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Serempathy: A New Approach To Innovation. An Application To Forty-Six Regions Of Atlantic Arc Countries[1]

Author: **Pablo COTO-MILLÁN**, **Miguel Ángel PESQUERA**, **Pedro CASARES-HONTAÑÓN**, **Pablo DE CASTRO** - University of Cantabria, Spain cotop@unican.es, pesquerm@unican.es, casaresp@unican.es, castropm@unican.es

This research provides a new theoretical approach to innovation called Serempathy: Serendipity (which is achieved by chance) + Empathy (putting your self in the other). Serempathy relies on collaborative relationships between: University, private companies and public administration. In this theoretical approach adds chance to scientific discovery and an environment of empathy. Ideas aren't self-contained things; they're more like ecosystems and networks.

The work also provides data processed in recent years (2004-2006) for forty six Atlantic Arc Regions (the forty regions of countries: United Kindong, France, Portugal and Spain), overall and in different clusters, providing relevant empirical evidence on the relationship between Human Capital, Technological Platform, Innovation, Serempathy and Output. In the econometric and statistical modeling is considered especially for forty regions of the Atlantic Arc.

Keywords: *Serempathy, development, Atlantic Arc, regions*

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Introduction

This research studies the role of Human Capital, Technological Capital and Relational Capital among the generation of innovation, production and its economics effects in terms of sales and employment for each region. This is done through a general economic model composed of a basic equation that has as *exogenous variables* the Human Capital, Technological Capital and Relational Capital in order to explain the innovation *as endogenous variable*.

The operation of the innovation generation process consist in that aside from the right combination of Human Capital and Technological Capital, there are other relational, cultural and institutional regional factors, this is what we will call Relational Capital, which affects to the understanding and support of Human and Technological Capital and generates in combination with them, innovation and acts at the same time generating economic effects over the output in terms of units, over the sales and the generation of employment.

The estimation of the model adopted is done by using econometric techniques from the available data concerning the variables involved regarding the forty-eight regions of the Atlantic Arc belonging to the following countries: United Kingdom, Ireland, France, Spain and Portugal.
It also compares the estimations of the model for various definitions of Human, Technological and Relational Capital, in order to analyze its impact on innovation.

Finally factors affecting the production of Human, Technological and Relational Capital of the generation of innovation between the European countries are analyzed in detail and conclusions are extracted from the obtained results.

Literature Review

The role of Human and Technological Capital in the economic growth has been a topic of growing interest and debate between economics, geographers and other social researchers. Some of the most significant researches on these issues are listed below.

At the beginning of economic theory it was thought that the natural wealth of a region or country was the main determinant factor of growth. Subsequently, the natural resources were replaced by all kind of infrastructures, mainly of transport, made by man. With the industrial revolution and the subsequent theories of Solow (1956, 1957) technological progress becomes key explanatory factor. Nowadays, after the main contributions of Lucas (1988), we tend to think that the main factor of growth is the Human Capital, understood in a fairly broad sense. By these we mean that when talking about Human Capital we should not think exclusively in education, experience and skills of workers: we tend to consider the innovative capacity and human values. Even in the line of New Institutional Economics we can think of the quality of the institutions as a cause of the economic growth. Basically these are the factors of modern growth theory, especially that which has been developing since the mid-eighties until today.

For a long time, Technology and Human Capital have been considered as the driving forces of economic growth. In this regard, Solow´s (1970) work stands out which highlights the relevance of the effect of technological change on the economic growth.

Jacobs (1961, 1969) studies were focused on the transference of knowledge in cities. In his reasoning, cities play a crucial role in the economic development through the interaction between people and the generation of new products and new technology.

Later, Romer (1986, 1987 and 1990) establishes the connection between knowledge, human capital and economic growth through his endogenous economic growth model, arguing that investments in Human Capital create externalities and increasing returns.

The seminal endogenous regional model of Lucas (1988) shows that cities act transferring knowledge and generating powerful human externalities that increase productivity and boost the economic growth.

