in the development of the components of the regional innovation Systems. This can be checked in Annex I, where the results obtained in each of the partial indices are included.

As far as the period trend is concerned, the data series available is very limited for carrying out an adequate diagnosis. Here at least ten years would be necessary to be able to point to the existence or otherwise of convergence between regions. Yet again the need to continue the research in the future by means of successive updating of the IAIF-RIS (EU) database is shown.

In general terms it can be said that the ranking occupied by European regions is fairly stable. If we look at the first ten places for 2000, a Finnish region *Phojois-Suomi (fi15)-* in 1998 and a German one in 1999-*Hessen (de7)-* are the only ones which are no longer in the "top 10" of the 2000 index. Below there will be needed a more detailed analysis of the results for the year 2000.

[60] In this context the importance of market size was shown by Adam Smith in his work ·*The Wealth of Nations"* in 1776, especially in book 1 "Of the causes of progress in the productive capacity of labour and how its product is naturally distributed among the different classes": Similarly, other noted economists such as Allyn Young (1928) have stressed this fact. What is more, from the empirical viewpoint in Baumert's work (2006) it has been proved that the *Regional productive-economic environment*- in the case of the European regions studied here and for the period 1995-2001-is the variable which presents the highest coefficient (Beta 0.830) in the regression model which studies the knowledge-generation function, using patents as a dependent variable, and where R2=0.905 is obtained (Baumert (2006), p.144.

4.4. IAIF INDEX OF INNOVATION IN EUROPE: RESULTS OF 2000

Once the methodology and structure of the IAIF Index are known, analysis of the results will centre first of all on those obtained in the total mark-section 4.4.1.- and subsequently –section 4.4.2.- on the partial indices. Later on, they are presented by intervals-25% range with regard to the maximum mark achieved in the total index, in section 4.4.3.- the number of regions per country in each one, the percentage of the European GDP the regions account for, as well as the proportion of the country's GDP. Finally, -section 4.4.4. the existing relationship between the IAIF index and per capita GDP and regional GDP will be studied by means of a linear regression analysis.

In Graph 4.1. the maximum, minimum and mean values[61] are recorded for each of the fifteen countries and for the European Union as a whole[62]. Moreover, Table 4.4.includes the name of the regions obtaining the maximum and minimum values. In view of these results it can be stated that the European Union as a whole shows very characteristic traits.

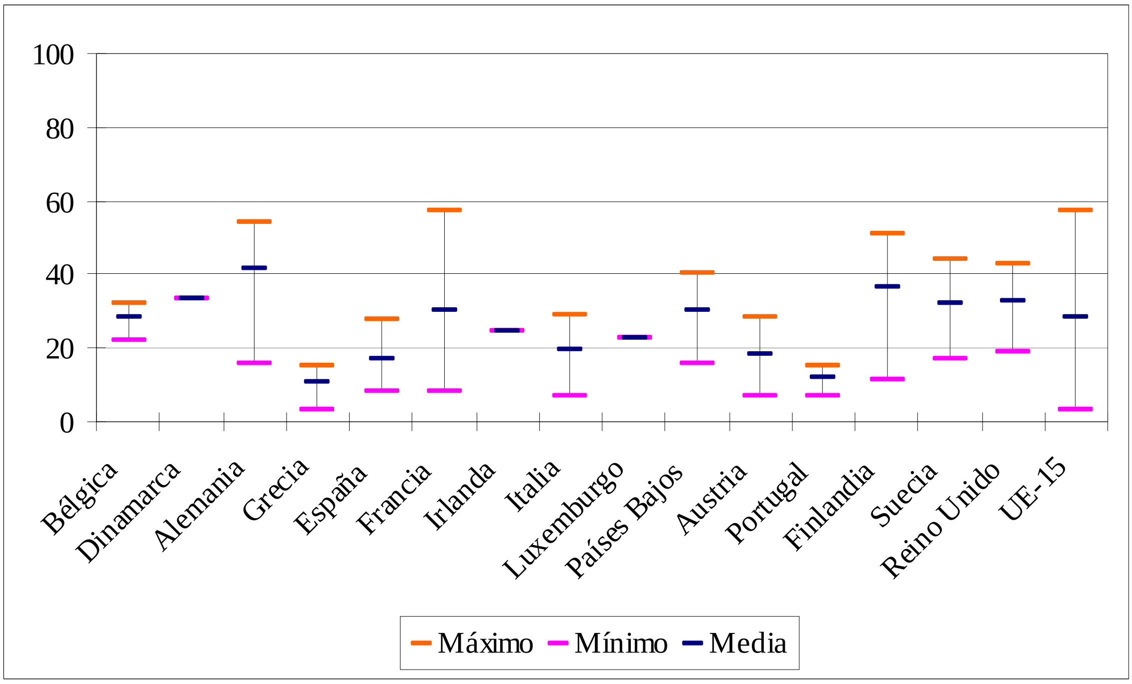
In the first place and, as has already been mentioned, the region in first place in he IAIF Index ranking *Île de France (fr1)* only achieves 57.03 points of the possible 100 that it could obtain. This fact, given the way the index is constructed, allows it to be stated that there is no region in the study that is leader for each of the different elements making up the regional innovation System[63].

Secondly, there is an important dispersion among the fifteen countries which affects both the maximum and minimum values of each of them, as reflected in Graph 4.1. In this way, for example, in Germany the region with the lowest value in the index- *Mecklenberg-Vorpommern (de8)* with 15.94 points-has a higher mark than the Greek region *Attiki (gr3)* –with 14.98-which obtained the maximum value. Moreover, the average value of the IAIF Index of countries such as Germany, Denmark, Finland, Sweden and the United Kingdom, is above that of regions with the highest value in Belgium, Greece, Spain, Italy, Austria and Portugal[64]. Thirdly, the dispersion of values of the index within each country is also important since it indicates the difference of points between the regions. This fact is accentuated in countries like France, Germany, Italy and the United Kingdom.

To sum up, the IAIF Index reflects the existence of an important diversity in regional innovation Systems, so that the inequalities between them are highly noticeable, both on the national plane and the one corresponding to the joint consideration of the countries comprising the European Union.

[61] The mean of each country has been calculated as a weighted mean where the weight of the different regions stems from the proportion of GDP that each one accounts for in the country as a whole. Regarding the partial indices which will be analysed later on, the same procedure has been followed.
[62] The European Union mean has been calculated via a weighted mean where the weight of each country derives from the percentage that GDP accounts for as part of the European Union total.
[63] Specifically, their values in the partial indices are: in the regional productive-economic environment 98.30, in the partial index Innovatory firms 47.33, in the University index 41.86, in the National innovation environment one 28.51, in Public administration 36.35, and finally, in the Degree of sophistication of demand, 60.88.
[64] The mean is also higher than Ireland and Luxembourg, countries with just one region.

Graph 4.1. IAIF index of regional innovation



Source: own preparation

Table 4.4. Maximum and minimum values on the IAIF Index

	Max*.	Region	Min**.	Region	Mean.
Belgium	32,03	*Bruxelles-capitale (be1)*	22,22	*Région Wallonne(be3)*	28,56
Denmark	33,18	*Denmark(dk)*	33,18	*Denmark (dk)*	33,18
Germany	54,08	*Nordrhein-Westfalen(dea)*	15,94	*Mecklenburg-Vorpommern(de8)*	41,82
Greece	14,98	*Attiki(gr3)*	3,41	*Notio Aigaio (gr42)*	10,91
Spain	27,58	*Comunidad de Madrid (es3)*	8,08	*Islas Baleares(es53)*	17
France	57,03	*Île de France(fr1)*	8,04	*Corse (fr83)*	30,01
Ireland	24,36	*Ireland (ie)*	24,36	*Ireland (ie)*	24,36
Italy	28,9	*Lombardia (it2)*	7,06	*Valle d'Aosta (it12)*	19,27
Luxembourg	22,34	*Luxembourg (lu)*	22,34	*Luxembourg (lu)*	22,34
Low Countries	40,22	*Noord-Brabant (nl41)*	15,9	*Drenthe (nl13)*	30,03
Austria	28,49	*Vienna (at13)*	7,14	*Burgenland (at11)*	18,03
Portugal	15,38	*Lisboa e Vale do Tejo (pt13)*	6,98	*Algarve (pt15)*	12,01
Finland	50,93	*Uusimaa (suuralue)(fi16)*	11,23	*Åland (fi2)*	36,3
Sweden	43,98	*Stockholm (se01)*	16,84	*Småland med öarna (se09)*	32,04
United Kingdom	42,68	*South East (ukj)*	18,97	*Northern Ireland (ukn)*	32,49
UE-15	57,03	*Île de France(fr1)*	3,41	*Notio Aigaio (gr42)*	28,29

* Maximun value of the country
** Minimun value of the country
Source: own preparation

4.4.2. Partial indices of European regions

Below the main traits of the partial indices making up the IAIF Index are shown. It is important to underline that countries containing the region with the maximum value in Europe are not always the same in different partial indices, as will be seen below.

- **Regional productive-economic environment**

An analysis of the partial index- Regional productive-economic environment –Graph 4.2. and Table 4.5.- shows the existence of significant differences between and within countries. Only the discrepancies are smaller in each state's minimum mark, as can be observed. Germany and France present the most outstanding behaviour both in the mean and in the leading regions of each country, specifically in Germany *Nordrhein-Westfalen (dea)* with 98.3 points and in France *Île de France (fr1),* with 83.56 points.

At the tail end of the regional environment factor we find Greece, Austria, Portugal, Finland and Sweden, where, as is reflected in Graph 4.2., the value of the most developed region of the above-mentioned countries is lower than 20 points and thus also below the European mean, which stands at 32.76.

When analysing the differences within the countries, a look at Graph 4.2.shows us that the most notable ones are Germany, France and the United Kingdom.

- ***Innovating firms***

Regarding the partial index Innovating firms, graph 4.3. and Table 4.6 show the existing contrasts. Three states show regions with a high value in this index: Finland, with the region of *Uusimaa (fi16)* 94.1-, the Low Countries with the *Noord Brabant (n141)* region 85.37-and Sweden with *Stockholm (se01)*-80.88-. Moreover, in Sweden and Finland the mean is found way above the remaining European Union countries, except for the Low Countries. The three previously mentioned States, moreover, also display regions with low marks, which determines the important differences existing within them in the area of innovating firms.

Another point: the weakest performance presented here corresponds to the Mediterranean countries Greece, Spain, Portugal and Italy, where the regions with the highest points total do not attain the European mean of 18.76 points.

