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Economic Development and Intellectual Capital: An International Study

Desarrollo económico y capital intelectual: un estudio internacional

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Abstract

In this paper we study relationships between economic development and the national level of intellectual capital. To measure the intellectual capital of nations we have used a model adapted to microeconomic level that takes into account aspects not contemplated by GDP. It considers intangible assets such as human development, economic structure, international trade, foreign image and innovation. This model is applied to 82 countries grouped in three clusters according to their efficiency in intellectual capital. The empirical results show the importance of structural capital in nation's wealth, while human capital does not contribute significantly to economic development.

Keywords: Economic Development; Intellectual Capital; Indicators; Wealth.

Resumen

En este artículo se estudian las relaciones entre el desarrollo económico y el nivel de capital intelectual de los países. Para medir el capital intelectual de un país usamos un modelo adaptado desde el ámbito microeconómico que incluye aspectos no considerados por el PIB. Este modelo considera activos intangibles tales como el desarrollo humano, la estructura económica, el comercio internacional, la imagen externa del país y la innovación. Desde un punto de vista empírico se lleva a cabo una aplicación del modelo a 82 países agrupados en tres grupos de acuerdo con su nivel de eficiencia en relación al capital intelectual. Los resultados muestran la importancia del capital estructural en la riqueza de un país, mientras que el capital humano no contribuye de una forma significativa en el desarrollo económico.

Palabras clave: Desarrollo económico; Capital intelectual; Indicadores; Riqueza.

JEL Classification: F02, J24, O3, O57.

1. Introduction

In a knowledge society, competitive advantage shifts from material and financial assets to intangible assets. This is due to several factors, including human capital, research, development and innovation (R&D&I), quality and environment. These factors have become influential in recent times where economic and social growth is concerned. In short, intellectual capital is becoming one of the main driving forces behind development and, as such, should be measured more precisely. This, together with GDP, would allow us to obtain a more accurate estimate of total (material and non material) wealth of a country.

In this sense, GDP does not expressly include variables such as human development, integration of information in homes, industrial framework, quality of life or environment. As a result, institutions such as the World Bank are working towards creating an indicator that captures all factors that influence the development and the growth in wealth of a nation. The idea is not only to account for such aspects, but also to understand how they interact. We can no longer continue to believe that using up the natural resources of a country that exports them makes it richer. Hence, scholars are proposing measures related to GDP that take into account negative externalities and the impact of economic activity on the environment in order to obtain a more comprehensive measure that is directly related to social wellbeing. Some examples worth highlighting include the Index of Sustainable Economic Welfare (ISEW) proposed by Daly and Cobb, (1989) and the research by Corrado et al. (2006), Montañez (2008) and Pulido (2008, 2009), which studies intangibles and their contribution to economic development.

All of the above indicates the need to establish a measure of intellectual capital in order to gain insight into the relative advantage that some countries or regions have over others in order to develop policies to guide future economic development. For this reason, this paper analyses the relationship between intellectual capital and economic development, considering aspects that are beyond the scope of GDP.

One of the contributions of this research is the use of a national intellectual capital measurement model that is obtained since the microeconomic systems of business organisations within the domain of national accounts. In the business approach, hidden assets (intangibles) are defined as non material, invisible and uncontrollable, but capable of generating future worth. They can be monitored by building absolute indicators (which are normally reported as expenses in balance sheets), filtered by efficiency indicators. As regards the macroeconomic domain, intangible assets are vital in order to improve estimates of wealth for a given region or country through a similar process to that employed at microeconomic level. In this case, the efficiency indicators would filter some items accounted for as expenses or external to the value of a country's output.

In this sense, intellectual capital can usually be divided into technological or structural capital and human capital. These components make it possible to elaborate and estimate an indicator of intellectual capital for a territory, capable of analysing progress made in terms of information society and comparing it. In this paper we have constructed indicators of structural, human and aggregate capital. The latter encompasses the first two to ascertain their relationship to economic development.

Efficiency indicators have been developed using a synthesis of variables reduced by principal component analysis (PCA) techniques. The method used to develop such indices is inspired by the intangible accounting management models implemented in enterprises by Edvinsson and Malone (1997) and Kaplan and Norton (1997). The result is an indicator that enables us to analyse to what extent intangibles have been implemented and developed in different countries, as well as the final advantage of managing such intangibles. That is, the possibility of generating wealth in the future.

In this paper, we show that it is possible to measure development and management of knowledge in a country using indicators of intellectual capital. Working this idea as support, we have established the following hypothesis: knowledge acts as a divergent factor of wealth, that is, that rich countries are richer in knowledge and manage it more efficiently than poor countries. Thus, in a global economy, human capital circulates in the opposite direction to development, that is, from poor countries to rich countries. In summary, we want display that relationships between economic development and knowledge are stronger in richest countries.