Also, the connection between Human Capital and regional growth is supported by a large body of empirical evidences contrasted at national and regional levels. In the same thread of thought, recent researches (Barro (1991); Glaeser et al (1995); Glaeser (1998; 1999; 2000a y 2000b); Simon (1998), Glaeser et al (2001); Rauch (1993); Young (1998); Eaton and Eckstein (1997); Black and Henderson (1998); Glendon (1998); and Shapiro (2006))

have empirically contrasted Lucas speculation, stressing the role of human capital and economic growth.

Berry and Glaeser´s (2005) work highlight the growing gap over the past decades in levels of human capital between regions among U.S.A.
Finally, Florida (2002a, b, c; 2005a and b; and 2006) has advocated the need to better understand the factors that generate innovation and creates a new concept of Creative Capital which is what enables territories to attract talent. He concludes that the Creative Capital operates more as a dynamic flow or a static stock.

This research argues that what are really relevant are the collaborative relationships that exist between universities, private companies and public administration. The university provides a grounding of Human Capital, scientifically trained, that adequately related to private enterprise can generate open innovation. However, it is still necessary the relationship between private companies and public administration to implement the discovery and become a reality. The link and liaison between the Human Capital and Technological is the Relational Capital, and that link is collaborative and appropriate when done with creativity.

The Data

The European Commission in order to track innovation in European regions has made a recent report (2009) which includes lots of indicators for the years 2004 and 2006 made with the same definitions and methodology. There is an earlier work from 2003 with different definitions that does not allow its expansion to the 2004 and 2006 years. It has been taken the arithmetic mean of each variable for both 2004 and 2006. In total, the battery of indicators is fifteen for a total of forty-eight regions belonging to the following Atlantic Arc countries: UK, Ireland, France, Spain and Portugal. This paper contains a comparison of the battery of the fifteen indicators for the forty-eight Atlantic Arc regions.

Human Capital

As mentioned above, to obtain an index of Human Capital of the forty eight regions of the Atlantic Arc, the following two indicators are

combined: Tertiary Education and Life-long learning. From the arithmetic mean of the values of these indicators for the years 2004 and 2006 the Human Capital index has been developed.

Table 1. Human Capital Indexes for the regions of the Atlantic Arc

Region	Country	Human Capital Index	Tertiary education 2004-2006	Life-long learning 2004-2006
Galicia	es11	4.49	4.24	4.75
Principado de Asturias	es12	4.24	4.12	4.36
Cantabria	es13	3.95	3.72	4.17
Pais Vasco	es21	6.39	6.13	6.64
Comunidad Foral de Navarra	es22	5.05	4.86	5.24
La Rioja	es23	3.5	3.58	3.41
Aragón	es24	4.55	4.37	4.72
Comunidad de Madrid	es3	4.98	4.99	4.98
Castilla y León	es41	4.82	4.73	4.92
Castilla-la Mancha	es42	3.52	3.29	3.74
Extremadura	es43	3.31	3.14	3.49
Cataluña	es51	3.94	3.89	3.99
Comunidad Valenciana	es52	4.48	4.39	4.57
Illes Balears	es53	3.51	3.16	3.87

Andalucia	es61	3.87	3.8	3.95
Región de Murcia	es62	4.06	4.04	4.09
Canarias (ES)	es7	4.24	4.19	4.28
Île de France	fr1	6.02	5.83	6.2
Bassin Parisien	fr2	3.67	3.59	3.76
Nord - Pas-de-Calais	fr3	4.09	3.96	4.22
Est	fr4	4.13	3.99	4.27
Ouest	fr5	4.24	4.11	4.37
Sud-Ouest	fr6	4.42	4.23	4.61
Centre-Est	fr7	4.42	4.34	4.5
Méditerranée	fr8	4.21	4.21	4.2
Norte	pt11	1.83	1.75	1.9
Algarve	pt15	2.34	2.37	2.32
Centro (PT)	pt16	1.99	1.94	2.04
Lisboa	pt17	3.38	3.34	3.43
Alentejo	pt18	1.41	1.4	1.43
North East (England)	ukc	6.38	6.25	6.51
North West (England)	ukd	6.46	6.39	6.52

Yorkshire and The Humber	uke	6.45	6.45	6.46
East Midlands (England)	ukf	6.52	6.45	6.6
West Midlands (England)	ukg	6.43	6.33	6.53
Eastern	ukh	6.48	6.43	6.52
London	uki	8.37	8.07	8.66
South East	ukj	7.23	7.19	7.28
South West (England)	ukk	6.82	6.65	6.99
Wales	ukl	6.64	6.67	6.6
Scotland	ukm	7.45	7.36	7.53
Northern Ireland	ukn	6.08	6.06	6.09

Source: Regional Innovation Scoreboard. 2009 (Data 2004-2006).