Regarding behaviour within nations, heterogeneity seem to be higher in those containing the regions with the highest marks in the index, that is, the Low Countries, Finland, Sweden, Germany and –France

- ***University***

In the partial index University, the differences between countries are repeated. In this case, the regions with the highest values are located in Sweden-*Övre Norrland (se08)* with 81.57 points-, Greece[65] - *Ipeiros (gr21)* with 77.46 points-, The Low Countries *Groningen (n111)*, with 75.48 points- and Austria- *Vienna (at13)* with 66.14 points-.

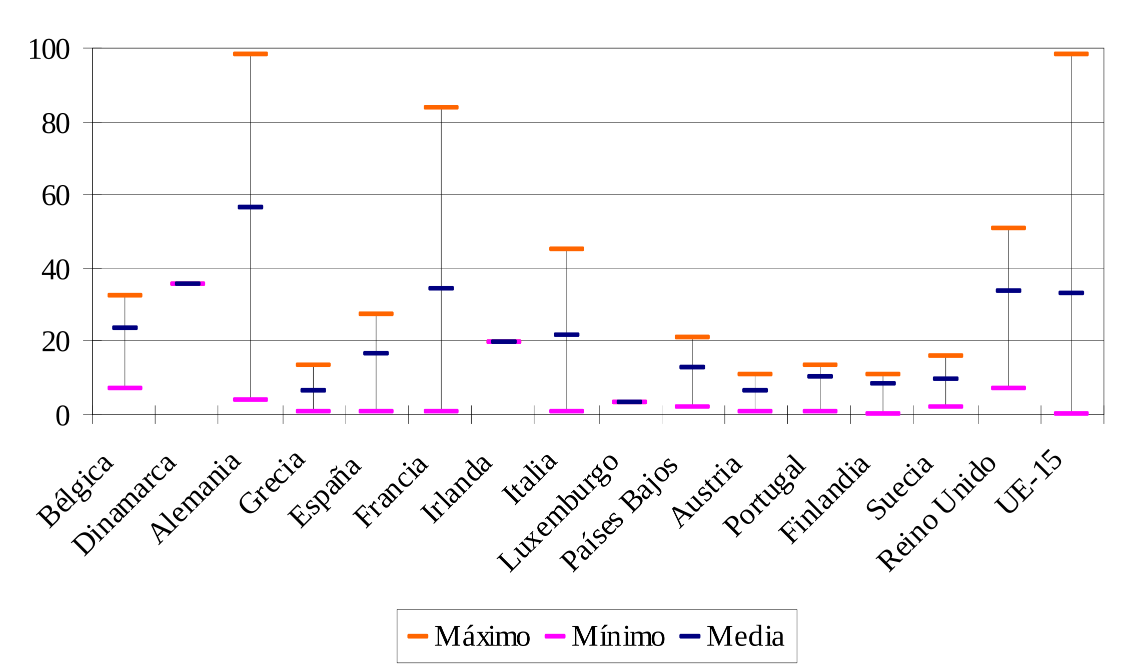
Regarding the minimum values of the whole of the European Union, they are attained in four of the states which contain the maximum values, specifically in Greece, the Low Countries, in Austria and in Finland, along with Italy.

Also worthy of note is that the mean of each of the countries studied in the partial index University is located in the 20-40 point range, except in Finland and Sweden where it is higher than the United Kingdom, which is lower.

Finally, it is convenient to point out that the differences within countries are important. This can be appreciated in Graph 4.4. and in table 4.12., particularly in the cases of Greece, the Low Countries and Austria

[65] In Greece there is another region with a very high points total in the partial index, namely *Kentiki Macedonia*. See Annex III Partial index University

Graph 4.2. Partial regional productive-Economic Index



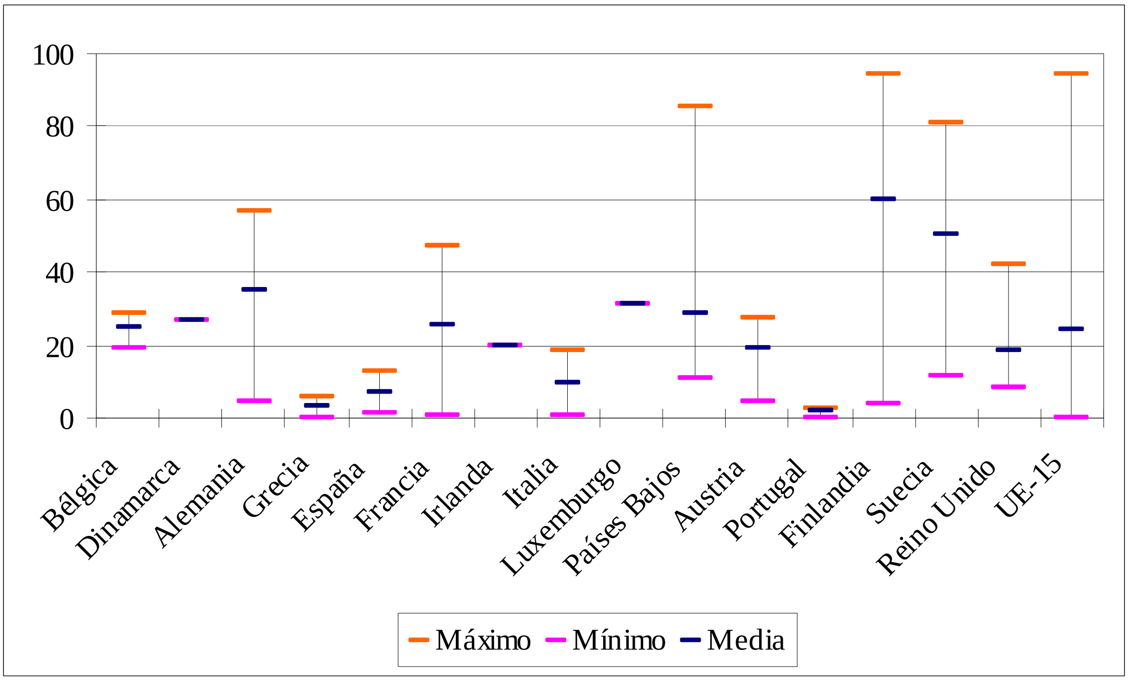
Source: own preparation

Table 4.5. Maximum and minimum values of the partial regional productive-economic Index

	Max*.	Region	Min**.	*Region*	Mean
Belgium	32,28	*Vlaams Gewest (be2)*	7,24	*Bruxelles-capiale (be1)*	23,29
Denmark	35,29	*Denmark (de)*	35,29	*Denmark (dk)*	35,29
Germany	98,3	*Nordrhein-Westfalen (dea)*	4,1	*Bremen (de5)*	56,44
Greece	13,26	*Attiki (gr3)*	0,34	*Voreio Aigaio (gr41)*	6,36
Spain	27,07	*Cataluña (es51)*	0,81	*La Rioja (es23)*	16,55
France	83,56	*Île de France (fr1)*	0,8	*Corse (fr83)*	34,06
Ireland	19,37	*Ireland (ie)*	19,37	*Ireland (ie)*	19,37
Italy	44,88	*Lombardia (it2)*	0,39	*Valle d'Aosta (it12)*	21,46
Luxembourg	3,03	*Luxembourg (lu)*	3,03	*Luxembourg(lu)*	3,03
Low Countries	21,16	*Zuid-Holland (nl33)*	1,75	*Flevoland (nl23)*	12,63
Austria	10,7	*Vienna (at13)*	0,92	*Burgenland (at11)*	6,48
Portugal	13,37	*Lisboa e Vale do Tejo (pt13)*	0,91	*Algarve (pt15)*	10,12
Finland	10,94	*Uusimaa (suuralue) (fi16)*	0	*Åland (fi2)*	8,03
Sweden	15,92	*Stockholm (se01)*	1,99	*Mellersta Norrland (se07)*	9,75
United Kingdom	50,64	*South East (ukj)*	7,07	*Northern Ireland(ukn)*	33,43
UE-15	98,3	*Nordrhein-Westfalen (dea)*	0	*Åland (fi2)*	32,76

* Maximun value of the country ** Minimun value of the country
Source: own preparation

Graph 4.3. Partial Index Innovatory firms



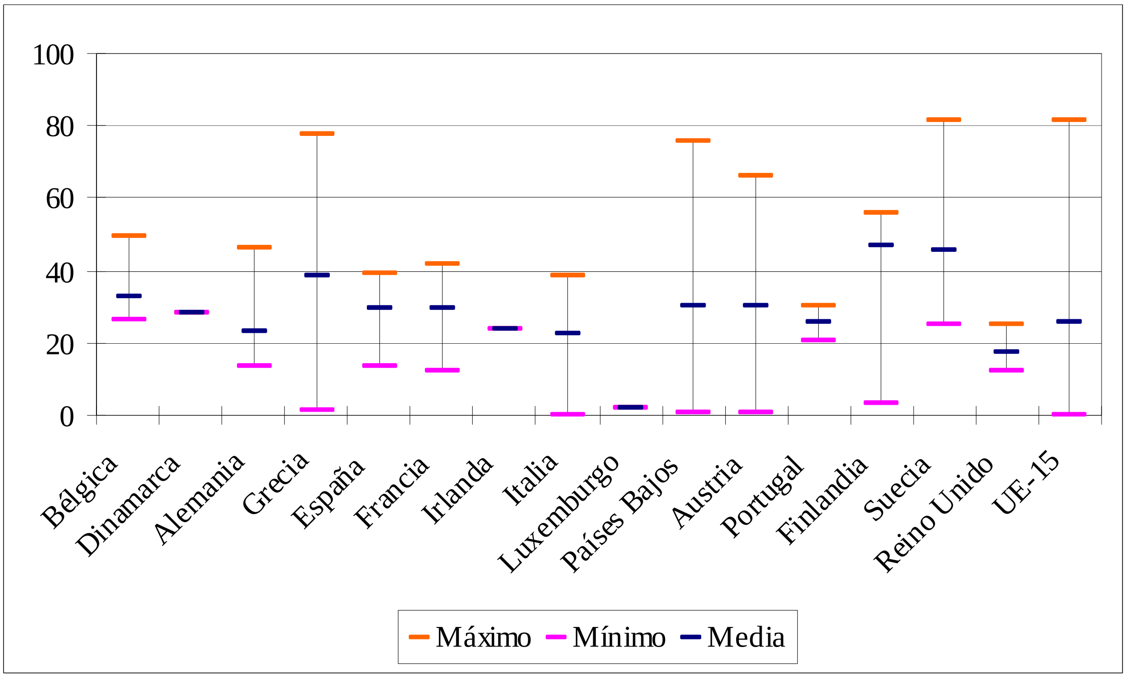
Source: own preparation.

