How do European countries manage their knowledge? A cross analysis of investment and performance

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Abstract

This paper presents a cross analysis of European countries studying knowledge variables related to investment and performance. The findings of the factor analysis reflects the existence of four key factors (Push&Pull Effect; How what we are like; Education Domino Effect; and Knowledge Employment) which should be taken into account for managing governmental strategies within the European market. According to these factors, four countries' cluster have been identified focusing the case of the first cluster composed by Sweden, Finland, Denmark, Germany, Netherlands and Austria, which has been called "knowledge countries". This paper presents interesting findings about how European countries manage their knowledge and in consequence, how they establish their growth strategies.

Keywords knowledge management, Government, factor analysis, European clustering.

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1. Introduction and justification of the study

Globalization, technological advances and competitive advantages are key elements associated with the new knowledge economy and all these elements contribute to national productivity, competitive advantage and industrial performance (Martinus, 2010; Goldberg, 2006, Orlando and Verba, 2005). This approach has brought to the fore the knowledge component of labour productivity contributing to national productivity of the countries.

Several academicians, such as Lederman and Maloney (2003) or Guellec and Van Pottelsberghe (2001), hold that innovation or the generation of technical knowledge has positive effects the economic and productivity growth. In this sense, Lederman and Maloney (2003), using regressions with data panels of five-year averages between 1975 to 2000 from 53 countries, find that a one-percentage point increase in the ratio of total research expenditure to GDP increases the growth rate of GDP by 0.78 percentage points. Another interesting study by Guellec and Van Pottelsberghe (2001) holds that public and foreign R&D all have statistically significant positive effects on productivity growth.

The growth of a country in terms of knowledge has been analyzed from several points of view. For example, following Jones (2002), growth in any particular country is driven by the implementation of ideas discovered throughout the world. This stock of ideas is proportional a worldwide research effort, which in turn is proportional to the total population of innovation countries. Inputs such as human capital and ideas and outputs such as innovation or knowledge define the new knowledge production function. In this scenario, the key question of this paper is outlined: How do countries manage their knowledge? And in particular, how do European countries manage their knowledge? That is to say, this cross county study attempts to measure the investment variables and result variables related to the knowledge component.

The importance of knowledge management within enterprises is well known and accepted (Villela and Muniz, 2010) but in the case of countries, knowledge is not recognized yet as a key strategy for international competitiveness. In the last decade,

some research has suggested that knowledge management could improve administrative efficiency and provide more accurate information (Misra & Hariharan, 2003; Prokopiadou *et al.*, 2004; Saussois, 2003).

The aim of this paper is to try to identify, thanks to a factor analysis, the organizational success parameters which explain the importance of knowledge management in country management. In this way, this paper provides an exploratory study of the European states' knowledge in order to explain how their governmental strategies, based on, for example, expenditures on research and development, could be lead to a better growth position in the European ranking. The contribution of this paper is explained by two points: first, we apply knowledge management to countries' behaviour rather than merely applying it to enterprises and, secondly, we establish a comparison between European countries by taking into account how each one manages its knowledge.

This paper is structured as follows: in Section 2, we describe the methodology for analyzing the knowledge structure in the European countries (data, variables and research method). Section 3 presents the results of the study and preliminary considerations about the factors implied in the analysis. Our findings and discussion are presented in Section 4; and in the final section, the conclusion and future works are presented.

2. Theoretical Model

We want to study the behaviour of a country in terms of knowledge management. In this sense, we are going to define those investment and performance variables which could be related to knowledge. Using a factor analysis we will establish a relationship between the investment and performance of knowledge in a country trying to obtain information about governmental strategies. After that, once the factors which explain the relationship between investment and performance variables are identified, we will compare the European countries by making a clustering them (see Figure 1).

[Insert Figure 1]

3. Methodology

3.1 Data source

Data for this study were drawn from the Eurostat Database[1]. In this way, our paper includes all the European Union countries (see Table 1). 2005 is the only year in which there are fewer missing data, so we have selected it for our study in order to obtain more conclusions about all the countries[2].

[Insert Table 1]

3.2 Description of variables

The variables have been classified into the following categories: (1) country description, (2) investment and (3) performance (see Table 2). All of them are related directly or indirectly with knowledge within the countries. These variables have been selected according to past contributions about knowledge management where authors highlight some factors in this area (see Table 3).

3.3 Research Method

In this study, we apply the factor analysis technique described by Kim and Mueller (1994: p.1) as a *"variety of statistical techniques whose objective is to represent a set of variables in terms of a smaller number of underlying variables or factors".* In this sense, common factor analysis is used to *"identify underlying factors or dimensions reflecting what the variables share in common"* (Hair *et al.*, 1995, p.375). Our Factor analysis model is defined by following equations:

[Insert Table 2]

$$X_1 = l_{11}F_1 + l_{12}F_2 + \ldots\ldots\ldots + l_{1m}F_m + e_1$$
$$X_2 = l_{21}F_1 + l_{22}F_2 + \ldots\ldots\ldots + l_{2m}F_m + e_2$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$X_p = l_{p1}F_1 + l_{p2}F_2 + \ldots\ldots\ldots + l_{pm}F_m + e_p$$

[1] Eurostat is a database published by the European Commission and all the information used in this paper was accessed in June 2010 on the website: http://epp.eurostat.ec.europa.eu.

[2] In the case of missing data, we have used the trend of previous years. When the trend has not been, missing data has been replaced by the average of data from other years in the country.

where

F_1, F_2,…, F_m are common factors

e_1, e_2,…, e_p are specific factors

l_{jh} is the weight *h* factor in *j* variable. These types of coefficients are called factor loadings.