In this way, this paper is structured in five sections. Section 2 describes methodology and model to elaborate intellectual capital indicators. Later, in Section 3, we group countries according to their level of development according to the efficiency indicator of intellectual capital. Three large groups are created as a result, which go from most to least developed. The foregoing groups were used to develop an analysis of variance to ascertain whether there were significant differences in the level reached in the main indicators of economic development. In Section 4, a regression analysis is performed to measure effect of intangibles on economic development. Finally, we show the main results, limitations and conclusions.

2. A National Efficiency Index of Intellectual Capital

First of all, it is necessary to establish the concept that we are going to study: intellectual capital of nations. Intellectual capital from a company perspective is based on value that is hidden from traditional accounting systems and which is based on the ability to generate future value. Hence, since the research by Kaplan and Norton (1997) and Edvinsson and Malone (1997), the gap between market value and book value in favour of the former is identified as intellectual capital and is justified by factors related to human skills and organisational structure. When investigating the value of intellectual or intangible capital in a nation, the main difference is the quantity of information involved, as well as the peculiarities of the entity being studied (company versus State). Sánchez (2004) briefly reviews these definitions, highlighting that for Bradley (1997) a country's intellectual capital is its ability to transform knowledge and intangible resources into wealth. Edvinsson and Stenfelt (1999) perceive intellectual capital as the value of ideas generated by the union between human and structural capital, which allows knowledge to be produced and shared. According to Malhotra (2000), the definition would involve a set of hidden assets that explain the growth of a country and the added value of stakeholders. Therefore, this perception of intellectual capital, methodologically speaking, completes the definition of the value of a country's production. That is, its value would coincide with the value of hidden or immaterial production stemming from factors such as the development of its inhabitants, quality of life and wellbeing and technical progress. This definition of intellectual capital will be used in this research to construct national index such that comparisons may be established between countries, considering aspects other than the simple value of production.

In the literature, the approaches to and indicators of intellectual or intangible capital at macroeconomic level can be divided into two large groups:

1) Models specifically aimed at measuring and managing the intellectual capital of nations or regions that have been adapted from company management systems, particularly those based on the Skandia Navigator. Among these, it is worth highlighting Rembe (1999) for Sweden, López et al. (2008) for the European Union 25 (regional level), Lin and Edvinsson (2008) for 40 countries, or Schiuma et al. (2008) for Italian regions.
2) Competitiveness analysis and other studies related to establishing national or regional indicators. In this case, information systems use the aggregate level directly as a starting point. Examples include 'European Scoreboard' by the European Commission from 2000, Atkinson (2002) for the United States, the research by the World Bank (2006) on 120 countries, or the work by Ståhle and Bounfour (2008) that includes data for 51 countries over the period dating from 2000 to 2005.

After studying several approaches, we decided to use a method that involved transferring the classification of intangible assets (Nevado and López, 2002; López and Nevado, 2006) in models at company level to macroeconomic level, making any necessary adjustments. We thereby establish some visible intangible assets and some hidden ones. The latter are the basis for the main models, such as the Skandia Navigator, Integrated Analysis and Balanced Scorecard, in the territories in order to: obtain tools for managing intellectual capital and not confine the research to merely measurement and evaluation.

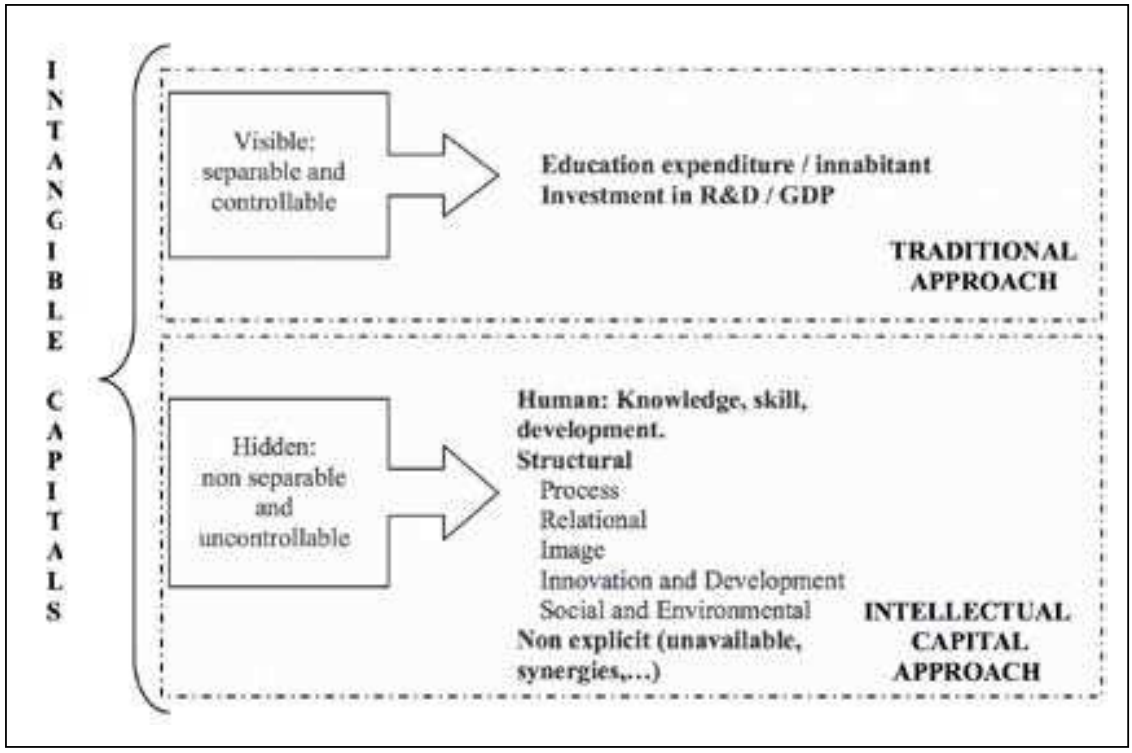
In this approach, national intellectual capital is defined as an immaterial element that generates future profits and which can be controlled by each State. However, within the current framework of national accounts, there are few items that can be defined as such, except for education and innovation and development costs. These expenses are an ongoing reference to intellectual capital of a country (traditional analysis). However, even when their definition is changed to investment, they remain insufficient, as a series of capitals that would complete the picture are omitted. It is these uncontrollable, non separable capitals that must be studied further in order to measure them and, in turn, exert control over them, consider their relationship to GDP, the potential wealth they entail, as well as ascertaining whether or not this new wealth is more disperse than the wealth measured traditionally by means of production value.