Table 4.6. Maximum and minimum vales of the partial Index Innovatory firms

	Max*.	Región	Min**.	Región	Media
Bélgica	28,58	*Bruxelles-capitale (be1)*	19,32	*Région Wallonne (be3)*	25,02
Dinamarca	26,51	*Denmark (dk)*	26,51	*Denmark (dk)*	26,51
Alemania	56,59	*Baden-Württemberg (de1)*	4,26	*Mecklenburg-Vorpommern (de8)*	35,3
Grecia	5,43	*Attiki (gr3)*	0,12	*Notio Aigaio (gr42)*	3,04
España	13	*Comunidad de Madrid (es3)*	1,11	*Islas Baleares (es53)*	7,15
Francia	47,33	*Île de France (fr1)*	0,66	*Corse (fr83)*	25,2
Irlanda	19,53	*Irlanda (ie)*	19,53	*Irlanda (ie)*	19,53
Italia	18,68	*Piemonte (it11)*	0,52	*Calabria (it93)*	9,84
Luxemburgo	31,25	*Luxemburgo (lu)*	31,25	*Luxemburgo (lu)*	31,25
Países Bajos	85,37	*Noord-Brabant (nl41)*	10,66	*Zeeland (nl 34)*	28,52
Austria	27,41	*Vienna (at13)*	4,66	*Burgenland (at 11)*	19,32
Portugal	2,48	*Lisboa e Vale do Tejo (pt13)*	0,3	*Alentejo (pt14)*	2,06
Finlandia	94,1	*Uusimaa (suuralue) (fi16)*	3,61	*Åland (fi 2)*	60,19
Suecia	80,88	*Stockholm (se01)*	11,3	*Småland med öarna (se09)*	50,37
Reino Unido	41,9	*Eastern (ukh)*	8,1	*Wales (ukl)*	18,76
UE-15	94,1	*Uusimaa (suuralue) (fi16)*	0,12	*Notio Aigaio (gr42)*	24,19

* Valor máximo del país
** Valor mínimo del país
Fuente: elaboración propia

Graph 4.4. Partial index University



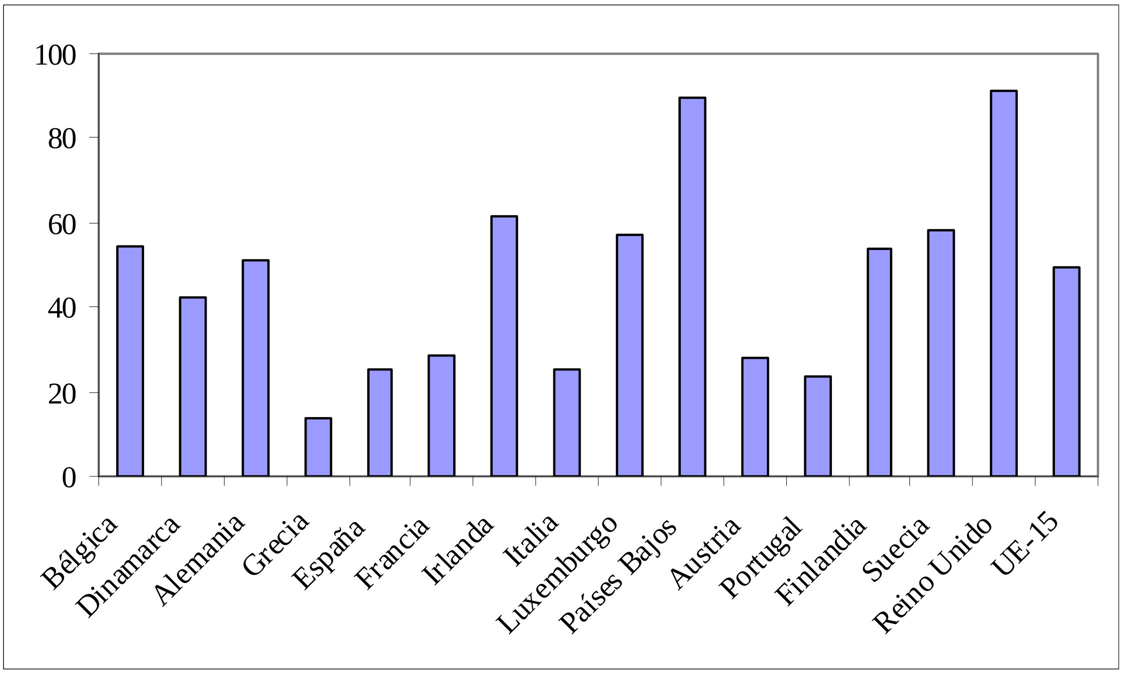
Source: own preparation

Table 4.7. Maximum and minimum values in the partial index University

	Max.*	Region	Min.**	Region	Mean
Belgium	49,22	*Bruxelles-capitale (be1)*	26,5	*Vlaams Gewest (be2)*	32,68
Denmark	28,47	*Denmark (dk)*	28,47	*Denmark (dk)*	28,47
Germany	46,05	*Berlin (de3)*	13,26	*Brandenburg (de4)*	23,13
Greece	77,46	*Ipeiros (gr21)*	1,07	*Peloponnisos (gr25)*	38,3
Spain	39,3	*Comunidad de Madrid (es3)*	13,26	*Islas Baleares (es53)*	29,73
France	41,86	*Île de France (fr1)*	12,18	*Corse (fr83)*	29,45
Ireland	23,44	*Ireland (ie)*	23,44	*Ireland (ie)*	23,44
Italy	38,53	*Umbria (it52)*	0	*Valle d'Aosta (it12)*	22,65
Luxembourg	2	*Luxembourg (lu)*	2	*Luxembourg (lu)*	2
Low Countries	75,48	*Groningen (nl11)*	0,76	*Flevoland (nl23)*	29,91
Austria	66,14	*Vienna (at13)*	0,84	*Burgenland (at11)*	30,37
Portugal	30,04	*Norte (pt11)*	20,4	*Centro (pt12)*	25,7
Finland	55,57	*Pohjois-Suomi (fi15)*	3,16	*Åland (fi2)*	46,73
Sweden	81,57	*Övre Norrland (se08)*	24,96	*Småland med öarna (se09)*	45,53
United Kingdom	25,29	*Scotland (ukm)*	11,9	*South West (ukk)*	17,53
EU-15	77,46	*Ipeiros (gr21)*	0	*Valle d'Aosta (it12)*	25,57

* Maximun value of the country
** Minimun value of the country
Source: own preparation

Graph 4.5. Partial index national innovation environment



Source: own preparation

Table 4.8 Values of the Partial index national innovation environment

Belgium (BE)	54,63
Denmark (DK)	42,09
Germany (DE)	50,94
Greece (GR)	13,91
Spain (ES)	25,5
France (FR)	28,51
Ireland (IE)	61,55
Italy (IT)	25,31
Luxembourg (LU)	57,16
Low Countries (NL)	89,72
Austria (AT)	28,17
Portugal (PT)	23,6
Finland (FI)	54,02
Sweden (SE)	58,25
United Kingdom (UK)	91,01
UE-15	49,6

Source: own preparation

- ***National innovation environment***

As has been previously mentioned, the different indicators comprising the partial index national innovation environment refer to the national area, so it is more relevant to perform an analysis by intervals.

Thus in the 0-25 point range-that is , those countries which have a very weak national innovation environment- Greece and Portugal are situated, as is seen in graph 4.5 and Table 4.13. In the 25-50 point range, we find Spain, France and Denmark, where the latter has a points total very close to the mean for the countries analysed. In the third range with a developed national environment, most European Union states are situated: Belgium, Germany, Ireland, Luxembourg, Finland and Sweden. Finally, there are two countries in the fourth interval- with a strong national innovation environment-the United Kingdom and the Low Countries.

n

- ***Public administration***

In the partial index Public Administration the differences between countries are also significant, as can be seen in Graph 4.6. and Table 4.14. The regions with the highest marks of the fifteen European Union States analysed are found in the Low Countries- *Flevoland (n123)* with 94.61 points-, Finland *Uusimaa (fi16)*with 75.74-, Italy – *Lazio (it6)* with 69.29-and Germany- *Berlin(de3)* with 66.8 points.

Regarding the lower values of the index, the differences are smaller. Specifically all the countries have regions with a value of less than 10 points, except in the uniprovincial states of Luxembourg and Denmark.

As far as the national mean is concerned, it can be appreciated that, with the exception of Finland, Belgium and Ireland, it is around 10 to 30 points, with the latter two countries showing the weakest development in the Public administration factor of the whole group studied.

Finally, it is worthwhile indicating that the differences within the countries are also marked particularly in the cases of Finland, Italy and the Low Countries.

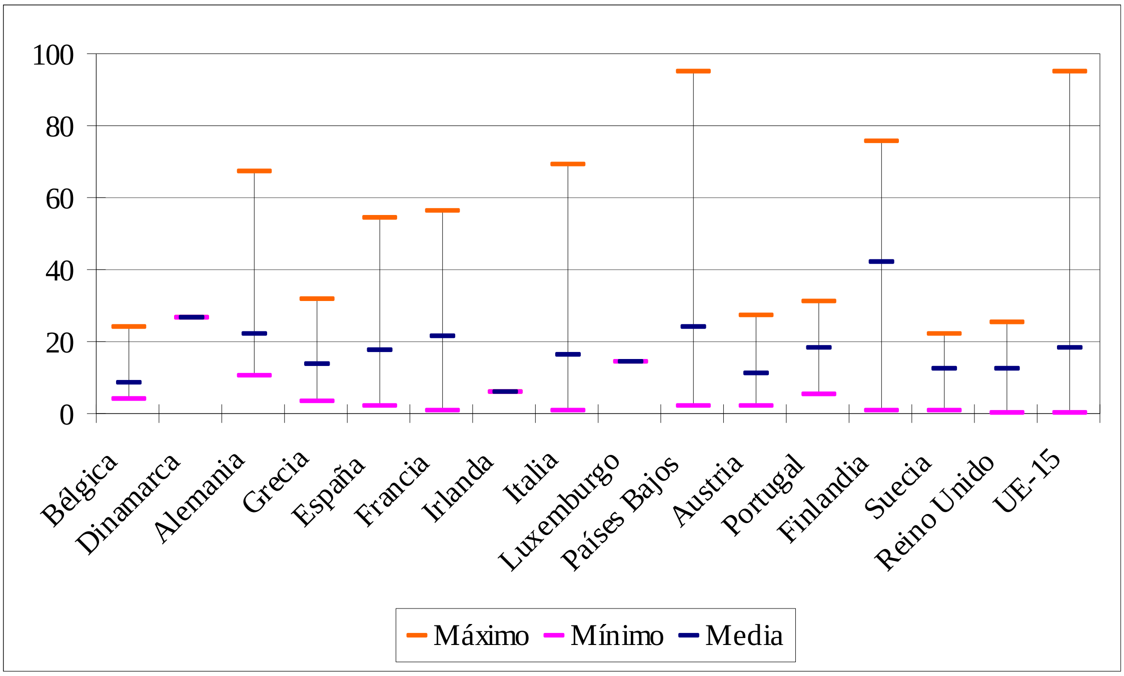
- ***Degree of sophistication of demand***

In the case of the partial index degree of sophistication of demand, the differences among the countries quantified by means of the maximum, minimum and mean values are once more significant as seen in Graph 4.7. and Table 4.15.