This technique helps researchers *"make sense of large bodies of interrelated data"* (Hair *et al.*, 1995, p. 404). In our case, we recollected European variables linked to knowledge. Consequently, we encountered a large body of interrelated data of which we have tried to make sense via a factor analysis, which was used in this study to identify the critical factors in the European countries to managing knowledge.

Principal component analysis (PCA) with Varimax rotation is used in the study. Hair *et al.* (1995) recommend rotation because it "*simplifies the factor structure and usually results in more meaningful factors"* (p.380).

[Insert Table 3]

4. Results and interpretation

4.1 Construct validity

In our study, the KMO (Kaiser Meyer Olkin Coefficient) measure of sampling adequacy reveals that the KMO is 0.735. Also, the P value of Bartlett's test is 0 (less than the explicit level of 0.05) (see Table 4) (Cronbach, 1970). These tests indicate that factor analysis is appropriate for these data.

[Insert Table 4]

4.2 Exploratory factor analysis

Using a rotated component matrix (see Table 5), we define four factors in the study, which explained more than 78 per cent of the data (see Table 6). Hair *et al.* (1995) argue that "it is not uncommon to consider a solution that accounts for 60% as satisfactory" (p. 378). In this way, our study is considered satisfactory. The four critical factors for managing the knowledge have been defined as: (1) *Push&Pull-Effect*; (2) *What we are like*; (3) *Education domino effect*; and (4) *Knowledge Employment* (see Table 7).

[Insert Table 5]

4.3 Factor 1: Push&Pull-Effect

The Push&Pull-Effect factor explains around 35 per cent of the variance and relates investment variables to performance variables. For example, some countries could develop a policy of investment which would allow them to obtain important results based on their knowledge structure. In the same way, other countries could develop their knowledge structure through investment in their businesses. Following the Economic Theory of Solow, (1957) and Romer (1986, 1990a), it is possible to demonstrate that technical progress is a major source of productivity growth and an effective innovation system. In this sense, an innovation system refers to the network of institutions, rules and procedures that exert influence by the way in which a country acquires, creates, disseminates and uses knowledge (Chen & Dahlman, 2004).

[Insert Table 6]

4.4 Factor 2: What we are like

This factor defines the essence of each country and represents around 15 per cent of the variance. That is to say, depending on the date of incorporation into the European Union, the GDP per capita and even depending on the percentage of enterprises using information technologies, the position of each country changes on the world map. Governmental strategy cannot modify this factor directly in order to obtain better results on the knowledge structure of each country, but when the strategy was designed should be taken into account.

4.5 Factor 3: Education domino effect

This factor is explained graphically in the Figure 2 and explains more than 14 per cent of the variance. The domino effect is perceived as the consequence of the investment in education which has an impact on the GDP (see Figure 2). Four variables define the

education domino effect: total public expenditure on education, percentage of employment in high- and medium-high-technology manufacturing sectors, number of enterprises that have access to internet and price index - percentage change on the previous period.

Figure 2 represents the interaction between the previous variables, explaining that the expenditure on education causes improvements in qualified employment and, in thus, companies demand better forms of client-interaction, qualified employees, making it possible for the economy of this country to grow as a part of investment plan on knowledge. In the case of basic education, it should be interesting to reflect its importance as a tool of increasing peoples' capacity to learn and to use information. On the other hand, technical secondary-level education, and higher education in engineering and scientific areas needs technological innovation. For example, the production of new knowledge is generally associated with higher-level of teaching and research (Chen & Dahlman, 2004). The study of Cohen and Soto (2001) finds positive effects of education on economic growth. Hanushek and Kimko (2000) take an alternative approach by focusing on the effects of educational quality on economic growth.

[Insert Figure 2]

4.6 Factor 4: Knowledge employment

This factor, which represents around 13 per cent of the variance, is actually crucial for those countries which design their international strategy based on a knowledge structure. This factor includes the presence of employment based on knowledge. As OECD countries hold, the role of knowledge workers and information workers becomes increasingly crucial (OECD, 2001).

Following Lopez-Bassols (2002), there is a positive association between productivity gains and use of knowledge workers. The new knowledge economy requires new skills related to knowledge employment. In this way, patent domain is an important issue within the knowledge process (Foley & Smeaton, 2010).

[Insert Table 7]

5. Findings and discussion

This paper identifies four crucial factors for the European countries interested in managing their knowledge efficiently: "Push&Pull-Effect", "What we are like", "Education domino effect" and "Knowledge Employment". At this point, we consider it interesting to identify similar behaviours regards knowledge management among the studied countries.

Firstly, a cross-factor analysis is proposed in order to obtain clusters of countries (see Figure 3). Attending to Factor 1 and Factor 2 explained 62,13 per cent of the data, the following findings are explained:

[See Figure 3]

(1) Moving on from the "Push&Pull" factor to the "What we are like" factor, four clusters of countries are identified. The first cluster of countries is composed up of Sweeden, Finland, Denmark, Germany, the Netherlands and Austria. We have defined this cluster as "Knowledge countries". These countries present a high influence of the "Push&Pull-Effect" with respect to the descriptive Factor 2 ("What we are like"). That is to say, the importance of investment and performance variables on knowledge provides these countries with a better strategic position than other countries' groups (see Figure 4). In addition, the first cluster represents those active countries interested in improving the strategic position by they are defined ("What we are like" factor).