Table 1 shows the magnitudes for the different regions of the Atlantic Arc analyzed reach the synthetic index of Human Capital of the Atlantic Arc as well as the different simple indexes that compose it.

It is worth noting the following results:

1) Leader regions in relation with the global or synthetic index with the Human Capital are: London, South East, South West (England), Scotland, Île de France, País Vasco, Madrid, Northern Ireland y Navarra.
2) Middle regions with relation with the Human Capital index are: Galicia, Castilla León, Asturias, Cataluña, Cantabria, Canarias, Sud-Ouest, Centre-Est, Ouest y Mediterranée.

3) Regions with low level of Human Capital index are Bassin Parisien, Lisbon, Algarve, Alentejo, Norte y French Overseas Departments.

Technological Capital

The indexes used to obtain the synthetic index of the Technological Capital are the following two: Public R&D expenditures and Business R&D expenditures.

Table 2. Technological Capital Indexes for the Regions of the Atlantic Arc

Region	Country	Technological Capital Index	Public R&D Expenditures 2004	Business R&D Expenditures 2004
Galicia	es11	4.65	5	4.3
Principado de Asturias	es12	4.24	4.34	4.14
Cantabria	es13	3.53	3.71	3.35
Pais Vasco	es21	5.16	4.1	6.22
Comunidad Foral de Navarra	es22	5.77	5.39	6.14
La Rioja	es23	3.93	3.35	4.51
Aragón	es24	4.36	4.16	4.55
Comunidad de Madrid	es3	6.15	6.27	6.03
Castilla y León	es41	4.61	4.52	4.71
Castilla-la Mancha	es42	3.39	3.43	3.35
Extremadura	es43	4.19	5.15	3.22

Cataluña	es51	5.34	5.05	5.62
Comunidad Valenciana	es52	4.92	5.58	4.26
Illes Balears	es53	2.8	3.27	2.32
Andalucia	es61	4.59	5.35	3.83
Región de Murcia	es62	4.29	4.52	4.06
Canarias (ES)	es7	3.91	4.74	3.08
Île de France	fr1	7.39	7.18	7.6
Bassin Parisien	fr2	4.74	3.71	5.77
Nord - Pas-de-Calais	fr3	4.16	4.4	3.93
Est	fr4	5.49	5.3	5.68
Ouest	fr5	4.96	4.68	5.24
Sud-Ouest	fr6	6.95	6.85	7.05
Centre-Est	fr7	6.64	6.19	7.09
Méditerranée	fr8	6.38	6.93	5.83
Norte	pt11	4.23	4.63	3.83
Algarve	pt15	2.24	3.19	1.28
Centro (PT)	pt16	4.16	4.57	3.74
Lisboa	pt17	5.3	6.02	4.58

Alentejo	pt18	3.6	3.78	3.41
North East (England)	ukc	4.7	5.15	4.26
North West (England)	ukd	5.57	4.29	6.85
Yorkshire and The Humber	uke	4.74	5.15	4.33
East Midlands (England)	ukf	5.83	5.25	6.41
West Midlands (England)	ukg	5.62	5.85	5.39
Eastern	ukh	7.46	6.31	8.61
London	uki	5.05	6.27	3.83
South East	ukj	7.55	7.99	7.12
South West (England)	ukk	5.97	5.58	6.36
Wales	ukl	5.06	5.44	4.68
Scotland	ukm	5.58	6.19	4.98
Northern Ireland	ukn	4.45	4.29	4.61

Source: Regional Innovation Scoreboard. 2009 (Data 2004-2006).

Table 2 shows the magnitudes for the different European regions analyzed that reach both the synthetic index of the Technological Capital and the different indexes that compose them.