The state in which the region with the highest mark is to be found is Belgium- specifically *Bruselles –capitale (be1)*- where the index value is 100, followed by Luxembourg. On the opposite side, countries containing the regions with lower degrees of sophistication of demand are clearly Portugal, Greece and Spain, where their most advanced regions in this regard do not attain the European mean of 35.53 points.

Once again, it can be well understood that significant differences exist among member states of the European Union, the most notable being in Belgium and Germany.

Graph 4.6 Partial Public administration index



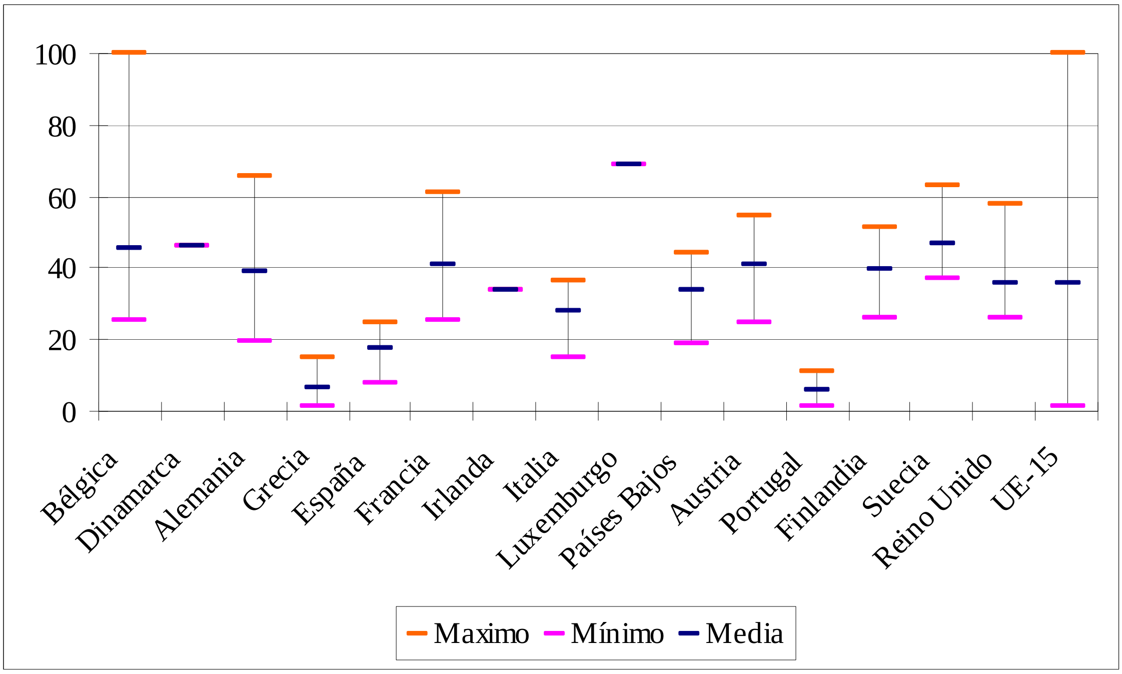
Source: own preparation

Table 4.9. Maximum and minimum values of the partial Public Administration index

	Max.*	Region	Min.**	Region	Mean
Belgium	23,73	*Bruxelles-capitale (be1)*	4,18	*Région Wallonne (be3)*	8,21
Denmark	26,64	*Denmark (dk)*	26,64	*Denmark (dk)*	26,64
Germany	66,8	*Berlin (de3)*	10,56	*Rheinland-Pfalz (deb)*	22,04
Greece	31,61	*Kriti (gr43)*	3,27	*Sterea Ellada (gr24)*	13,65
Spain	54,2	*Comunidad de Madrid (es3)*	1,95	*Navarra (es22)*	17,23
France	56,25	*Languedoc-Roussillon (fr81)*	0,34	Limousin (fr63)	21,34
Ireland	5,6	*Ireland (ie)*	5,6	*Ireland (ie)*	5,6
Italy	69,29	*Lazio (it6)*	0,89	*Molise (it72)*	16,23
Luxembourg	14,28	*Luxembourg (lu)*	14,28	*Luxembourg(lu)*	14,28
Low Countries	94,61	*Flevoland (nl23)*	1,97	*Limburg (nl42)*	24,01
Austria	27,28	*Vienna (at13)*	2,06	*Vorarlberg (at34)*	10,7
Portugal	31,1	*Lisboa e Vale do Tejo (pt13)*	4,92	*Norte (pt11)*	17,91
Finland	75,74	*Uusimaa (suuralue) (fi16)*	0,42	*Åland (fi2)*	42,2
Sweden	21,69	*Småland med öarna (se09)*	0,45	*Sydsverige (se04)*	11,99
United Kingdom	25,36	*South East (ukj)*	0,17	*North East (ukc)*	12,07
EU-15	94,61	*Flevoland (nl23)*	0,17	*North East (ukc)*	18,22

* Maximun value of the country
** Minimun value of the country
Source: own preparation

Graph 4.7. Partial index degree of sophistication of demand



Source: own preparation

Table 4.10 Maximum and minimum values of the partial index Degree of sophistication of demand

	Max.*	Region	Min.**	Region	Media
Belgium	100	*Bruxelles-capitale (be1)*	25,44	*Région Wallonne (be3)*	45,72
Denmark	46,23	*Denmark (dk)*	46,23	*Denmark (dk)*	46,23
Germany	65,34	*Hamburg (de6)*	19,68	*Thüringen (deg)*	39,15
Greece	14,65	*Sterea Ellada (gr24)*	1,53	*Anatoliki Makedonia, Thraki (gr11)*	6,57
Spain	24,86	*Comunidad de Madrid (es3)*	7,51	*Extremadura (es43)*	17,47
France	60,88	*Île de France (fr1)*	25,11	*Corse (fr83)*	40,81
Ireland	34,07	*Ireland (ie)*	34,07	*Ireland (ie)*	34,07
Italy	36,23	*Trentino-Alto ADILE (it31)*	15,02	*Calabria (it93)*	28,02
Luxembourg	69,07	*Luxembourg (lu)*	69,07	*Luxembourg (lu)*	69,07
Low Countries	44,36	*Utrecht (nl31)*	18,71	*Flevoland (nl23)*	33,86
Austria	54,58	*Vienna (at13)*	40,59	*Burgenland (at11)*	24,61
Portugal	10,82	*Lisboa e Vale do Tejo (pt13)*	1,32	*Norte (pt11)*	5,94
Finland	51,25	*Uusimaa (suuralue) (fi16)*	25,87	*Itä-Suomi (fi13)*	39,34
Sweden	63,18	*Stockholm (se01)*	37,04	*Norra Mellansverige (se06)*	46,63
United Kingdom	57,81	*London (uki)*	25,68	*North East (ukc)*	35,97
EU-15	100	*Région Bruxelles (be1)*	1,32	*Norte (pt11)*	35,53

* Maximun value of the country; ** Minimun value of the country: Source: own preparation

4.4.3. Analysis of results by intervals

In this section, the results obtained by the IAIF Index of innovation in Europe as a whole during2000 have been grouped in four intervals calculated from the region achieving the highest mark and which as a result correspond to 100% of maximum value. In this way, in the 100-75 range are included those obtaining a mark between 100 and 75% of the leader-*Île de France (fr1)*-, and so on for the rest.

From the information recorded in Table 4.16, where the number of countries per interval is shown, several conclusions can be drawn.

In the first place most of the European regions-specifically 124-have a mark below 50% compared to the one in first place in the ranking. Secondly, behind *Île de France (fr1)*, there are only five regions with a mark above 75%. Precisely they are the three German regions of *Nordrhein-Westfalen (dea), Bayern (de2)* and *Baden-Württemberg (de1)* , and the Finnish *Uusimaa (fi16)* and the Swedish *(Stockholm) (se01).*

Thirdly, the countries which have no regions in the fourth interval-Systems with a lower innovation capacity –are Belgium, Denmark, Germany, Luxembourg, the Low Countries and the United Kingdom. Fourthly, there exist two States, Greece and Portugal, where all the regions are found in the group of systems with a lower innovation capacity. Finally, countries like France, Finland and Sweden show an important variety of regions which are present in the four intervals.

Table 4.11. Number of regions by country and interval

	Interval 100-75	Interval 75-50	Interval 50-25	Interval 25-0	TOTAL
Belgium		2	1		3
Denmark		1			1
Germany	3	3	10		16
Greece				13	13
Spain			3	14	17
France	1	1	13	7	22
Ireland			1		1
Italy			7	13	20
Luxembourg			1		1
Low Countries		4	8		12
Austria			5	4	9
Portugal				5	5
Finland	1	1	3	1	6
Sweden	1	1	5	1	8
United Kingdom		3	9		12
EU-15	6	16	66	58	146

Source: own preparation

Table 4.12. Percentage of GDP of the EU-15 by country and interval

Table 4.13. Percentage of GDP of the EU-15 by country and interval

	Interval 100-75	**Interval 75-50**	**Interval 50-25**	**Interval 25-0**	**TOTAL**
Belgium		2,28	0,72		3
Denmark		2,03			2,03
Germany	13,96	5,61	6,42		25,99
Greece				1,26	1,26
Spain			3,33	3,41	6,74
France	4,91	1,68	8,39	2,22	17,2
Ireland			0,96		0,96
Italy			9,54	3,93	13,47
Luxembourg			0,22		0,22
Low Countries		2,99	1,68		4,67
Austria			1,75	0,81	2,56
Portugal				1,21	1,21
Finland	0,55	0,14	0,82	0,01	1,52
Sweden	0,78	0,45	1,5	0,24	2,97
United Kingdom		6,81	9,39		16,2
EU-15 % of DGP	20,2	21,99	44,72	13,09	100
%of regions	4,1	10,9	45	40	1,00

Source: own preparation

In Table 4.17 again by intervals, the percentage of GDP accounted for by regions located in them is shown. The conclusion to be drawn is the positive relationship between the development of innovation capabilities and European GDP. In this way, the countries accounting for more than 50% of the GDP of the Europe analysed here are Germany, France and the United Kingdom. The regions of these four countries which are located in the first section from 100 to 75% are four – the French one *Île de France (fr1)* and the German ones *Nordrhein-Westfalen (dea), Bayern (de2) and Baden Württemberg (de1)*-and these concentrate 18% of European GDP. If we add to these four regions the two remaining ones from the first interval-the Finnish *Uusimaa (fi16)* and the Swedish *Stockholm (se01*-the percentage of GDP rises to 20.2%. In the second interval, where sixteen regions are located, 21.99% is concentrated. Thus just 22 regions account for more than 40 of GDP ,and this coincides with those presenting a more developed regional innovation System quantified by the Index.