[See Figure 4]

(2) Factor 2 is the first step necessary for competing in the international market. In this way, the second cluster is defined by Spain, Portugal, Ireland, Greece and Italy. These European countries are defined by the greater importance of Factor 2 against Factor 1: they do not improve their international strategy by investing in knowledge. The identification of this cluster is consistent with recent research that shows how the economies of these countries have common characteristics that define the new vulnerable economies (Bird, 2010).

(3) There is a cluster defined as “midway”. Cluster 3 is represented by France, Belgium and the United Kingdom and their growth is explained by the similar relation between Factor 1 and Factor 2. These countries adopt measures to improve their knowledge in the same way to make the most of their starting position (“What we are like” Factor) in the European Union.

(4) The final cluster is defined by Lithuania, Slovenia, Slovakia, Romania, Estonia, Hungary, Poland, Cyprus, the Czech Republic, Latvia, Bulgaria and Malta. The relationship between them is explained by the low use in their strategies of the variables which define Factor 1 (“Push&Pull”). In this way, they do not take into account knowledge strategies in order to improve their competitive position in the European Union.

(5) Finally, we have identified a special case: that Luxembourg. This European country is defined by the importance of Factor 2 against Factor 1. Luxembourg is the best user of the national competitive advantages which are defined by the “What we are like” Factor. Before Malta joined the European Union in 2004, Luxembourg represented the smallest country in the group in terms of geographic size, population and gross domestic product (Fontagné, 2004). The size is directly related with Factor 2 “What we are like”, which provides the following advantages (Meyer, 2008): a transparent and flexible institutional system, easy contacts between people and good internal communication, a homogeneous population rendering social consensus and stability easier, increased know-who, informal relationships, openness to world markets, rapid decision-making, etc (De Biasio, 2001). And the fundamental disadvantage is the low proportion of researchers (Meyer, 2008).

Secondly, we have attempted to identify the competitive advantages of cluster 1 called “Knowledge countries” with respect to other clusters. In this sense, we selected five variables in the study which have a direct relationship with knowledge creation (see Figure 5):

- Patent applications to the European Patent Office (EPO).
- Research and development expenditure.
- R&D expenditure (BERD) of businesses in ICT sector as % of total R&D expenditure.
- European high-technology patents.
- Researchers per million inhabitants.

Knowledge countries present an interesting behaviour as to how they manage their knowledge. According to Figure 5, public investment in research and development of Knowledge countries is higher than the rest of the European members and the result of this investment is identified through the important number of industrial and high-technology patents. Public investment is 2.7 per cent of the GPD, compared to cluster 3, which represents the second investor. And the result for patents in Knowledge countries is 229.94 per million inhabitants, instead of 117.90 in the case of cluster 3.

[Insert Figure 5]

Clusters 2 and 4 are not very significant due to these countries not investing in research and development in the same way as the Knowledge countries. Cluster 2 invests 0.9 per cent of the GPD and the investment of Cluster 4 is 0.74 per cent of the GPD. In this sense, public investment in Knowledge countries is around two points higher. In consequence, the results of both clusters are really poor compared again with Luxemburg, Sweden, Finland, Denmark, Germany, Netherlands and Austria (39.52 patents for cluster 2 and 12.92 patents for cluster 4 in contrast to 229.94 in Knowledge countries). Therefore, the results of patents from the Knowledge countries are better than Clusters 2 and 4.

Finally, the results of France, Belgium and the United Kingdom, which represent cluster 3, are not very significant because their behaviour is defined as lying between that of the Knowledge countries behaviour and those countries that show an absence of knowledge parameters. So, for that reason, we define this cluster as “midway” between Knowledge countries and clusters 2 and 4.

With respect to private investment based on research and development, the results are similar for all the clusters: 8.50 per cent in Knowledge countries, 8.81 per cent in the case of cluster 3 “medium way”, 10.15 per cent in cluster 2 and 11.63 in cluster 3.

The case of Luxembourg presents differences with respect to the Knowledge countries. Its results regards patents are very interesting (211.33 patents per million inhabitants, in second place behind the Knowledge countries) but its investment comes from the enterprises which decide to invest in knowledge. Public investment is 1.56, less than the Knowledge countries and cluster 3; private investment is 79.70 per cent above the average of Cluster 3 in private investment (11.63). In 1984, the agency

Luxinnovation was created to support innovation particularly in the sector of small and medium-sized enterprises (Musyck & Hadjimanolis, 2005). In 1960, Luxembourg had deficient scientific resources (OECD, 1963) but from this year the country has decided to put a lot of effort into science and research and take advantage creating specific institutions to promote research (Meyer, 2008). Nowadays, its results are excellent. In the case of Knowledge countries, the investment comes from the public government, whereas to Luxembourg uses private investors for this issue.

The number of researchers in the countries is also interesting. Cluster 2 and cluster 4 have a small number of researchers (3449.95 and 2822.76 per million inhabitants respectively) compared to Knowledge countries (6692.15), Luxembourg (5296.71) and the "midway" cluster (4916.54).

In this sense, the final analysis offers up an interesting point: knowledge investment. In the case of the Knowledge countries and Luxembourg, we see that they invest in knowledge and innovation more than others, and that these states also obtain the best results. On the other hand, cluster 2 and cluster 4 make little investment and their results are worse than others. The number of researchers agrees with these results: in Luxembourg and the Knowledge countries, that where the best results are obtained, I here are more than in cluster 2 and cluster 4, where the results are poor. Finally, we identify a special "midway" case: cluster 3. As its name indicates, Belgium, France and the United Kingdom have a midway position between the first group, made up of the Knowledge countries and Luxembourg, and cluster 2 and cluster 4 in all of the analyzed variables.