Therefore, intellectual capital of a country is made up of visible, separable and controllable assets, in the sense that the government is able to control them in some way (for example, using Budget) and hidden, non separable and uncontrollable assets, which have an enormous potential for future wealth, but which the government is unable to control entirely. The structures for measuring intangible capitals are summarised in Figure 1, which includes several capitals in each group. While the majority of research carried out at macroeconomic level to date focuses on the use of visible capitals, in this case emphasis is placed on hidden capitals, including human, structural and non explicit capitals.

The main difference between the two is that the hidden asset approach cannot be observed directly, using indicators instead to estimate the generators of a country's wealth. For example, traditional approach uses expenditure on education per inhabitant as a visible asset for human talent. However, in the hidden asset approach talent is the result of a combination of indicators of human resources, using expenditure on education per inhabitant, but also the activity and literacy rates. The result determines both investment (accountable expenditure) and how well it has been used or level of efficiency and combination. The main limitation of this approach is the difficulty involved in obtaining all the necessary information, a problem that is overcome at microeconomic level by conducting surveys. The advantage is

that the resulting information, despite the aforementioned shortfall, is more relevant and more accurately represents the asset being measured.

Figure 1.Structures for measuring intangible capitals



Source: Own elaboration.

Using this conceptual framework as a basis, an integrated ad hoc model is designed on a global scale. This is based on models of firm intellectual capital management and the competitiveness analysis, under the theoretical and conceptual view of national intangible capital as an 'invisible value' of that space. Finally, for this transfer, it must also be taken into account that, apart from establishing the model, a method is incorporated to build a new synthetic indicator. In order to do so, the changes in reporting systems made in microeconomic approach must undoubtedly be transferred to the reporting systems for national accounts, as regards intellectual capital.

In accordance with considerations made in other models, in first place, it is worth establishing the vision of a country and its activities, projects and intangible capitals as a whole by means of a National Index of Intellectual Capital (NIIC). For this, it is necessary to identify the indicator for each and allocate them to the capitals already defined.

Following this method, two large groups of capital are identified: human and structural or non human capitals. Structural capital, due its very nature, will undergo the most changes in the case of nations. Besides these two groups, a set of capitals that are not contemplated due to identification

errors, lack of information or not being included among those listed above, are added under the category of non explicit capitals (equation 1).

NIIC = Human + Structural + Non Explicit (1)

Human capital encompasses knowledge, skills and personal development towards achieving objectives (equation 2). It also includes cultural values, national labour market conditions and resource inflows from workers abroad.

Human = Knowledge + Skill + Development (2)

On the other hand, structural capital considers several intangibles related to the socio-economic framework of a country, namely the non human structure that enables a country generate future benefits: business structure, burocracy, image, international market share, technology, innovation and sustainability. This capital has been divided into:

- Process capital, which focuses generally on a country's private sector structure. More specifically, it measures information and management systems, bureaucracy and also organisational structures.
- Relation or trade capital, which captures the quality of the balance of trade.
- Marketing or image capital, which contemplates a country's domestic and foreign image and international relations.
- Research, development and innovation capital (R&D&i), which explicitly measures innovation, research and development possibilities through investment and how efficiently existing resources are exploited.
- Social and environmental capital (SE), which is determined by the social commitment of the social welfare state in relation to the quality of life of its inhabitants, together with action related to the environment and sustainable development.

Structural = Processes + Customer + Image + R&D&i + SE (3)

Finally, non explicit capital, as explained above, completes the picture provided by the integrated model, assuming variable estimation errors, omission of relationships, synergies and/or intangible capitals and data unavailability. This variable is, nevertheless, non observable and becomes less relevant when the rest of capitals are explained adequately.