In Table 4.18 the weight of the regions in each country's GDP is shown. The conclusion that was previously drawn for Europe can now also be applied to the national field. In this way a higher percentage of the nation's GDP is concentrated in the regions with a more developed innovative capacity. Thus, the countries having regions situated in the first interval, as is the case of Germany, where there are three, concentrate 53.72% of the country's GDP. The percentages are also high in Finland, Sweden and France with a region in the same grouping. On the other hand, the least advanced regions concentrate a lower percentage of GDP[66] .

[66] In the case of Spain the qualification must be added that 14 of the country's 17 regions are located in the fourth interval. In Portugal and Greece the percentage is 100%, since all the regions are in this fourth interval.

Table 4.14.Percentage of GDP of each country by interval

	Interval 100-75	Interval 75-50	Interval 50-25	Interval 25-0	TOTAL
Belgium		76,08	23,92		100
Denmark		100			100
Germany	53,72	21,59	24,69		100
Greece				100	100
Spain			49,45	50,55	100
France	28,52	9,76	48,83	12,89	100
Ireland			100		100
Italy			70,83	29,17	100
Luxembourg			100		100
Low Countries		64,1	35,9		100
Austria			68,4	31,6	100
Portugal				100	100
Finland	36,22	9,25	53,89	0,64	100
Sweden	26,2	14,99	50,17	8,64	
United Kingdom		42,04	57,96		100

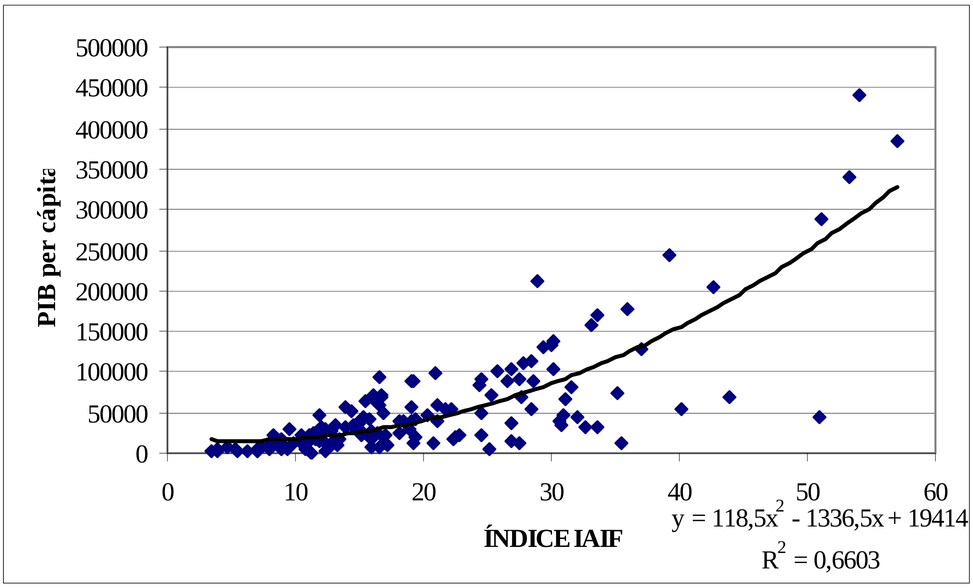
Source: own preparation

4.4.4. Relationship between innovative capacity and regions' economic performance

Finally, in concluding the analysis of the IAIF innovation Index for 2000 a calculation was made of the relationship existing between this indicator and two variables representing regions' economic performance: the GDP and the per capita GDP. For this purpose a regression analysis has been carried out, the results of which are recorded in Graphs 4.8 and 4.9[67] . In the first case it can be stated that 66% of the variation of the regional GDP may be explained by the regions' different innovative capacities, as reflected in Graph 4.8[68]. In the second analysis 54% of the GDP per capita variation will be explainable by the IAIF Index[69]. This suggests a positive relationship between the degree of development of the capacities of the regional innovation System and its economic development, which was already been seen in the previous analysis by intervals.

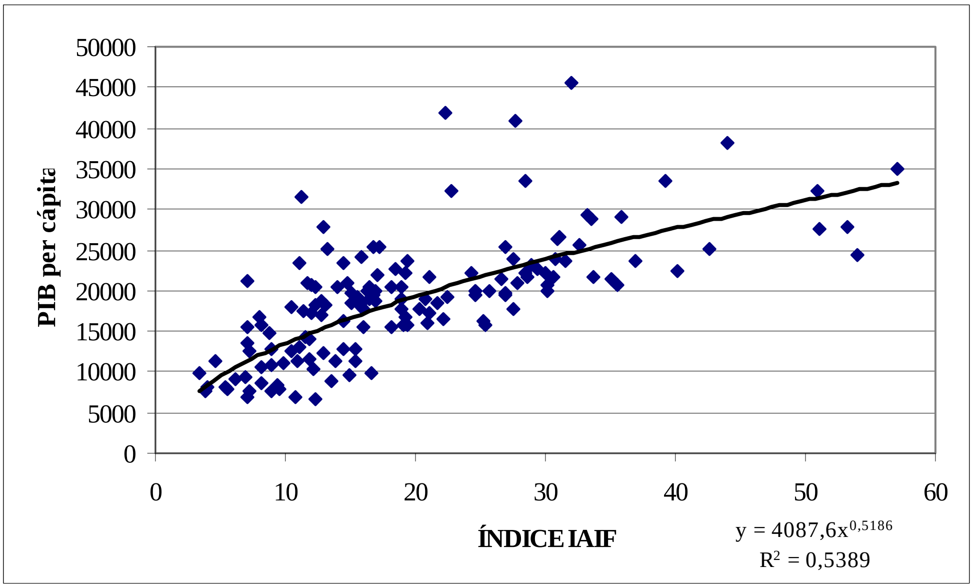
[67] This analysis is similar to the one presented by the European Commission (2002b and 2003b) with what is called the Synthetic Index of revealed regional innovation, with very similar results. See European Commission (2002b), p.20 and European Commission (2003b), p.10.
[68] In the graph the trend line which presented an adjustment in terms of R^2 that was higher than on this occasion has been *polynomial.* Other trend lines which have been calculated are the *linear,* with an R^2= 0.5769; *logarithmic* with an R^2= 0.4115; *polynomial* with an R^2 =0.6105; and e*xponential* with an R^2 = 0.5339.
[69] Just as before the trend line which presented an adjustment in terms of an R^2 higher than here is of a potential type. Other trend lines that have been calculated are the *linear* with an R^2 =0.4609, *logarithmic with an* R^2*= 0.489, polynomial* with an R^2 =0.4923, *exponential* with an R^2= 04559.

Graph 4.8. Relationship between the IAIF Index and GDP



Source: own preparation

Graph 4.9.Relationship between the IAIF Index and per capita GDP



Source: own preparation

Table 4.2. Results of the IAIF Index of Regional Innovation in Europe

	NUTS	REGION	1998	1999	2000	1998	1999	2000
1	fr1	Île de France	55,51	57,50	57,03	100%	100%	100%
2	dea	Nordrhein-Westfalen	52,29	53,67	54,08	94,19%	93,34%	94,82%
3	de2	Bayern	51,57	53,32	53,22	92,89%	92,74%	93,32%
4	de1	Baden-Württemberg	49,13	50,93	51,07	88,50%	88,58%	89,55%
5	fi16	Uusimaa (suuralue)	45,97	50,07	50,93	82,81%	87,08%	89,30%
6	se01	Stockholm	43,54	45,83	43,98	78,43%	79,71%	77,13%
7	ukj	South East	37,86	40,29	42,68	68,20%	70,08%	74,84%
8	nl41	Noord-Brabant	35,55	39,75	40,22	64,04%	69,14%	70,53%
9	uki	London	34,37	35,46	39,25	61,92%	61,68%	68,83%
10	ukh	Eastern	32,91	33,56	36,97	59,29%	58,37%	64,83%
11	de7	Hessen	34,22	35,95	35,92	61,65%	62,52%	62,98%
12	fi15	Pohjois-Suomi	36,60	35,46	35,47	65,93%	61,67%	62,20%
13	de3	Berlin	31,41	34,61	35,13	56,58%	60,19%	61,61%
14	de9	Niedersachsen	31,05	32,99	33,65	55,93%	57,38%	59,00%
15	nl31	Utrecht	30,78	34,13	33,56	55,45%	59,35%	58,85%
16	dk	Denmark	31,12	32,83	33,18	56,05%	57,10%	58,18%
17	se04	Sydsverige	24,74	30,41	32,58	44,57%	52,88%	57,13%
18	be1	Bruxelles-capitale	30,05	34,04	32,03	54,14%	59,21%	56,17%
19	nl33	Zuid-Holland	32,46	34,84	31,51	58,47%	60,59%	55,25%
20	nl32	Noord-Holland	28,68	31,15	31,09	51,67%	54,17%	54,52%
21	se0a	Västsverige	26,67	31,14	30,94	48,04%	54,16%	54,25%
22	se02	Östra Mellansverige	28,31	32,18	30,74	51,00%	55,98%	53,91%
23	fi17	Etelä-Suomi	26,71	29,82	30,64	48,12%	51,86%	53,74%
24	ukd	North West (including Merseyside)	26,29	26,84	30,20	47,37%	46,69%	52,96%
25	ukk	South West	26,02	27,25	30,14	46,88%	47,39%	52,86%
26	be2	Vlaams Gewest	29,05	31,62	30,04	52,34%	54,99%	52,67%
27	fr71	Rhône-Alpes	29,05	29,80	29,42	52,32%	51,84%	51,59%
28	it2	Lombardia	27,73	27,44	28,90	49,95%	47,72%	50,68%
29	deb	Rheinland-Pfalz	26,24	27,71	28,61	47,27%	48,20%	50,17%
30	at13	Vienna	25,99	28,32	28,49	46,81%	49,26%	49,95%
31	ukm	Scotland	24,34	25,31	28,40	43,84%	44,02%	49,79%
32	ukg	West Midlands	24,12	24,81	27,87	43,44%	43,15%	48,87%
33	de6	Hamburg	26,73	27,87	27,66	48,15%	48,48%	48,50%
34	es3	Comunidad de Madrid	23,40	26,71	27,58	42,16%	46,46%	48,36%
35	se08	Övre Norrland	22,04	28,48	27,56	39,70%	49,53%	48,32%
36	it6	Lazio	24,78	25,97	26,88	44,64%	45,16%	47,14%
37	nl11	Groningen	25,62	28,11	26,88	46,14%	48,89%	47,13%
38	nl22	Gelderland	26,17	28,29	26,86	47,14%	49,20%	47,09%
39	ukf	East Midlands	22,26	23,12	26,57	40,10%	40,20%	46,59%
40	uke	Yorkshire and The Humber	21,52	21,81	25,72	38,76%	37,93%	45,10%
41	ded	Sachsen	23,11	25,18	25,33	41,63%	43,79%	44,42%
42	nl23	Flevoland	25,00	25,72	25,22	45,03%	44,74%	44,22%
43	fr62	Midi-Pyrénées	23,71	25,39	24,58	42,72%	44,16%	43,10%
44	nl42	Limburg	23,57	24,77	24,57	42,45%	43,09%	43,09%
45	fr82	Provence-Alpes-Côte d'Azur	23,44	23,89	24,56	42,23%	41,55%	43,07%
46	ie	Ireland	19,96	21,45	24,36	35,96%	37,31%	42,71%
47	de5	Bremen	20,40	22,37	22,84	36,74%	38,90%	40,05%
48	nl21	Overijssel	21,22	22,87	22,52	38,22%	39,78%	39,48%
49	lu	Luxembourg	20,77	23,26	22,34	37,41%	40,45%	39,18%