The study presents two ways of investment in knowledge: public and private investment. Both ways produce positive effects in countries where an improvement researchers and, in consequence, the growth in number of patents is being sought. Governmental strategy should lead to policies of knowledge investment in order to obtain a better position in the GDP ranking. This point is in agreement with the studies prepared by the European Commission (2007), which argues that the key to economic growth lies in research and development (R&D).

6. Conclusions

This paper presents an original contribution in the knowledge management area. On one hand, we have studied the importance of knowledge management in a special organization: countries. Using factor analysis, we have identified four critical factors which should be taken into account by any Government interested in improving its economic growth thanks to the knowledge structure. Moreover, this point is also interesting for the countries: European states know the critical factors and their position on the knowledge management path.

The first factor identified has been called the "Push&Pull Effect" and it represents the relationship between investment and result variables. The second factor is called "What we are like" and it describes the country through objective elements such as date of incorporation to European Union, the percentage of enterprises using technologies and the nominal gross domestic product per capita. This factor represents the starting point for each country at competitive time. The education domino effect is the third factor identified in our paper. This factor tries to explain the relationship between expenditure on education and its results on the country by its growth through knowledge structure. Finally, the knowledge employment factor defines the capacity of each country for adopting knowledge structures.

This paper identifies countries by clusters depending on how they manage their knowledge. The first cluster has been called "Knowledge countries" and it is made up Sweden, Finland, Denmark, Germany, the Netherlands and Austria. These countries are the example of how knowledge should be managed by investing in research and development, thus increasing the researchers and patents incorporating qualified employment and knowledge technology. The second cluster is composed of Spain, Portugal, Ireland, Greece and Italy. These countries are at the end of the knowledge race joined to the countries of the fourth cluster (Lithuania, Slovenia, Slovakia, Romania, Estonia, Hungary, Poland, Cyprus, the Czech Republic, Latvia, Bulgaria and Malta). Neither of these clusters of countries have realized that governmental strategy based on knowledge is crucial for the present competitive market. Finally, the third cluster called "midway" and made up of by France, Belgium and the United Kingdom define an embryonic knowledge strategy which should be improved.

Luxembourg is a special case of behaviour: although its Government does not invest directly in knowledge, its enterprises invest considerable amounts in information and communication technologies.

Attending to the results of this paper, there is a direct relationship between the investment in research and development and the results on knowledge management measured by patents. These results are in agreement with Martinus´ study (2010), who holds that some countries present growth rates thanks to the adoption of a knowledge production function (Acs et al., 2002; Arnold, 2006; Berliant et al., 2006; Li, 2002; Nocco, 2005 and Varga and Schalk, 2004).

In general terms, these contributions could be of to help managers, practitioners and other stakeholders when it comes to providing the right strategic decision linked to knowledge. Specifically, the paper helps European countries because it allows their position on the knowledge management path to be known. In this sense, countries that compose clusters 2, 3 and 4 know that their investment in innovation must be increased in order to obtain better results in this area and in their economy in general. The risk could be minimized and the probability of success in these countries could be increased.

As future works, our intention is to apply the same technique for analyzing knowledge management to other interesting groups of countries such as OCDE, G-20 members and ASEAN.

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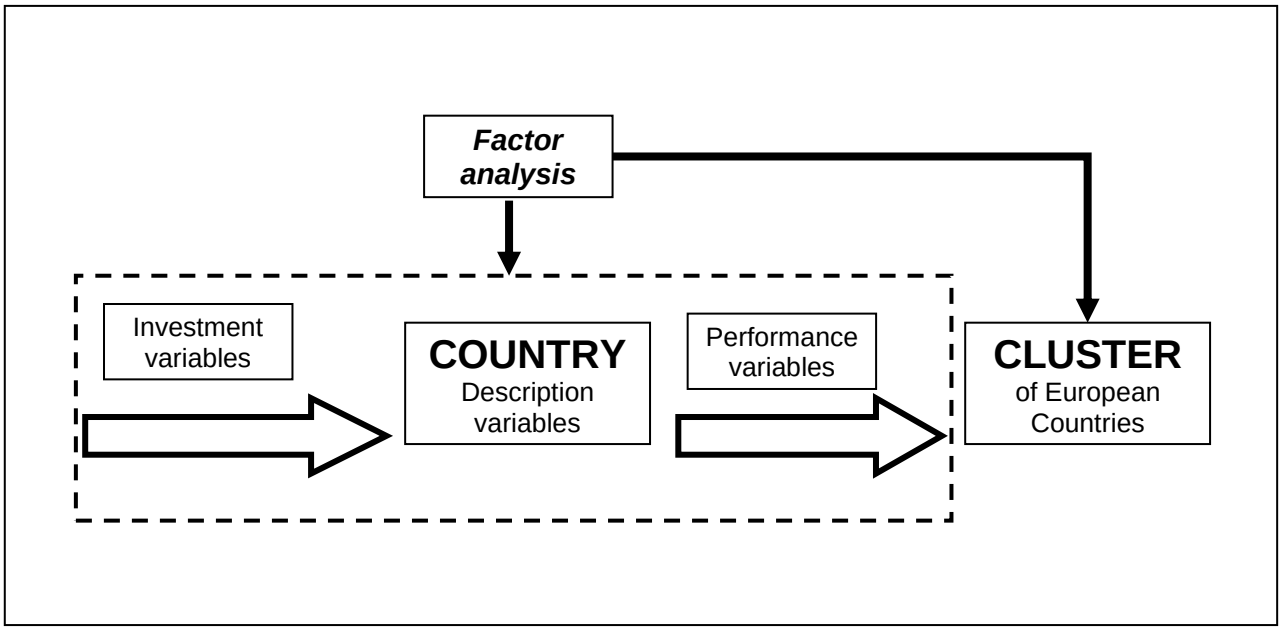

Figure 1. Theoretical model for analysing knowledge management in the case of countries.