Table 1. Scorecard for National Intangibles

Intangibles		*Indicators*	
	Theoretical justification	*Absolute (AI)*	*Efficiency (EI)*
Human Capital			
Knowledge Skill Development	Qualifications	*Education expenditure Capital formation Internal human capital*	*Literacy index (adjusted gross school enrolment)*
	Motivation and employability	*Non residential wage mass and remittances. Human capital exported*	*Activity rate (UN)*
	Excess employability		*Adjusted migration (2005)*
Process Capital			
Reporting and Management systems Organisational structure	System/structure quality	*Capitalisation/ Market value over resident firms as of 31st December*	*Adjusted firm start-up time*
	Level of management: technology		*Line index: adjusted mobile and land lines/inhabitant*
			Internet users per 100 inhabitants
Relational or Trade Capital			
Client Portfolio	Product brand name quality	*Trade balance in goods and services*	*High Technology Export Index*
			1-Development aid index
Marketing or Image Capital			
Image and International Institutional Relations	Internal image	*GDP*	*GDP Ranking*
			Life Expectancy Index
	External image		*Travel and Tourism Infrastructure Index*
Research, Development and Innovation Capital			
Innovation, Research and Development	Level of innovation and development	*Investment in R&D&i*	*Line Index: adjusted mobile and land lines/inhabitant*
	Technological level		*Internet users per 100 inhabitants*
Social and Enviornmental Capital			
Social and Environmental Responsibility	Environment	*Health expenditure (WHO, 2005)*	*CO_2 emissions per capita (2004)*
	Sustainability		*Hectares of green areas/ habitant (2005)*
	Quality of life, welfare society		*Life Expectancy Index*
			Access to health system in rural areas
			Access to water

Source: Own elaboration.
Note: Year in brackets if not 2006 due to unavailability of data.

The next stage of this research, once the measuring system has been determined, is to establish the indicator scorecard (Table 1) in order to be able to determine the intangibles included in equations 2 and 3. Following the intellectual capital approach, the first column defines the intangibles to be estimated as generators of long term benefits. We then justify each of these generators or intangibles in theoretical terms. Finally, overcoming the main problem related to obtaining information, two types of indicators are used: absolute indicators (AI), in monetary terms, and efficiency indicators (EI), in a percentage scale. In order to obtain the latter, when the variable does not have a percentage scale, variables have been rescaled assigning 100 to the highest value and 0 to the lowest. As a result, all the variables generated by the indicators have values ranging from 0 to 100 (minimum and maximum). That is, the maximum must coincide with the highest score obtained by the country with the highest value in the sample for the year in question, whereas the minimum will coincide with the countries that record the lowest scores. In appendix 1 we provide a description of the variables used in each capital.

The latter filter book expenditure included by the national government in the budget or its market value, according to the objective efficiency recorded and equation 4 below. Expense filtering was inspired by the process presented for the first time for Skandia by Edvinsson and Malone (1997), later modified in the method of Integrated Analysis by Lõpez and Nevado (2006).

$$C = \sum_{c=1}^{m} AI_c \cdot EI_c \qquad (4)$$

Where human or structural capital (C), is estimated by one or more absolute indicators m, filtered by k efficiency indicators and synthesized into only one indicator, weighted in accordance with a subjective weighting w. The procedure followed to allocate weights to efficiency indicators is based on the development of a principal component analysis (PCA) that makes it possible to assign weights to each indicator highly objectively. More specifically, bearing in mind that it is impossible to directly assign weights to each efficiency indicator, we proceeded to transform them into the same number of principal components (PC) as indicators available:

$$PC_{ic} = \sum_{i=1}^{k} u_i x_i \qquad (5)$$

Where u_i are the characteristic vectors of each principal component and x_i the variables used to make the efficiency indicators. Once these components have been obtained, we proceeded to build one indicator of efficiency by weighting each component in accordance with the percentage of variance retained by each.

$$EI_c = \sum_{i=1}^{k} w_i PC_{ic} \quad (6)$$

Where w is the percentage of variance retained by each component (a total of k, the same number as variables). Hence, equation 4 would be transformed into:

$$C = \sum_{c=1}^{m} AI_c \cdot \sum_{i=1}^{k} w_i \, PC_{ic} \quad (7)$$

As a result, following a similar procedure to that proposed by Alfaro and López (2008), we can obtain efficiency indicators, to filter the absolute indicators, which are far from being as subjective as the person performing the analysis due to being based on a widely used technique in economics, namely principal component analysis.

When we apply it, there is always one fundamental limitation: the availability of statistical information. In this sense, a complete database that is the closest to this approach is compiled by the World Bank Group (WBG). Notwithstanding, it must be completed in some cases by information from other sources, such as; the United Nations (UN) and the World Economic Forum (WEF). Furthermore, proxies are used on more than a few occasions, as the desired variables are not included in the sources mentioned.