The main findings in relation to the Technological Capital are:

1) Some regions of the UK are the top positions in the ranking of technology, measured by the global technology indicator. These

regions are: South East, East Midlands (England), West Midlands (England) and North East (England).

2) Other fifteen regions are situated reasonably well in a medium level respect of the global technology indicator. These regions are: Madrid, Yorkshire and the Humber, Scotland, Wales, Northern Ireland, Ceuta, Asturias, Cantabria, Border, Midlands and Western, Pais Vasco, Aragón, Mediterranée, Algave and Alentejo.
3) Last positions of the ranking are occupied by: Bassin Parisien, Nord-Pas-de Calais, Ouest, Castre-Est, Navarra, La Rioja, Sud-Ouest, Centro (PT), Regions Autonomes des Azores and Madeira and French Overseas Departments.

Relational Capital

The relational capital synthetic index is compiled from the following two indicators: sum of all SMEs innovation in-house and the sum of innovative SMEs collaborating with others.

Table 3. Relational Capital Indexes for Regions of the Countries of Atlantic Arc

Region	Country	Relational Capital Indexes	SMES Innovating In-House 2004	Innovative SMES Collaborating With Others 2004
Galicia	es11	2.88	2.87	2.89
Principado de Asturias	es12	3.21	3.8	2.62
Cantabria	es13	3.43	4.14	2.71
Pais Vasco	es21	4.79	5.06	4.53
Comunidad Foral de Navarra	es22	4.81	5.1	4.53

La Rioja	es23	3.53	3.77	3.3
Aragón	es24	3.97	4.32	3.62
Comunidad de Madrid	es3	3.31	4.28	2.35
Castilla y León	es41	3.28	3.71	2.85
Castilla-la Mancha	es42	2.51	3.82	1.2
Extremadura	es43	2.37	2.34	2.4
Cataluña	es51	4.12	5.25	3
Comunidad Valenciana	es52	3.37	4.01	2.73
Illes Balears	es53	1.84	2.21	1.46
Andalucia	es61	2.52	3.58	1.47
Región de Murcia	es62	3.37	4.35	2.4
Canarias (ES)	es7	2.27	3.18	1.35
Île de France	fr1	2.41	0.79	4.03
Bassin Parisien	fr2	1.7	0.09	3.31
Nord - Pas-de-Calais	fr3	1.92	0.26	3.57
Est	fr4	2.79	0.64	4.93
Ouest	fr5	2.53	0.84	4.23
Sud-Ouest	fr6	3.02	0.88	5.16

Centre-Est	fr7	2.44	0.6	4.29
Méditerranée	fr8	2	0.5	3.51
Norte	pt11	4.11	5.36	2.85
Algarve	pt15	4.54	5.26	3.83
Centro (PT)	pt16	5.78	7.83	3.73
Lisboa	pt17	5.98	7.45	4.52
Alentejo	pt18	4.88	6.16	3.59
North East (England)	ukc	5.68	6.25	5.11
North West (England)	ukd	5.68	6.31	5.05
Yorkshire and The Humber	uke	5.79	6.33	5.26
East Midlands (England)	ukf	6.35	6.87	5.82
West Midlands (England)	ukg	5.62	6.1	5.13
Eastern	ukh	6.14	6.97	5.3
London	uki	5.06	5.38	4.74
South East	ukj	5.99	6.51	5.47
South West (England)	ukk	6.03	6.5	5.56
Wales	ukl	5.9	6.73	5.06

Scotland	ukm	5.31	5.82	4.79
Northern Ireland	ukn	4.56	5.3	3.81

Source: Regional Innovation Scoreboard. 2009 (Data 2004-2006).

The main results obtained in terms of Relational Capital for the regions studied are:

1) East Midlands (England); Eastern; Lisbon; South West (England), Wales, Centro (PT), Scotland, Northern Ireland, País Vasco and Navarra in the top positions.
2) Alentejo, Norte, Cantabria, Asturias, Rioja, Madrid, Ceuta, Cataluña and Murcia follow them closely with intermediate levels.
3) Est, Ouest, Sud-Ouest, Ile de France, Centre-Est, Mediterranée, French overseas departments, bassin Parisien, Nord-Pas-de-Calais and Melilla occupy the las places in Relational Capital.