	NUTS	REGION	1998	1999	2000	1998	1999	2000
50	**be3**	Région Wallone	20,76	23,60	22,22	37,40%	41,05%	38,96%
51	**ukl**	Wales	17,47	18,75	21,75	31,47%	32,61%	38,13%
52	**fr81**	Languedoc-Roussillon	19,05	20,90	21,06	34,31%	36,35%	36,94%
53	**def**	Schleswig-Holstein	19,42	21,17	21,04	34,98%	36,83%	36,90%
54	**es51**	Cataluña	18,65	20,47	20,96	33,60%	35,60%	36,75%
55	**fi14**	Väli-Suomi	19,85	20,17	20,82	35,76%	35,09%	36,50%
56	**ukc**	North East	16,89	17,34	20,28	30,43%	30,16%	35,55%
57	**se06**	Norra Mellansverige	18,50	19,50	19,35	33,33%	33,91%	33,93%
58	**de4**	Brandenburg	17,34	19,37	19,31	31,23%	33,69%	33,86%
59	**fi13**	Itä-Suomi	19,49	19,24	19,29	35,10%	33,46%	33,83%
60	**it4**	Emilia-Romagna	18,16	17,92	19,26	32,70%	31,16%	33,77%
61	**deg**	Thüringen	17,23	18,62	19,06	31,05%	32,39%	33,42%
62	**it11**	Piemonte	17,79	17,84	18,99	32,04%	31,03%	33,30%
63	**fr52**	Bretagne	18,28	18,72	18,99	32,92%	32,56%	33,29%
64	**ukn**	Northern Ireland	14,52	15,35	18,97	26,15%	26,71%	33,27%
65	**fr42**	Alsace	18,56	18,68	18,51	33,44%	32,48%	32,46%
66	**dee**	Sachsen-Anhalt	16,36	17,72	18,14	29,48%	30,83%	31,82%
67	**at22**	Steiermark	16,70	17,74	18,09	30,09%	30,85%	31,72%
68	**se07**	Mellersta Norrland	19,07	17,99	17,17	34,35%	31,29%	30,10%
69	**dec**	Saarland	15,35	16,83	17,02	27,64%	29,26%	29,84%
70	**nl12**	Friesland	16,12	16,82	16,98	29,03%	29,26%	29,78%
71	**fr24**	Centre	16,48	16,74	16,95	29,69%	29,11%	29,71%
72	**se09**	Småland med öarna	13,24	16,82	16,84	23,85%	29,25%	29,53%
73	**it51**	Toscana	15,18	15,45	16,75	27,35%	26,87%	29,37%
74	**es61**	Andalucía	14,70	16,50	16,68	26,49%	28,70%	29,25%
75	**fr61**	Aquitaine	16,31	16,51	16,56	29,37%	28,72%	29,04%
76	**nl34**	Zeeland	15,76	16,89	16,53	28,39%	29,37%	28,98%
77	**it32**	Veneto	15,21	15,06	16,49	27,40%	26,20%	28,91%
78	**fr72**	Auvergne	15,77	16,30	16,40	28,41%	28,36%	28,75%
79	**fr51**	Pays de la Loire	15,40	15,91	16,30	27,74%	27,67%	28,58%
80	**fr3**	Nord - Pás-de-Calais	15,26	15,40	16,02	27,49%	26,78%	28,10%
81	**de8**	Mecklenburg-Vorpommern	14,04	15,63	15,94	25,29%	27,18%	27,95%
82	**at33**	Tirol	14,49	15,53	15,92	26,11%	27,01%	27,92%
83	**nl13**	Drenthe	15,52	16,54	15,90	27,95%	28,77%	27,89%
84	**fr41**	Lorraine	15,64	15,56	15,79	28,18%	27,06%	27,68%
85	**fr43**	Franche-Comté	15,55	15,26	15,60	28,01%	26,55%	27,36%
86	**it8**	Campania	13,96	14,21	15,45	25,15%	24,72%	27,09%
87	**pt13**	Lisboa e Vale do Tejo	13,55	14,50	15,38	24,40%	25,22%	26,97%
88	**it33**	Friuli-Venezia Giulia	13,14	13,31	15,10	23,66%	23,14%	26,48%
89	**it13**	Liguria	13,50	13,49	15,04	24,33%	23,46%	26,37%
90	**gr3**	Attiki	11,68	14,02	14,98	21,03%	24,39%	26,26%
91	**fr23**	Haute-Normandie	14,60	14,47	14,78	26,29%	25,17%	25,92%
92	**at31**	Oberösterreich	14,10	14,18	14,53	25,41%	24,66%	25,49%
93	**es21**	País Vasco	13,35	13,97	14,47	24,05%	24,30%	25,37%
94	**es52**	Comunidad Valenciana	12,07	13,72	14,39	21,74%	23,86%	25,24%
95	**fr26**	Bourgogne	13,68	13,86	13,97	24,65%	24,11%	24,50%
96	**ita**	Sicilia	13,02	12,96	13,91	23,46%	22,55%	24,40%
97	**gr12**	Kentriki Makedonia	9,27	12,23	13,51	16,70%	21,27%	23,69%
98	**at34**	Vorarlberg	13,99	13,01	13,25	25,20%	22,62%	23,24%
99	**fr22**	Picardie	13,55	13,12	13,14	24,40%	22,82%	23,05%
100	**at32**	Salzburg	11,36	12,32	12,95	20,46%	21,44%	22,70%
101	**es41**	Castilla y León	10,89	12,71	12,88	19,61%	22,10%	22,59%

	NUTS	REGION	1998	1999	2000	1998	1999	2000
102	**es22**	Navarra	10,45	12,41	12,83	18,83%	21,58%	22,51%
103	**fr25**	Basse-Normandie	12,08	12,37	12,74	21,76%	21,52%	22,35%
104	**fr53**	Poitou-Charentes	12,34	12,28	12,34	22,22%	21,36%	21,64%
105	**at21**	Kärnten	11,83	11,47	12,33	21,32%	19,94%	21,62%
106	**gr21**	Ipeiros	7,64	10,04	12,27	13,76%	17,46%	21,51%
107	**es11**	Galicia	10,03	11,79	12,20	18,06%	20,50%	21,39%
108	**at12**	Niederösterreich	11,48	11,54	12,07	20,68%	20,08%	21,17%
109	**it52**	Umbria	10,30	10,81	11,93	18,55%	18,80%	20,91%
110	**it91**	Puglia	10,49	10,40	11,91	18,89%	18,10%	20,88%
111	**es24**	Aragón	10,08	11,69	11,79	18,15%	20,33%	20,67%
112	**fr21**	Champagne-Ardenne	11,64	11,40	11,73	20,97%	19,82%	20,57%
113	**it71**	Abruzzo	10,21	10,40	11,51	18,40%	18,09%	20,19%
114	**it53**	Marche	9,64	9,99	11,38	17,36%	17,38%	19,96%
115	**fi2**	Åland	11,47	10,91	11,23	20,67%	18,97%	19,69%
116	**it31**	Trentino-Alto Adige	9,74	9,53	11,11	17,54%	16,58%	19,48%
117	**itb**	Sardegna	9,86	10,00	11,07	17,77%	17,39%	19,41%
118	**es12**	Principado de Asturias	8,35	9,92	10,98	15,05%	17,25%	19,26%
119	**gr23**	Dytiki Ellada	6,85	9,35	10,81	12,33%	16,26%	18,96%
120	**fr63**	Limousin	10,08	10,14	10,46	18,17%	17,64%	18,34%
121	**es7**	Canarias	9,26	10,25	10,41	16,69%	17,83%	18,26%
122	**es62**	Murcia	8,50	9,80	9,92	15,32%	17,04%	17,39%
123	**pt11**	Norte	8,62	8,79	9,57	15,52%	15,28%	16,78%
124	**gr43**	Kriti	7,30	8,42	9,35	13,15%	14,64%	16,40%
125	**pt12**	Centro	7,64	8,17	8,98	13,75%	14,22%	15,74%
126	**es42**	Castilla-la Mancha	7,37	8,25	8,94	13,27%	14,35%	15,67%
127	**es13**	Cantabria	8,58	8,86	8,90	15,45%	15,42%	15,60%
128	**es23**	La Rioja	6,97	8,37	8,83	12,55%	14,55%	15,49%
129	**es43**	Extremadura	6,73	7,73	8,23	12,12%	13,44%	14,43%
130	**it93**	Calabria	7,02	6,82	8,22	12,65%	11,87%	14,41%
131	**es53**	Islas Baleares	7,09	7,94	8,08	12,76%	13,81%	14,17%
132	**fr83**	Corse	7,44	7,63	8,04	13,40%	13,27%	14,11%
133	**it92**	Basilicata	6,29	6,26	7,28	11,32%	10,89%	12,76%
134	**pt14**	Alentejo	6,28	6,40	7,25	11,32%	11,14%	12,71%
135	**at11**	Burgenland	6,62	6,53	7,14	11,92%	11,35%	12,52%
136	**gr11**	Anatoliki Makedonia, Thraki	4,42	5,97	7,13	7,97%	10,39%	12,50%
137	**it72**	Molise	5,41	5,34	7,11	9,75%	9,29%	12,46%
138	**it12**	Valle d'Aosta	5,62	5,27	7,06	10,13%	9,17%	12,38%
139	**pt15**	Algarve	5,66	5,84	6,98	10,20%	10,16%	12,24%
140	**gr13**	Dytiki Makedonia	4,43	4,34	6,22	7,98%	7,55%	10,91%
141	**gr41**	Voreio Aigaio	5,04	4,40	5,51	9,08%	7,65%	9,66%
142	**gr14**	Thessalia	2,94	3,98	5,33	5,29%	6,92%	9,34%
143	**gr24**	Sterea Ellada	3,12	3,56	4,69	5,62%	6,19%	8,23%
144	**gr25**	Peloponnisos	2,27	2,50	3,98	4,09%	4,34%	6,98%
145	**gr22**	Ionia Nisia	2,13	2,68	3,89	3,84%	4,66%	6,82%
146	**gr42**	Notio Aigaio	2,20	2,45	3,41	3,97%	4,26%	5,97%