The need for scores from absolute indicators at this level is a problem that if solved would improve the estimation. As a result of these limitations, a scorecard is designed, which includes an open system of variables to estimate intangible capitals on a national scale. Nevertheless, the proposed method always allows efficiency or relative indexes to be comparable, whereas absolute indexes and the final values of intangibles may only be compared in relative terms (GDP per capita).

In this sense, we have built a synthetic index that uses only efficiency indicators to analyse the relationships with economic development without correlations. In order to synthesize the efficiency indicators into only one indicator for each type of capital, we take the following steps. First, we convert the efficiency indicators into principal components (showed in table 7 and 8) to obtain objective weightings according to the variance weight of each principal component. Then, we calculate a weighting average of these principal components to obtain one efficiency indicator for each capital using weightings obtained objectively. Finally, we obtain the synthetic National Efficiency Index of Intellectual Capital (NEIIC), human (NEIHC) and structural (NEISC) indicators show in appendix 2. We have used these indicators to add only the non monetary information and objectively assess the relationships with economic development. The use of these indicators avoids possible situations of collinearity that can appear with the use of economic variables.

Using the information from the World Bank as our main source, we proceeded to apply the proposed model to 82 countries with information referring to 2006, except in some cases where the most recent data available were used. The countries were chosen depending on the availability of information for the majority of variables considered, as there were not enough data from the sources mentioned to be able add more countries. We must remember that in order to synthesize the efficiency indicators under consideration into one indicator for each kind of capital, weightings have been allocated according to the variance weight of their principal components.

3. National Efficiency Index and economic development

Using the National Efficiency Index of Intellectual Capital (NEIIC), we group the countries according to their level of intellectual capital in order to verify the hypothesis established in the introduction, taking the last available year 2006 as a reference. More specifically, we have organised the 82 countries considered into three large groups of 31, 31 and 20 countries, respectively, using a hierarchical cluster analysis and Ward's method. The groups of countries are similar in size in order to avoid size differences having an influence. The first cluster contains the 31 countries that recorded the highest score on the efficiency index of knowledge management. The second group comprises 31 countries that are developing nations in knowledge management or intangible assets. Finally, the third cluster is made up of the 20 least developed countries in terms of intellectual capital.

Using these groups, we explore whether they display significant differences in the averages of the variables related to economic development. It was not possible to obtain all the information we would have liked. Therefore, we have used the best available information to measure economic development. More specifically, we have utilised the following variables as indicators of economic development: GDP, value added in agriculture, industry and services, Gross Capital Formation (GCF), investment in R&D and electric power consumption, all in per capita terms. We have included aggregates for the value of production, production structure, investment and expressly technological and technical investment, directly related to economic development.

In the first place, Table 2 includes the homogeneity test of the variance within groups, a necessary requisite in order to select the statistics that we can use to compare their averages (ANOVA). We can see how in all cases the null hypothesis of homogeneity is rejected, therefore, we have used the Welch statistic to compare the averages.

The Welch statistics displayed in Table 3, at the critical level of 0.05, verify the existence of significant differences between the groups for the variables considered.

Table 2. Test of homogeneity of variance. Levene's statistic.

Variable	*Levene's statistic*	*df1*	*df2*	*Sig.*
GDP	27,290	2	79	,000
Value added agriculture	11,583	2	74	,000
Value added industry	11,906	2	74	,000
Value added services	19,565	2	74	,000
GCF	19,418	2	78	,000
R&D&i	46,854	2	68	,000
Electric power consumption	13,507	2	76	,000

Source: Own elaboration.

Table 3. Robust test of average equality (ANOVA).Welch statistic.

Variable	*Welch Statistics*	*Sig.*
GDP	60,640	,000
Value added agriculture	33,369	,000
Value added industry	39,035	,000
Value added services	49,862	,000
GCF	58,278	,000
R&D&i	42,324	,000
Electric power consumption	45,087	,000

Source: Own elaboration.

These results indicate that countries have achieved different levels of economic development based on their level of intellectual capital. Furthermore, we are interested in comparing each group to the rest in order to ascertain which groups are the furthest apart and which record the highest levels on average for each variable. Taking into account that the hypothesis of variance homogeneity has been rejected, we can use the statistics: T2 of Tamhane, T3 of Dunnett, Games-Howell or C of Dunnett in order to make multiple comparisons. Concretely, in this paper we have used the T2 of Tamhane because it is the most common and all the foregoing statistics yield similar results. These results are showed in Table 4.

Significant differences are observed among the three groups in terms of the variables considered. The second group, which is made up of developing countries, records intermediate values in comparison to the higher scores registered by the first group and the lower values displayed by the third group. That is, depending on how efficiently countries manage intangibles, the values registered by the main macroeconomic variables are going to be different on

average. Without doubt, this analysis shows the importance of factors not picked up in the economic development of a country by traditional economic indicators. However, it is very interesting to ascertain between which groups of countries such differences emerge and of course which group records the highest values. The results confirm that the poorest countries are even poorer when considering the intangible perspective proposed in this paper, and that the richest are richer still. The first group records the top scores in the analysed variables, therefore demonstrating the positive effect of knowledge development on the level of economic progress achieved.