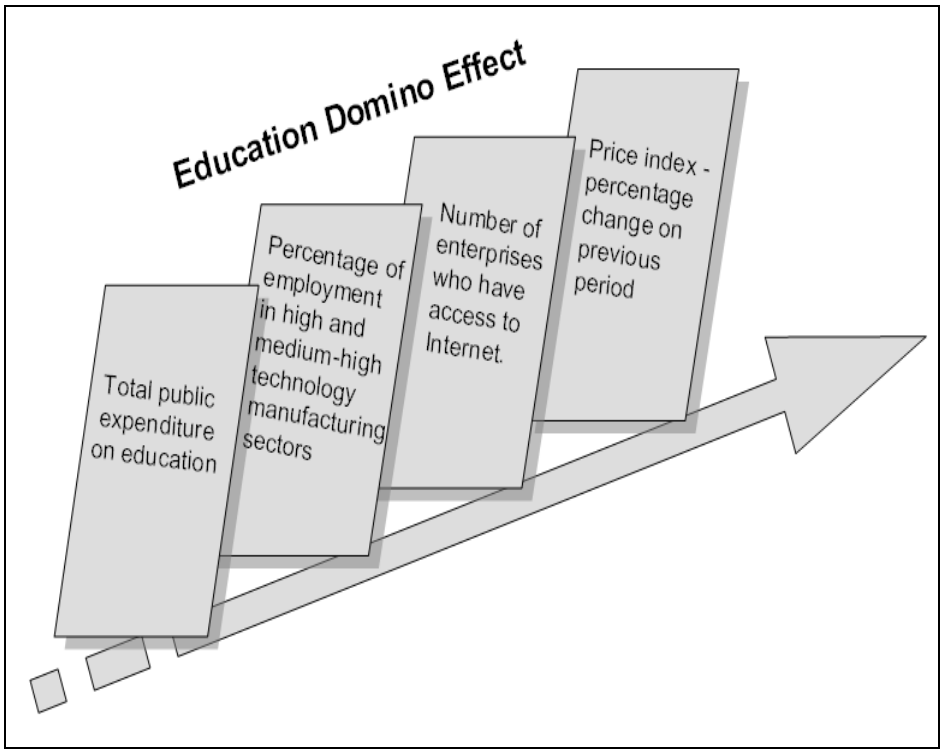

Figure 2. Graphical explanation of Factor 3: Education domino effect.