The Model

Structure

Towards a better understanding of the questions raised, we created a general model of generation of innovation for the European countries, in order to isolate and analyze the independent effects of Human, Technology and Relational Capital with other variables of innovation and economic development.

A schematic representation of the general theoretical model of Serempathy and the regional development is shown in Figure 1. The arrows identify the hypothetical structure of relationships between key variables.

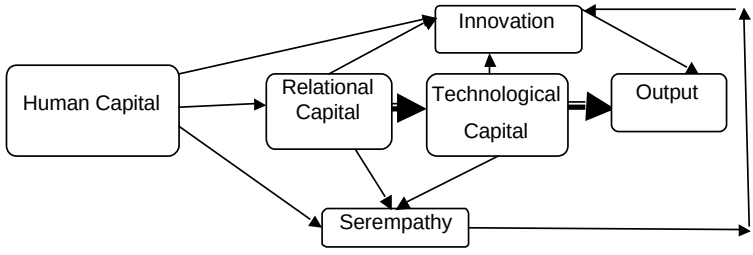

Fig. 1. Structure of the relationships between Human, Technological and Relational Capital with Serempathy, Innovation and Output

Next, we will proceed to estimate the contribution of Human Capital, Technological Capital and Relational Capital. We will use an aggregate production function which contains as a variable to explain the innovation or throughput and as explanatory variables three defined factors of production such as Human Capital, Technological Capital and Relational Capital. Such function will be of type:
From the cause and effects relations of the previous model we estimate a production function of innovation as follows:

$$I = f\left(y_1, y_2, y_3\right) = \gamma\ y_1^{\alpha_1} y_2^{\alpha_2} y_3^{\alpha_3};\ \left(\gamma > 0, \alpha_i > 0\right),$$

(1.1)

In the previous equation (1.1) innovation is represented by I, and it is explained by three production factors as the effect of Human Capital, represented by y_1 , the investment in Technological Capital represented by y_2, the investment in Relational Capital which we will call y_3. The expression (1.1) will take now logarithms and obtaining the following specification:

$$\text{Log}\ I_{i,t} = \gamma + \alpha_1\ \text{Log}\ y_{1,i,t} + \alpha_2\ \text{Log}\ y_{2,i,t} + \alpha_3\ \text{Log}\ y_{3,i,t} + \varepsilon_{i,t}$$

(1.2)

Where ε_1 represent the mistakes of the econometric estimation, while the rest of variables have been previously defined. Table 5 shows the results of the estimation of the equation (1.2).
The model helps to unravel which is the way of production for the approach of innovation.

The model adopted also enables the stimulation and analyze of the effects of relationships (Relational Capital) which are influenced by various institutional and regional cultural factors – for example, the university, the private companies and the empathy and support of the public

administration, on the geographic distribution of innovation and in turn, on the economic growth.

We have included the Innovation Index from Eurostat, this index is an indicator based on the number of patents registered and applied by the EPO (European Patent Office) per million of population with source Eurostat.

This research will use a set of econometric and statistical techniques, carrying out multivariate regressions of Human Capital, Technological Capital, Relational Capital and Innovation, in terms of number of patents in order to study the nature of the causal relations between the variables in the model of stages described above.

The Variables

Variables used in this model are the following:

- Dependent Variable: Innovation (Patents)

The dependent variable used in the model to approximate of innovation, index of the number of patents, also explained in the previous section.

Independent variables are the following:

- Indexes of Human Capital

It was considered in order to represent the talent, Human Capital 1 index, as a traditional or conventional indicator of the Human Capital, measured as the population with tertiary education aged between 25 and 64 years with source Eurostat, and the Human Capital 2 as an index from the participation for every 100 people in learning throughout life between 25 and 64 years with source Eurostat.

- Indexes of Technological Capital

It includes a technology variable to account the independent effects of the technology in the regional development. Besides studying the effect of each of the indicators used to obtain the Technological Capital index: share of GDP in public expenditure on R&D source Eurostat (Technological Capital 1), share of GDP in private expenditure on R&D source Eurostat (Technological Capital 2).