Table 4. Multiple comparisons test (T2 of Tamahane).

Dependent variable	*Groups (I)*	*Groups (J)*	*Mean differences (I-J)*	*Sig.*
GDP	1	2	28624.51(*)	,000
		3	32122.69(*)	,000
	2	1	-28624.51(*)	,000
		3	3498.19(*)	,000
	3	1	-32122.69(*)	,000
		2	-3498.19(*)	,000
Value added agriculture	1	2	299.32(*)	,000
		3	422.04(*)	,000
	2	1	-299.32(*)	,000
		3	122.72(*)	,002
	3	1	-422.04(*)	,000
		2	-122.72(*)	,002
Value added industry	1	2	8085.98(*)	,000
		3	9172.98(*)	,000
	2	1	-8085.98(*)	,000
		3	1087.01(*)	,000
	3	1	-9172.98(*)	,000
		2	-1087.01(*)	,000
Value added services	1	2	21053.48(*)	,000
		3	23287.39(*)	,000
	2	1	-21053.48(*)	,000
		3	2233.92(*)	,000
	3	1	-23287.39(*)	,000
		2	-2233.92(*)	,000
GCF	1	2	6499.45(*)	,000
		3	7376.92(*)	,000
	2	1	-6499.45(*)	,000
		3	877.47(*)	,000
	3	1	-7376.92(*)	,000
		2	-877.47(*)	,000

R&D&i	1	2	668.11(*)	,000
		3	691.29(*)	,000
	2	1	-668.11(*)	,000
		3	23.18(*)	,000
	3	1	-691.29(*)	,000
		2	-23.18(*)	,000
Electric power consumption	1	2	6620.19(*)	,000
		3	8429.68(*)	,000
	2	1	-6620.19(*)	,000
		3	1809.49(*)	,000
	3	1	-8429.68(*)	,000
		2	-1809.49(*)	,000

* Significant difference between means at 0.05 level.
Source: Own elaboration.

4. Relationship between development and intangibles

We must now check the different situations regarding the relationships of each group with the main aggregate macroeconomic variables. The departure hypothesis is to determine if the countries where there has been more development of intangible assets are also the richest. That is, if intellectual capital incorporates an economic gap in its development. We have two problems or limitations for testing it with the available data: maybe, in relationships estimate, an endogeneity problem is present and we work with cross section data, that is, a static model. In this sense, we test development long run relationships and we suppose causality from intangibles to development over idea that intangibles are capable generating wealth.

In other hand, many experts coincide that GDP is not a sufficient measure of territorial wealth, as it does not consider other factors that are also decisive in development - see the criticism of GDP as a measure of wealth beginning with Kuznets (1955) right through to Stiglitz (2003)-. Notwithstanding, when other intangible factors are measured, results are usually better, with the most developed nations maintaining their position, but opening up a larger gap back to the least developed countries. Therefore, we will analyse the results of the clusters, as well as the differences in the relationship with the main economic magnitudes in line with the efficiency index of intellectual capital.

The result cannot be more conclusive, according to Table 5. Cluster 1 displays the closest relationship between economic development and the efficiency index (NEIIC) in econometric terms (see the results for relationship 1 of the statistical t and coefficient of determination – R^2 –). Furthermore, the relationship is even more significant when structural conditions such as image, innovation, development, processes, etc. – relationship 2 – are taken into account (NEISC). On the other hand, if we take the given clusters into account, human effects (NEIHC) far from explain said ties in all cases, with determination

coefficients being close to zero. In any event, the relationship with human factors would be inverse, that is, the least developed clusters would have a closer relationship. In this sense, for example, the coefficient of determination for cluster 3 is higher than that for cluster 1.

Therefore, the relationship with national wealth shows a divergent trend in international economic development. Intangible management and the level of intellectual capital, basically structural, appear to be more closely linked to GDP per capita in the cluster of developed countries.

If we analyse the variables one by one, we could say that gross capital formation per capita, relationship 4, shows a clearly positive trend regarding intangibles, being more outstanding the more developed the cluster is, with key differences among them.

Investment in R&D&I per capita, relationship 5, follows the same trend as that detailed above. Results are also conclusive, as R&D&i is very closely linked to intangible capital in the top-ranked countries. This establishes a significant technological knowledge gap among the groups of countries.

Finally, electric power consumption per capita (EPC) shares a closer relationship with the indicator of intellectual capital in the poorest countries. Therefore, looking inside a given cluster, this relationship is more important than in developed countries. In this case, it does not seem to be a decisive factor for knowledge capital, but more a need of development regardless of the progress in intangibles.