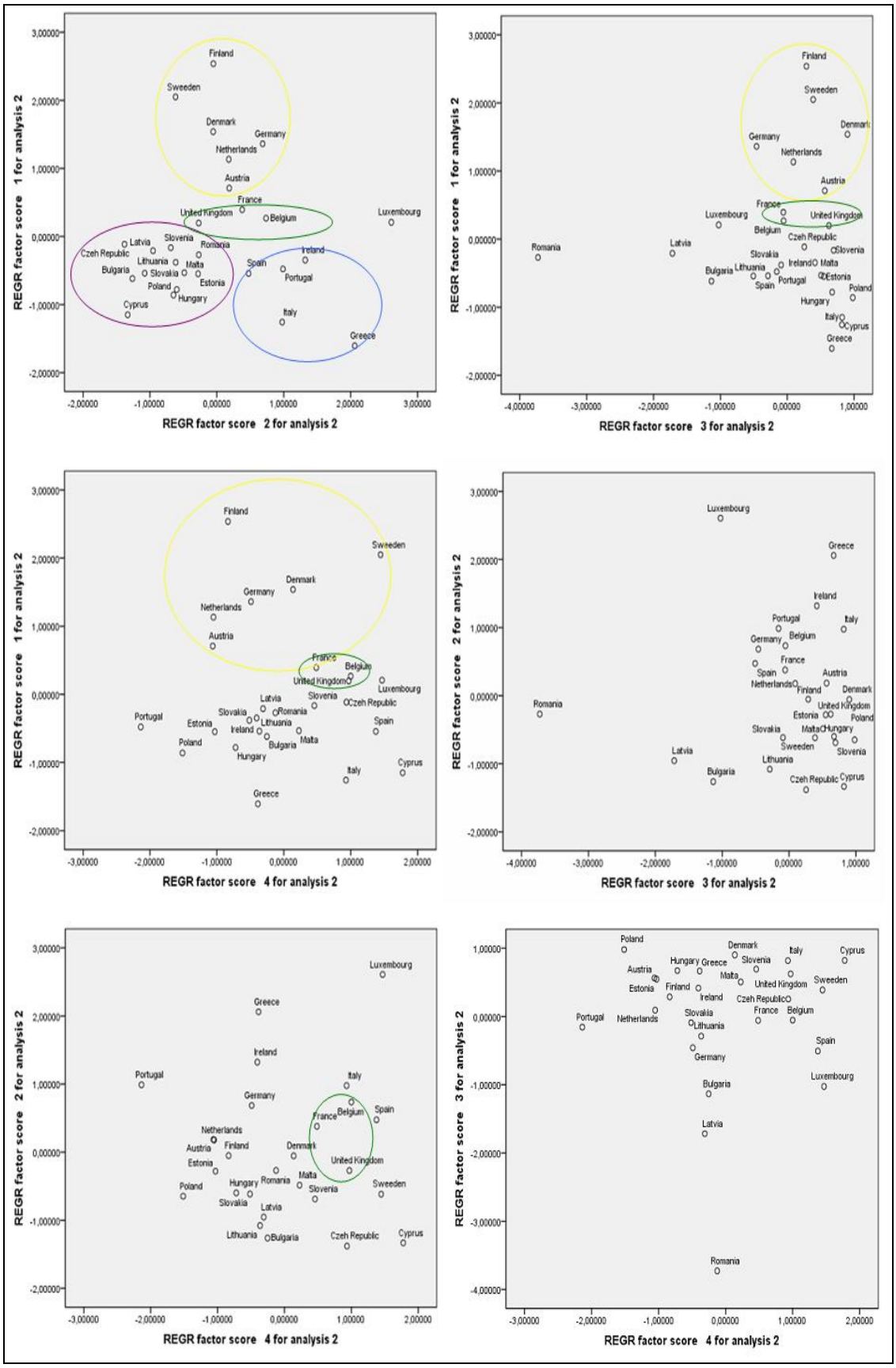

Figure 3. Cross-factor analysis of European countries

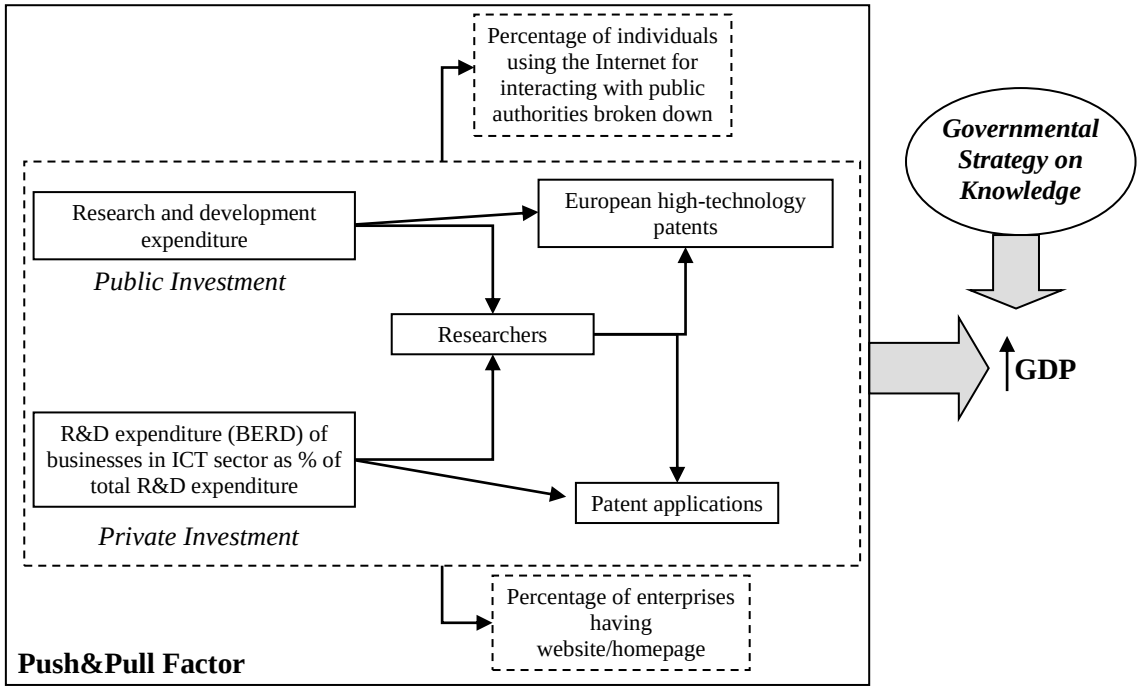

Figure 4. Relationship between the variables of the Push&Pull-Effect Factor

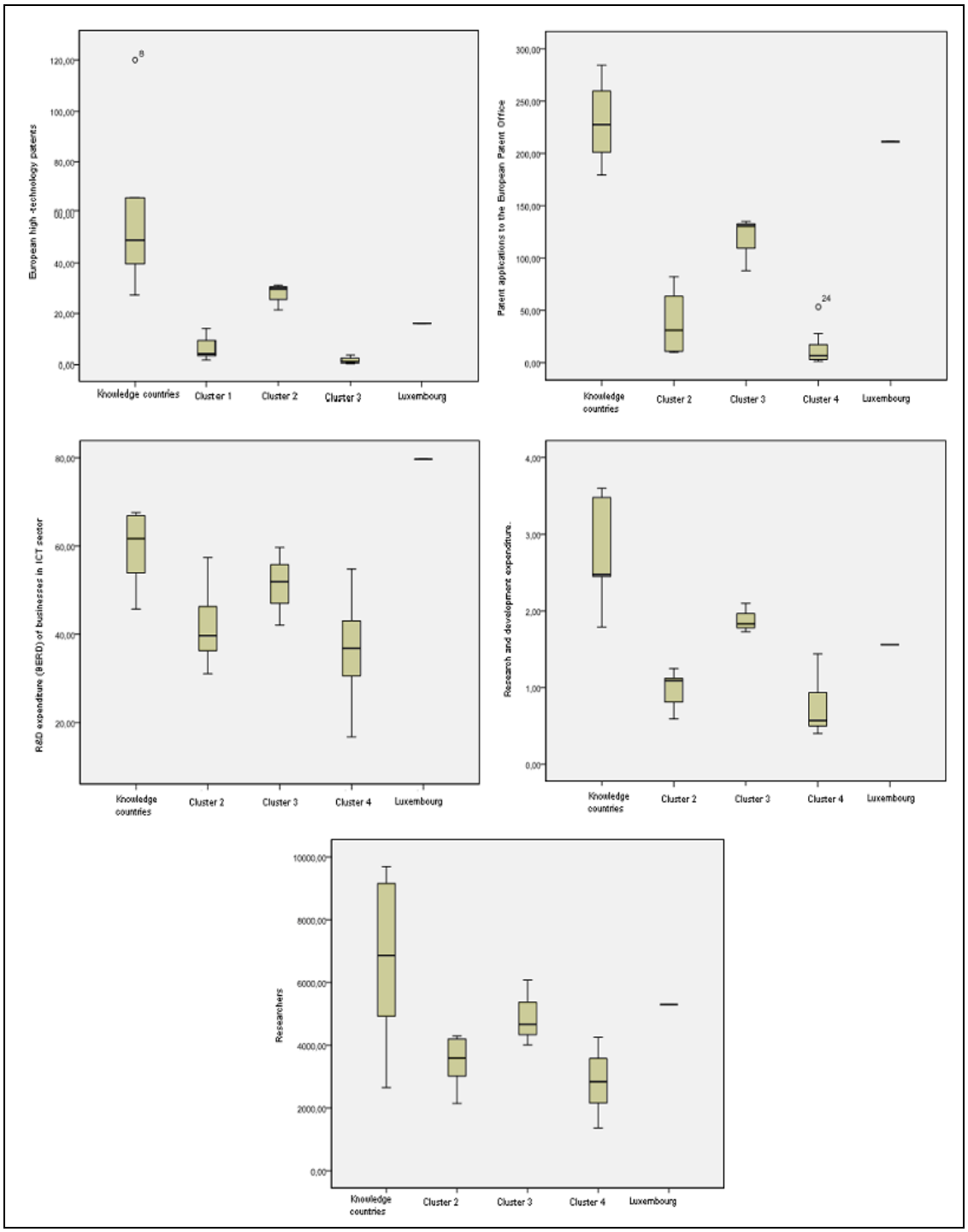

Figure 5. Knowledge variables analysis of European countries

Table 1.
Information about Member States of European Union

Member States of the European Union	Year of EU entry	Total area km^2	Population (in million)
Austria	1985	83 870	8.3
Belgium	Founding member	30 528	10.7
Bulgaria	2007	111 910	7.6
Cyprus	2004	9 250	0.8
Czech Republic	2004	78 866	10.5
Denmark	1973	43 094	5.5
Estonia	2004	45 000	1.3
Finland	1995	338 000	5.3
France	Founding member	550 000	64.3
Germany	Founding member	356 854	82
Greece	1981	131 957	11.2
Hungary	2004	93 000	10
Ireland	1973	70 000	4.5
Italy	Founding member	301 263	60
Latvia	2004	65 000	2.3
Lithuania	2004	65 000	3.3
Luxembourg	Founding member	2 586	0.5
Malta	2004	316	0.4
Netherlands	Founding member	41 526	16.4
Poland	2004	312 679	38.1
Portugal	1986	92 072	10.6
Romania	2007	237 500	21.5
Slovakia	2004	48 845	5.4
Slovenia	2004	20 273	2
Spain	1986	504 782	45.8
Sweden	1995	449 964	9.2
United Kingdom	1973	244 820	61.7

Table 2.
Description of Variables analyzed for European Members States.

Country Description	Investment Variable	Performance Variable
Individuals using internet with public authorities broken down by purpose	Researchers per million inhabitants	European high-technology patents
Date incorporation to EU	Expenditure on education as percentage of GDP or public expenditure	Price index - percentage change on previous period
GDP per capita		
Percentage of employment in knowledge-intensive service sectors	Research and development expenditure	Patent applications to the European Patent Office (EPO)
Number of enterprises who have access to Internet	R&D expenditure (BERD) of businesses in ICT sector as percentage of total R&D expenditure	Nominal Gross Domestic Product per capita
Percentage of enterprises using extranet/intranet		
Enterprises having website/homepage		
Percentage of employment in high- and medium-high-technology manufacturing sectors		
Human resources in science and technology as a share of labour force		