Source: own preparation

Table 4.3. Results of the IAIF Index for Regional Innovation in Europe arranged by countries

	NUTS	REGION	1998	1999	2000	1998	1999	2000
		BELGIUM						
18	**be1**	Bruxelles-capitale	30,05	34,04	32,03	54,14%	59,21%	56,17%
26	**be2**	Vlaams Gewest	29,05	31,62	30,04	52,34%	54,99%	52,67%
50	**be3**	Région Wallone	20,76	23,6	22,22	37,40%	41,05%	38,96%
		DENMARK						
16	**dk**	Denmark	31,12	32,83	33,18	56,05%	57,1%0	58,18%
		GERMANY						
4	**de1**	Baden-Württemberg	49,13	50,93	51,07	88,50%	88,58%	89,55%
3	**de2**	Bayern	51,57	53,32	53,22	92,89%	92,74%	93,32%
13	**de3**	Berlin	31,41	34,61	35,13	56,58%	60,19%	61,61%
58	**de4**	Brandenburg	17,34	19,37	19,31	31,23%	33,69%	33,86%
47	**de5**	Bremen	20,4	22,37	22,84	36,74%	38,90%	40,05%
33	**de6**	Hamburg	26,73	27,87	27,66	48,15%	48,48%	48,50%
11	**de7**	Hessen	34,22	35,95	35,92	61,65%	62,52%	62,98%
81	**de8**	Mecklenburg-Vorpommern	14,04	15,63	15,94	25,29%	27,18%	27,95%
14	**de9**	Niedersachsen	31,05	32,99	33,65	55,93%	57,38%	59,00%
2	**dea**	Nordrhein-Westfalen	52,29	53,67	54,08	94,19%	93,34%	94,82%
29	**deb**	Rheinland-Pfalz	26,24	27,71	28,61	47,27%	48,20%	50,17%
69	**dec**	Saarland	15,35	16,83	17,02	27,64%	29,26%	29,84%
41	**ded**	Sachsen	23,11	25,18	25,33	41,63%	43,79%	44,42%
66	**dee**	Sachsen-Anhalt	16,36	17,72	18,14	29,48%	30,83%	31,82%
53	**def**	Schleswig-Holstein	19,42	21,17	21,04	34,98%	36,83%	36,90%
61	**deg**	Thüringen	17,23	18,62	19,06	31,05%	32,39%	33,42%
		GREECE						
136	**gr11**	Anatoliki Makedonia, Thraki	4,42	5,97	7,13	7,97%	10,39%	12,50%
97	**gr12**	Kentriki Makedonia	9,27	12,23	13,51	16,70%	21,27%	23,69%
140	**gr13**	Dytiki Makedonia	4,43	4,34	6,22	7,98%	7,55%	10,91%
142	**gr14**	Thessalia	2,94	3,98	5,33	5,29%	6,92%	9,34%
106	**gr21**	Ipeiros	7,64	10,04	12,27	13,76%	17,46%	21,51%
145	**gr22**	Ionia Nisia	2,13	2,68	3,89	3,84%	4,66%	6,82%
119	**gr23**	Dytiki Ellada	6,85	9,35	10,81	12,33%	16,26%	18,96%
143	**gr24**	Sterea Ellada	3,12	3,56	4,69	5,62%	6,19%	8,23%
144	**gr25**	Peloponnisos	2,27	2,5	3,98	4,09%	4,34%	6,98%
90	**gr3**	Attiki	11,68	14,02	14,98	21,03%	24,39%	26,26%
141	**gr41**	Voreio Aigaio	5,04	4,4	5,51	9,08%	7,65%	9,66%
146	**gr42**	Notio Aigaio	2,2	2,45	3,41	3,97%	4,26%	5,97%
124	**gr43**	Kriti	7,3	8,42	9,35	13,15%	14,64%	16,40%
		SPAIN						
107	**es11**	Galicia	10,03	11,79	12,2	18,06%	20,50%	21,39%
118	**es12**	Principado de Asturias	8,35	9,92	10,98	15,05%	17,25%	19,26%
127	**es13**	Cantabria	8,58	8,86	8,9	15,45%	15,42%	15,60%
93	**es21**	País Vasco	13,35	13,97	14,47	24,05%	24,30%	25,37%
102	**es22**	Navarra	10,45	12,41	12,83	18,83%	21,58%	22,51%
128	**es23**	La Rioja	6,97	8,37	8,83	12,55%	14,55%	15,49%
111	**es24**	Aragón	10,08	11,69	11,79	18,15%	20,33%	20,67%
34	**es3**	Comunidad de Madrid	23,4	26,71	27,58	42,16%	46,46%	48,36%
101	**es41**	Castilla y León	10,89	12,71	12,88	19,61%	22,10%	22,59%
126	**es42**	Castilla-la Mancha	7,37	8,25	8,94	13,27%	14,35%	15,67%

	NUTS	REGION	1998	1999	2000	1998	1999	2000
129	**es43**	Extremadura	6,73	7,73	8,23	12,12%	13,44%	14,43%
54	**es51**	Cataluña	18,65	20,47	20,96	33,60%	35,60%	36,75%
94	**es52**	Comunidad Valenciana	12,07	13,72	14,39	21,74%	23,86%	25,24%
131	**es53**	Islas Baleares	7,09	7,94	8,08	12,76%	13,81%	14,17%
74	**es61**	Andalucía	14,7	16,5	16,68	26,49%	28,70%	29,25%
122	**es62**	Murcia	8,5	9,8	9,92	15,32%	17,04%	17,39%
121	**es7**	Canarias	9,26	10,25	10,41	16,69%	17,83%	18,26%
		FRANCE						
1	**fr1**	Île de France	55,51	57,5	57,03	100%	100%	100%
112	**fr21**	Champagne-Ardenne	11,64	11,4	11,73	20,97%	19,82%	20,57%
99	**fr22**	Picardie	13,55	13,12	13,14	24,40%	22,82%	23,05%
91	**fr23**	Haute-Normandie	14,6	14,47	14,78	26,29%	25,17%	25,92%
71	**fr24**	Centre	16,48	16,74	16,95	29,69%	29,11%	29,71%
103	**fr25**	Basse-Normandie	12,08	12,37	12,74	21,76%	21,52%	22,35%
95	**fr26**	Bourgogne	13,68	13,86	13,97	24,65%	24,11%	24,50%
80	**fr3**	Nord - Pás-de-Calais	15,26	15,4	16,02	27,49%	26,78%	28,10%
84	**fr41**	Lorraine	15,64	15,56	15,79	28,18%	27,06%	27,68%
65	**fr42**	Alsace	18,56	18,68	18,51	33,44%	32,48%	32,46%
85	**fr43**	Franche-Comté	15,55	15,26	15,6	28,01%	26,55%	27,36%
79	**fr51**	Pays de la Loire	15,4	15,91	16,3	27,74%	27,67%	28,58%
63	**fr52**	Bretagne	18,28	18,72	18,99	32,92%	32,56%	33,29%
104	**fr53**	Poitou-Charentes	12,34	12,28	12,34	22,22%	21,36%	21,64%
75	**fr61**	Aquitaine	16,31	16,51	16,56	29,37%	28,72%	29,04%
43	**fr62**	Midi-Pyrénées	23,71	25,39	24,58	42,72%	44,16%	43,10%
120	**fr63**	Limousin	10,08	10,14	10,46	18,17%	17,64%	18,34%
27	**fr71**	Rhône-Alpes	29,05	29,8	29,42	52,32%	51,84%	51,59%
78	**fr72**	Auvergne	15,77	16,3	16,4	28,41%	28,36%	28,75%
52	**fr81**	Languedoc-Roussillon	19,05	20,9	21,06	34,31%	36,35%	36,94%
45	**fr82**	Provence-Alpes-Côte d'Azur	23,44	23,89	24,56	42,23%	41,55%	43,07%
132	**fr83**	Corse	7,44	7,63	8,04	13,40%	13,27%	14,11%
		IRELAND						
46	**ie**	Ireland	19,96	21,45	24,36	35,96%	37,31%	42,71%
		ITALY						
62	**it11**	Piemonte	17,79	17,84	18,99	32,04%	31,03%	33,30%
138	**it12**	Valle d'Aosta	5,62	5,27	7,06	10,13%	9,17%	12,38%
89	**it13**	Liguria	13,5	13,49	15,04	24,33%	23,46%	26,37%
28	**it2**	Lombardia	27,73	27,44	28,9	49,95%	47,72%	50,68%
116	**it31**	Trentino-Alto Adige	9,74	9,53	11,11	17,54%	16,58%	19,48%
77	**it32**	Veneto	15,21	15,06	16,49	27,40%	26,20%	28,91%
88	**it33**	Friuli-Venezia Giulia	13,14	13,31	15,1	23,66%	23,14%	26,48%
60	**it4**	Emilia-Romagna	18,16	17,92	19,26	32,70%	31,16%	33,77%
73	**it51**	Toscana	15,18	15,45	16,75	27,35%	26,87%	29,37%
109	**it52**	Umbria	10,3	10,81	11,93	18,55%	18,80%	20,91%
114	**it53**	Marche	9,64	9,99	11,38	17,36%	17,38%	19,96%
36	**it6**	Lazio	24,78	25,97	26,88	44,64%	45,16%	47,14%
113	**it71**	Abruzzo	10,21	10,4	11,51	18,40%	18,09%	20,19%
137	**it72**	Molise	5,41	5,34	7,11	9,75%	9,29%	12,46%
86	**it8**	Campania	13,96	14,21	15,45	25,15%	24,72%	27,09%
110	**it91**	Puglia	10,49	10,4	11,91	18,89%	18,10%	20,88%
133	**it92**	Basilicata	6,29	6,26	7,28	11,32%	10,89%	12,76%
130	**it93**	Calabria	7,02	6,82	8,22	12,65%	11,87%	14,41%