TABLE 5. DEVELOPMENT AND INTANGIBLES RELATIONSHIP

Relationship. Dependent variable	Independent variable	Total-82 Coeff. / (t) R^2	Cluster 1-31 Coeff. / (t) R^2	Cluster 2-31 Coeff. / (t) R^2	Cluster 3-20 Coeff. / (t) R^2
1. GDP	NEIIC	1415.79 / (13.36) 0.69	3705.82 (9.47) 0.76	465.22 (4.01) 0.36	243.88 (3.14) 0.35
2. GDP	NEISC	1199.69 / (13.41) 0.69	2976.78 (9.54) 0.76	338.07 / (4.05) 0.36	162.91 (2.46) 0.25
3. GDP	NEIHC	1284.61 (7.64) 0.42	584.75 (1.34) 0.06	43.97 (0.3) 0.003	76.38 (1.44) 0.10
4. GCF	NEIIC	331.02 (13.47) 0.70	780.10 (7.51) 0.66	148.77 (4.64) 0.43	67.78 (2.94) 0.34
5. RDi	NEIIC	37.54 (10.19) 0.60	79.58 (5.32) 0.49	3.53 (3.04) 0.25	0.57 (0.70) 0.06
6. EPC	NEIIC	371.97 (9.78) 0.55	860.02 (4.11) 0.37	177.51 (2.44) 0.17	108.50 (3.82) 0.48

Note : (t) T Values; R^2 Coefficient of determination.
Source: Own elaboration.

In short, intellectual capital of a country is a critical factor of its economic development; even more when a country's wealth is more significant, which is why it is a divergent factor. In addition, origin of intangible capital is structural, making situations of potential convergence in intellectual capital more difficult to accomplish, as they are more closely related to the image of a country, its technological situation and the processes than to level of inhabitants talent. Probably, human capital will always be a more variable factor, due to situations of population movements, or brain attraction to countries with more developed intangible structure.

5. Conclusions

GDP has traditionally been used to measure national economic development. However, in current knowledge economy, other factors have influence on economic development and do not appear to be well captured by GDP. In this sense, we have elaborated a national indicator of intellectual capital that picks up these factors (intangibles), differentiating two main components: human and structural capitals.

The approach developed agrees to obtain efficiency indexes for these intangibles that allow us to analyse their management rank and to compare it with others territories. In this sense, we can use these indicators to group countries in accordance with the level of national intellectual capital reached. Later, we analyse the structural impact of this level on economic development, measured across a set of macroeconomic aggregates.

The results show that differences exist in economic level reached by different groups of countries depending on development in intellectual capital. As a result, countries that have seen these factors not contemplated by GDP are more developed, boast better records where the economic variables considered are concerned. In addition, analysing the relationship between intangibles and different economic variables considered, we find that structural factors (as image, processes, technology and social and environmental) are most closely related to wealth of a country. However, human capital does not contribute significantly to economic development. Moreover, human capital sometimes appears to be more important in poor countries, for example, in terms of national remittances per inhabitant. In any case, we could confirm that human knowledge factors are important, but flow simply from less developed nations towards more developed countries, quite unlike structural factors.

Therefore, this international application on measurement and management knowledge establishes that Intangible value can be measured and displays a similar relationship as tangible value. That is, countries that produce the most value in terms of goods and services also produce high intangible value. However, this relationship is divergent in development terms. That is, the difference rich and poor countries, in terms of GDP, is smaller than the gap between the top and bottom ranked countries in terms of intellectual capital and also in terms of how efficiently they manage knowledge as an intangible asset.

Finally, these results are limited. Information available are a cross section series to year 2006 and 82 countries. We are working to extend this model to a panel data with information for several years. In this new database scenario we could study relationships between growth and intangibles, but probably we will be working with a minor number of countries.

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Appendix 1

Table 6. Variables used for intellectual capital index

Intangibles	Variable	Variable description	Information Source
Internal Human Capital	Education expenditure	Public expenditure on education (millions US$)	UNESCO
	Literacy index (adjusted gross school enrolment)	Adjusted percentage of population aged 15 years and over who can both read and write (%)	UNESCO
Exported Human Capital	Non residential wage mass and remittances.	Workers' remittances and compensation of employees, received (millions US$)	World Bank Group (WBG)
	Activity rate	Active population divided by total population (%)	International Labour Organization (ILO)
	Adjusted migration	Net international migration: incoming less outgoing international migrants (persons)	United Nations (UN)
Process Capital	Capitalisation/Market value over resident firms as of 31st December	Share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges (millions US$)	World Bank Group (WBG)
	Adjusted firm start-up time	Time required to start a business is the number of calendar days needed to complete the procedures to legally operate a business	World Bank Group (WBG)
	Line index: adjusted mobile and land lines/ inhabitant	Mobile and fixed-line subscribers are the percentage of total telephone subscribers per 100 inhabitants	World Bank Group (WBG)
	Internet users per 100 inhabitants	Internet users are the percentage of people with access to the worldwide network	World Bank Group (WBG)
Relational or Trade Capital	Trade balance in goods and services	Trade balance in good and services is calculated as the difference between exports and imports (millions US$)	World Bank Group (WBG)
	High Technology Export Index	High-technology exports are the percentage of manufactured products with high R&D intensity exports	World Bank Group (WBG)
	Development aid index	Net official development assistance and official aid received in relation to GDP (millions US$)	Organisation for Economic Co-operation and Development (OECD)