Table 3.
Variables and authors emphasize its importance

Variables	Authors emphasize its importance
Individuals using internet with public authorities broken down by purpose	Junnarkar and Brown, 1997; Borghoff and Pareschi, 1998; Liebowitz, 1999; Bose, 2002; Lever, 2002
Number of enterprises who have access to Internet	Junnarkar and Brown, 1997; Borghoff and Pareschi, 1998; Liebowitz, 1999; Bose, 2002; Lever, 2002
Percentage of enterprises using extranet/intranet	Junnarkar and Brown, 1997; Borghoff and Pareschi, 1998; Liebowitz, 1999; Bose, 2002; Lever, 2002
Enterprises having website/homepage	Junnarkar and Brown, 1997; Borghoff and Pareschi, 1998; Liebowitz, 1999; Bose, 2002; Lever, 2002
Human resources in science and technology as a share of labour force	OECD, 2001; López-Bassols, 2002; Chen and Dahlman, 2004
Percentage of employment in knowledge-intensive service sectors	OECD, 2001; López-Bassols, 2002; Chen and Dahlman, 2004
Percentage of employment in high- and medium-high-technology manufacturing sectors	OECD, 2001; López-Bassols, 2002; Chen and Dahlman, 2004
Researchers per million inhabitants	Adams, 1990; Jones, 2002; Chen and Dahlman, 2004; Raspe and Van Oort, 2006; Lee and Choi, 2008
Expenditure on education as percentage of GDP or public expenditure	Chen and Dahlman, 2004; Goddard, 2007; Martínez-Fernández, Rerceretnam and Sharpe, 2007
Research and development expenditure	Kogut and Zander, 1992; Henderson and Cockburn, 1994; Davidsson and Segerstrom, 1998;Fleming, 2001; Guellec and van Pottelsberghe, 2001; Lederman and Maloney, 2003; Chen and Dahlman, 2004; Lindström and Heshmati, 2005; Comisión Europea, 2007
R&D expenditure (BERD) of businesses in ICT sector as percentage of total R&D expenditure	Kogut and Zander, 1992; Henderson and Cockburn, 1994; Davidsson and Segerstrom, 1998;Fleming, 2001; Guellec and van Pottelsberghe, 2001; Lederman and Maloney, 2003; Chen and Dahlman, 2004; Lindström and Heshmati, 2005; Comisión Europea, 2007
Nominal Gross Domestic Product per capita	Guellec and van Pottelsberghe, 2001; Acs, Anselin and Varga, 2002; Jones, 2002; Li, 2002; Lederman and Maloney, 2003; Chen and Dahlman, 2004; Varga and Schalk, 2004; Arnold, 2006; Berliant, Reed and Wang, 2006
Price index - percentage change on previous period	Guellec and van Pottelsberghe, 2001; Acs, Anselin and Varga, 2002; Jones, 2002; Li, 2002; Lederman and Maloney, 2003; Chen and Dahlman, 2004; Varga and Schalk, 2004; Arnold, 2006; Berliant, Reed and Wang, 2006
Patent applications to the European Patent Office (EPO)	Romer, 1990b; North, 1991; Gans, Murray and Stern, 2005; Murray and O´Mahony, 2007; Furman and Stern, 2008
European high-technology patents	Romer, 1990b; North, 1991; Gans, Murray and Stern, 2005; Murray and O´Mahony, 2007; Furman and Stern, 2008

Table 4.
KMO and Bartlett's test

Validity item		
Kaiser-Meyer-Olkin measure of Sampling adequacy		0.735
Bartlett's test of sphericity	Approx. Chi-Square	355.039
	Df	120
	Significance	0.000

Table 5.
Rotated Component Matrix
The coefficients less than 0.1 have been removed.

Variables	Component			
	1	2	3	4
Research and development expenditure.	**.908**	.154	.244	.139
European high-technology patents.	**.890**	.123	.153	-
Patent applications.	**.864**	.342	.126	.146
Researchers (per million inhabitants).	**.816**	.151	.295	.123
Percentage of individuals using the Internet for interacting with public authorities broken down.	**.791**	.225	.286	.153
R&D expenditure (BERD) of businesses in ICT sector as percentage of total R&D expenditure.	**.711**	.457	-	.219
Percentage of enterprises having website/homepage.	**.681**	.194	.551	.172
Date incorporation to EU.	.468	**.729**	.189	.109
Percentage of enterprises using Extranet/Intranet.	.251	**.718**	-	.104
Nominal Gross Domestic Product per capita.	.501	**.667**	.182	.357
Price index - percentage change on previous period.	-.273	-	**-.782**	-
Percentage of employment in high- and medium-high-technology manufacturing sectors.	.399	.270	**.742**	.147
Number of enterprises who have access to internet.	.183	-.544	**-.559**	.169
Total public expenditure on education as percentage of GDP.	.445	-.294	**.511**	-
Percentage of employment in knowledge-intensive service sectors.	-	-	.123	**.943**
Percentage of human resources in science and technology as a share of labour force.	.153	.178	-	**.927**

Table 6.
Total Variance Explained

Component		Rotation Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
Factor	1	5.657	35.358	35.358
	2	2.461	15.384	50.742
	3	2.393	14.955	65.697
	4	2.123	13.271	78.968

Extraction Method: Principal Component Analysis

Table 7.
Critical factors for defining the behaviour of Knowledge countries

Factor	Variable	Description
Push&Pull-Effect	Research and development expenditure. European high-technology patents (per million inhabitants). Patent applications to the European Patent Office (EPO) (per million inhabitants). Researchers (per million inhabitants). Percentage of individuals using the Internet for interacting with public authorities broken down. R&D expenditure (BERD) of businesses in ICT sector as % of total R&D expenditure.	This factor relates investment variables to performance variables.
What we are like	Date incorporation to EU. Percentage of enterprises using Extranet/Intranet. Nominal Gross Domestic Product per capita..	The governmental strategy cannot be modified directly.
Education domino effect	Price index - percentage change on previous period. based on 2000=100 and national currency (including 'euro fixed' series for euro area countries). Percentage of employment in high- and medium-high-technology manufacturing sectors. Number of enterprises who have access to Internet. Total public expenditure on education as percentage of GDP.	The effect domino is perceived as the consequence of the investment in education which has impact on the GDP.
Knowledge Employment	Percentage of employment in knowledge-intensive service sectors. Percentage of human resources in science and technology as a share of labour force.	This factor results crucial for those countries which design their international strategy basing on a knowledge structure.