	NUTS	REGION	1998	1999	2000	1998	1999	2000
96	**ita**	Sicilia	13,02	12,96	13,91	23,46%	22,55%	24,40%
117	**itb**	Sardegna	9,86	10	11,07	17,77%	17,39%	19,41%
		LUXEMBOURG						
49	**lu**	Luxembourg	20,77	23,26	22,34	37,41%	40,45%	39,18%
		LOW COUNTRIES						
37	**nl11**	Groningen	25,62	28,11	26,88	46,14%	48,89%	47,13%
70	**nl12**	Friesland	16,12	16,82	16,98	29,03%	29,26%	29,78%
83	**nl13**	Drenthe	15,52	16,54	15,9	27,95%	28,77%	27,89%
48	**nl21**	Overijssel	21,22	22,87	22,52	38,22%	39,78%	39,48%
38	**nl22**	Gelderland	26,17	28,29	26,86	47,14%	49,20%	47,09%
42	**nl23**	Flevoland	25	25,72	25,22	45,03%	44,74%	44,22%
15	**nl31**	Utrecht	30,78	34,13	33,56	55,45%	59,35%	58,85%
20	**nl32**	Noord-Holland	28,68	31,15	31,09	51,67%	54,17%	54,52%
19	**nl33**	Zuid-Holland	32,46	34,84	31,51	58,47%	60,59%	55,25%
76	**nl34**	Zeeland	15,76	16,89	16,53	28,39%	29,37%	28,98%
8	**nl41**	Noord-Brabant	35,55	39,75	40,22	64,04%	69,14%	70,53%
44	**nl42**	Limburg	23,57	24,77	24,57	42,45%	43,09%	43,09%
		AUSTRIA						
135	**at11**	Burgenland	6,62	6,53	7,14	11,92%	11,35%	12,52%
108	**at12**	Niederösterreich	11,48	11,54	12,07	20,68%	20,08%	21,17%
30	**at13**	Vienna	25,99	28,32	28,49	46,81%	49,26%	49,95%
105	**at21**	Kärnten	11,83	11,47	12,33	21,32%	19,94%	21,62%
67	**at22**	Steiermark	16,7	17,74	18,09	30,09%	30,85%	31,72%
92	**at31**	Oberösterreich	14,1	14,18	14,53	25,41%	24,66%	25,49%
100	**at32**	Salzburg	11,36	12,32	12,95	20,46%	21,44%	22,70%
82	**at33**	Tirol	14,49	15,53	15,92	26,11%	27,01%	27,92%
98	**at34**	Vorarlberg	13,99	13,01	13,25	25,20%	22,62%	23,24%
		PORTUGAL						
123	**pt11**	Norte	8,62	8,79	9,57	15,52%	15,28%	16,78%
125	**pt12**	Centro	7,64	8,17	8,98	13,75%	14,22%	15,74%
87	**pt13**	Lisboa e Vale do Tejo	13,55	14,5	15,38	24,40%	25,22%	26,97%
134	**pt14**	Alentejo	6,28	6,4	7,25	11,32%	11,14%	12,71%
139	**pt15**	Algarve	5,66	5,84	6,98	10,20%	10,16%	12,24%
		FINLAND						
59	**fi13**	Itä-Suomi	19,49	19,24	19,29	35,10%	33,46%	33,83%
55	**fi14**	Väli-Suomi	19,85	20,17	20,82	35,76%	35,09%	36,50%
12	**fi15**	Pohjois-Suomi	36,6	35,46	35,47	65,93%	61,67%	62,20%
5	**fi16**	Uusimaa (suuralue)	45,97	50,07	50,93	82,81%	87,08%	89,30%
23	**fi17**	Etelä-Suomi	26,71	29,82	30,64	48,12%	51,86%	53,74%
115	**fi2**	Åland	11,47	10,91	11,23	20,67%	18,97%	19,69%
		SWEDEN						
6	**se01**	Stockholm	43,54	45,83	43,98	78,43%	79,71%	77,13%
22	**se02**	Östra Mellansverige	28,31	32,18	30,74	51,00%	55,98%	53,91%
17	**se04**	Sydsverige	24,74	30,41	32,58	44,57%	52,88%	57,13%
57	**se06**	Norra Mellansverige	18,5	19,5	19,35	33,33%	33,91%	33,93%
68	**se07**	Mellersta Norrland	19,07	17,99	17,17	34,35%	31,29%	30,10%
35	**se08**	Övre Norrland	22,04	28,48	27,56	39,70%	49,53%	48,32%
72	**se09**	Småland med öarna	13,24	16,82	16,84	23,85%	29,25%	29,53%
21	**se0a**	Västsverige	26,67	31,14	30,94	48,04%	54,16%	54,25%
		UNITED KINGDOM						
56	**ukc**	North East	16,89	17,34	20,28	30,43%	30,16%	35,55%

	NUTS	REGION	1998	1999	2000	1998	1999	2000
24	**ukd**	North West (including Merseyside)	26,29	26,84	30,2	47,37%	46,69%	52,96%
40	**uke**	Yorkshire and The Humber	21,52	21,81	25,72	38,76%	37,93%	45,10%
39	**ukf**	East Midlands	22,26	23,12	26,57	40,10%	40,20%	46,59%
32	**ukg**	West Midlands	24,12	24,81	27,87	43,44%	43,15%	48,87%
10	**ukh**	Eastern	32,91	33,56	36,97	59,29%	58,37%	64,83%
9	**uki**	London	34,37	35,46	39,25	61,92%	61,68%	68,83%
7	**ukj**	South East	37,86	40,29	42,68	68,20%	70,08%	74,84%
25	**ukk**	South West	26,02	27,25	30,14	46,88%	47,39%	52,86%
51	**ukl**	Wales	17,47	18,75	21,75	31,47%	32,61%	38,13%
31	**ukm**	Scotland	24,34	25,31	28,4	43,84%	44,02%	49,79%
64	**ukn**	Northern Ireland	14,52	15,35	18,97	26,15%	26,71%	33,27%

Source: own preparation

Table 4.5. Coefficients Matrix for calculating marks in the components

	1	2	3	4	5	6
Average annual population (thousands of inhabitants)	0,130	-0,030	0,019	-0,001	-0,019	-0,061
Number of people employed	0,127	-0,022	0,010	0,011	-0,017	-0,062
Gross Fixed Capital formation (millions € 1995)	0,117	-0,023	0,006	-0,006	-0,017	0,008
Human resources in Sc and T services (total)	0,119	-0,025	0,017	0,019	0,002	-0,034
Gross Domestic Product (millions € 1995)	0,119	-0,025	0,007	-0,020	-0,016	0,016
Gross Added Value (millions € base 1995)	0,118	-0,023	0,007	-0,029	-0,015	0,022
Wages (millions € 1995)	0,119	-0,023	0,007	-0,018	-0,005	-0,005
Human resources in Sc and T in knowledge-intensive services (total)	0,116	-0,026	0,017	0,031	-0,003	-0,032
Human resources in Sc and T in high technology (total)	0,108	0,016	-0,010	-0,025	-0,011	-0,031
Hi-tech patents per each million population	-0,032	0,248	-0,030	-0,015	0,005	-0,234
Hi-tech patents per each million working population	-0,032	0,248	-0,029	-0,019	0,002	-0,226
Patents per each million of population)	-0,012	0,184	-0,049	-0,025	-0,038	-0,035
Patents per each million working population	-0,011	0,176	-0,050	-0,035	-0,045	-0,007
Firms' expenditure on R&D (%of GDP)	-0,009	0,164	-0,019	-0,029	-0,033	-0,022
Staff in R&D in firms (number of people) % of employment	-0,024	0,132	-0,015	-0,027	0,001	0,065
Staff in R&D in (full time equivalent) % of employment.	-0,015	0,122	-0,011	-0,059	-0,004	0,103
PA expenditure on R&D (%of GDP)	-0,016	-0,043	-0,059	0,008	0,365	0,011
Staff in R&D in PAs (number of people) % of employment	-0,024	-0,017	-0,024	-0,026	0,364	-0,003
Staff in R&D in PAs (full time equivalent) % of employment	-0,017	-0,029	-0,025	-0,030	0,363	0,033
University expenditure on R&D (% of GDP)	0,013	-0,081	0,323	0,109	-0,055	0,021
Staff in R&D in the University (number of people) % of employment.	0,004	0,015	0,310	-0,034	-0,041	-0,093
Staff in R&D in the University (full time equivalent) % of employment	0,000	0,029	0,291	-0,029	-0,006	-0,107
Number of third cycle students (‰ of population)	0,024	-0,119	0,300	0,025	-0,034	0,128
Seed and start up investment capital (% of GDP)	-0,028	-0,035	0,028	0,257	-0,007	0,057
Capital investment development (% of GDP)	0,004	-0,041	0,028	0,404	-0,012	-0,209
Penetration of TICs	-0,035	-0,017	0,028	0,249	-0,035	0,099
Economic Freedom Index	0,009	-0,038	-0,010	0,335	-0,006	-0,087
GDP per worker (€ per worker)	-0,025	-0,078	-0,002	-0,085	0,003	0,522
GDP per capita (€ per worker)	-0,024	-0,054	-0,020	-0,025	0,020	0,435

Method of extraction: Analysis of main components.
Rotation: Varimax

In this point, identification of the factors must be seen from a double viewpoint, on the one hand, within a theoretical setting of the innovation Systems and their innovatory capacity, the elements composing it are found to be highly related. In this manner, it must be remembered that when reference was made in Chapter 2 to the *Matrix of non-rotated components* (Table 3.4) and the *Matrix of rotated components* (Table 3.5) it was pointed out that only correlations higher than 0.50 were included so that they could be interpreted better. Nonetheless, this does not mean that a variable in question is not correlated with the other factors. Secondly, given that the aim we pursued is to find a measurement able to quantify in a single value the regions' innovative capacity, when the index is calculated the variables will be included in a single factor-shaded in blue-according to its greater degree of saturation in it. Also, the factors will determine the partial indices, the weighting of which in the final indicator will be determined by the degree of variance recorded by each one in the model.

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