- Indexes of Relational Capital

Another set of explanatory variables correspond to the measures of Relational Capital, understood not only as reducing barriers for the entry of Human Capital, but the facilitation and collaborative support. Relational Capital among the regions and the concentration of these opening factors create an economic, social and cultural environment more open to innovation.

For this variable a synthetic index of Relational Capital was used from the following two indicators: Sum of SMEs with intern innovation activities, with cooperation between workers and managers (in-house) (Relational Capital 1) and Sum of SMEs with extern collaboration with other companies (Relational Capital 2) with source Eurostat.

Results

Next we will proceed to estimate the different equations proposed in the model. Some regions were excluded because there were no data available of some variables as seen in previous section.

Estimation of the model
The results of the estimation of the equations (1.2) from the model adopted, relating to the Innovation (Number of Patents), are shown in table 5.
From these results the following conclusions can be drawn:

A) In this case, as in the rest of the literature on innovation, the variable that best approximates innovation is the number of patents.

B) The ratio between the Human Capital and innovation is significant. Technology Capital has a direct effect on the innovation.

C) Relational Capital of the innovative collaborations between companies is also significantly related with the innovation.

D) Innovation is explained reasonably well by the three key variables – Human, Technological and Relational Capital.

Table 4. Estimations for the second equation of the model in logarithms.

	Equation (1.2.a)		Equation (1.2.b)	Equation (1.2.c)
Independent Variables	LnInnovation (Patents)		LnInnovation (Patents)	LnInnovation (Patents)
Intercept	-0.3856 (-2.9521)		-0.3311 (-2.5634)	-0.3463 (-2.7225)
LnHuman Capital(Ln y_1)	0.4387 (3.3746)		0.2449 (1.9361)	-
LnHuman Capital (Tertiary Studies)(Ln y_{11})	-		-	0.2027 (2.2990)
LnTechnological Capital(Ln y_2)	1.1589 (5.9310)		0.8662 (3.5927) -	0.2396 (3.4127)
LnRelationalCapital(Ln y_3)	-0.2952 (-2.2830)		-	-
LnRelationalCapital (Colaborations in innovation with enterprises) (Ln y_{31})			0.2539 (1.8913)	0,3504 (2,7813)
LnRelational Capital (Innovation in-house) (Ln y_{32})	-		-	-
Observations	N	38	38	38
Estatisticals	R^2	0.6671	0.6802	0.6927

Source: Authors. Some regions have been removed from the samples for instance Ceuta and Melilla, in Spain, the Azores Island and other autonomous islands, Algarve and Alentejo in Portugal, the islands of the French Protectorate and regions with extremely low innovation data in France, as well as data of Scotland and the two regions of Ireland.

Serempathy Indicator

From table 5 equation (1.2.a) the results obtained for the countries of the Atlantic Arc in relation to the so-called Serempathy Indicator of the regions of the countries studied are shown in table 6.

$$S_t = [\ 1 - (\hat{I}_t - I_t)$$

Where S_t is Serempathy in period t, $\hat{I}_t$ is estimated innovation in equation 1.2.a and period t , and I_t is real innovation in period t.

Table 6. Serempathy Indicator for the Regions of Countries of Atlantic Arc

Region	Country	Serempathy
Galicia	es11	0,9351
Principado de Asturias	es12	0,8900
Cantabria	es13	0,8413
País Vasco	es21	0,9413
Comunidad Foral de Navarra	es22	1,0576
La Rioja	es23	1,2153
Aragón	es24	0,9629
Comunidad de Madrid	es3	0,9263

Castilla y León	es41	0,9024
Castilla-la Mancha	es42	1,2123
Extremadura	es43	0,3702
Cataluña	es51	1,1520
Comunidad Valenciana	es52	1,0034
Illes Balears	es53	1,3121
Andalucía	es61	0,7418
Región de Murcia	es62	0,7923
Canarias (ES)	es7	0,8157
Île de France	fr1	1,1435
Bassin Parisien	fr2	1,4182
Nord - Pas-de-Calais	fr3	1,2199
Est	fr4	1,1539
Ouest	fr5	1,2001
Sud-Ouest	fr6	0,9346
Centre-Est	fr7	1,1934
Méditerranée	fr8	1,0566
Norte	pt11	0,9800
Centro (PT)	pt16	0,8523

Lisboa	pt17	0,8034
North East (ENGLAND)	ukc	1,0628
North West (ENGLAND)	ukd	0,9766
Yorkshire and The Humber	uke	1,0304
East Midlands (ENGLAND)	ukf	0,9608
West Midlands (ENGLAND)	ukg	0,9853
Eastern	ukh	1,0106
London	uki	1,4211
South East	ukj	0,9618
South West (ENGLAND)	ukk	0,9900
Wales	ukl	0,9316

SOURCE: Own elaboration form table 5 equation (1.2.a) 2009 (DATA MEASURED BETWEEN 2004-2006)

Based on the results obtained of this synthetic indicator of Serempathy of all the regions of the Atlantic Arc countries, the following conclusions can be drawn:

1) The Atlantic Arc regions, particularly the English seem to have a significant Serempathy indicator. Thus, South East, Eastern, London, East Midlands (England), North West (England). In France, Spain, and Portugal are the leading regions in Serempathy indicator Bassins Parissin, Ile de France, Nord-Pas de Calais, Rioja, Castilla La Mancha, Navarra, Cataluña, Valencia and Illes Ballears, Norte and Centro.

2) The rest of English regions together, and some of the regions of other countries, also get average scores. This is the case of Lisbon, Wales, Yorkshire and the Humber, País Vasco, Galicia, Asturias, Castilla-León, Aragón, Cantabria and Madrid.
3) The remaining regions are facing significant competitive challenges in aspects of Serempathy.

In particular, the lower Spanish regions in Serempathy are: Extremadura, Andalucía and Murcia.

Conclusions

This research proposes the existence of a new drive of innovation and with it not only of the sales based on the accumulation of knowledge but in the collaborative relations between universities, companies and public administration.
This research analyzes the causes of innovation which are empirically contrasted for the case in all the regions of the Atlantic Arc countries: UK, Ireland, France, Spain and Portugal.

The main conclusions of the modeling performed are as follows:

A. With our database of the Atlantic area regions we have found empirical evidences that the Human Capital, particularly the core that we call tertiary education equivalent to university degree level, best explains the innovation that other non-traditional measures of talent based in other university and non-university educational levels.
B. Human Capital has a direct effect over the Throughput (Number of patents). Human Capital operates as a crucial intermediate variable in the process of economic growth which connects the factors outside the market or related to technological innovation.
C. Technological Capital or the technological platform has in this case, as in the traditional literature, an important role in generating innovation.
D. It is surprising the high explanatory power of the new Relational Capital, defined here. It seems that collaborative relations between

universities, private companies and public administrations, this is, the Relational Capital, are significantly associated with the generation of Innovation. The analysis shows that the relational factors (outside the market) have positive and relevant role in the production of Technological Capital and Innovation. Collaborative relations are outside the market; however, they provide the greasing between the innovation as an idea and its practical implementation. Certain regional conditions of relational type seem to play a significant role and encourage the creation of an environment or habitat that cat link the Human Capital with the Technological Capital and generate innovation. The three factors of Human, Technological and Relational Capital do not operate in competition with each other, but they tend to act playing complementary roles in the process of generating innovation.

E. All these results lead us to affirm that innovation in Europe is the result of a cumulative process which involves a combination of factors of the type identified by Jacobs, Florida, Clark and Glaeser, with Human Capital externalities identified by Lucas, Romer and Glaeser, and the role of Technological Capital noted by Romer and Solow. However, there is something more, is what we call Relational Capital, not reflected so far in the economic literature, which is what in our opinion stimulates the impulse of the implementation of innovation.

In short, it can be concluded that innovation in European countries takes place through a process based in the following stages:
The first stage generates Human Capital formed in public and/or private institutions.

In the second stage, the concentrations of Human Capital and Technological Capital generate research, technological development and even technological innovation.

In the third stage, relational, institutional and non-market factors (Relational Capital), such as, collaborative relationships between universities, private companies and public administrations, positively affect the production of Human Capital and its relation with the Technological

Capital, so that there is here a real boost to the generation of technological innovation.

Finally, higher levels of technological innovation lead to higher levels of regional economic development.

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