Marketing or Image Capital	GDP p.c.	Gross domestic product divided by midyear population (millions US$)	World Bank Group (WBG)
	GDP Ranking	This variable is an ordination of the countries from 0 to 100 using GDP p.c.	Own elaboration
	Life Expectancy Index	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life	World Bank Group (WBG)
	Travel and Tourism Infrastructure Index	Measurement of the factors that make it attractive to develop business in the travel and tourism industry of individual countries (scale from 1 to 6)	World Economic Forum (WEF)
Research, Development and Innovation Capital	Investment in R&D&i	Expenditure on Research & Development (millions US$)	United Nations Educational, Scientific and Cultural Organization (UNESCO)
	Line Index: adjusted mobile and land lines/ inhabitant	Mobile and fixed-line subscribers are the percentage of total telephone subscribers per 100 inhabitants	World Bank Group (WBG)
	Internet users per 100 inhabitants	Internet users are the percentage of people with access to the worldwide network	World Bank Group (WBG)
Social and Environmental Capital	Health expenditure	Sum of general government and private health expenditure in a given year (millions US$)	World Health Organization (WHO)
	CO_2 emissions per capita (2004)	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement (metric tons per capita)	World Bank Group (WBG)
	Hectares of green areas/habitant (2005)	Forest area divided by surface area (%)	World Bank Group (WBG)
	Life Expectancy Index	Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life	World Bank Group (WBG)
	Access to health system in urban areas	Percentage of urban population with at least adequate access to excreta disposal facilities	World Bank Group (WBG)
	Access to water	Percentage of urban population with reasonable access to an adequate amount of water from an improved source	World Bank Group (WBG)

APPENDIX 2

TABLE 7. PRINCIPAL COMPONENTS FOR THE HUMAN INDICATOR AND CLUSTER ASSIGNED.

Country – 2006	PC 1	PC 2	Human NEIHC	Cluster
Variance Weight in NEIHC (%)	70.54	29.46		
Argentina	52.41	13.13	40.84	2
Armenia	44.17	20.68	37.25	3
Australia	73.76	23.69	59.01	1
Austria	64.62	23.89	52.62	1
Bangladesh	7.39	56.72	21.92	3
Belgium	64.06	19.42	50.91	1
Bolivia	7.50	56.83	22.03	3
Botswana	48.76	27.70	42.56	3
Brazil	51.78	13.90	40.62	2
Bulgaria	48.89	15.49	39.05	2
Chile	50.01	16.86	40.25	2
China	42.54	23.17	36.84	2
Colombia	47.02	18.65	38.66	2
Costa Rica	55.09	31.83	48.24	2
Croatia	57.68	30.24	49.60	1
Czech Republic	52.98	19.02	42.97	1
Denmark	62.61	12.10	47.73	1
Ecuador	7.45	56.77	21.98	3
Egypt. Arab Rep.	6.76	56.07	21.29	3
El Salvador	43.99	21.01	37.22	2
Estonia	53.81	11.93	41.47	1
Finland	62.20	10.25	46.90	1
France	61.84	16.00	48.34	1
Georgia	45.19	19.91	37.75	2
Germany	58.20	19.66	46.85	1
Ghana	34.69	31.13	33.64	3
Greece	65.20	14.79	50.35	1
Hungary	56.17	15.40	44.16	1
Iceland	61.16	14.68	47.47	1
India	38.49	26.20	34.87	3
Indonesia	41.84	23.46	36.43	3
Ireland	81.63	34.32	67.69	1
Israel	62.16	21.93	50.31	1
Italy	63.74	21.64	51.34	1
Jamaica	47.03	18.25	38.55	2
Japan	52.29	15.05	41.32	1
Jordan	60.03	31.15	51.52	2
Kazakhstan	54.21	11.73	41.69	2
Kenya	36.38	26.05	33.34	3

Country – 2006	PC 1	PC 2	Human NEIHC	Cluster
Korea	56.71	8.83	42.61	1
Latvia	52.98	12.09	40.94	2
Lebanon	46.15	18.66	38.05	3
Lithuania	54.08	11.09	41.42	2
Luxembourg	60.71	34.20	52.90	1
Macedonia. FYR	41.21	20.36	35.07	2
Malawi	39.43	26.87	35.73	3
Malaysia	46.79	24.73	40.29	1
Malta	60.03	28.50	50.74	1
Mauritius	38.87	37.82	38.56	2
Mexico	47.97	17.08	38.87	2
Mongolia	47.60	17.92	38.86	3
Namibia	40.39	24.10	35.59	3
Netherlands	60.56	12.52	46.41	1
New Zealand	71.53	21.37	56.75	1
Nigeria	5.48	54.74	19.99	3
Norway	67.20	18.31	52.80	1
Pakistan	27.12	37.14	30.07	3
Panama	49.33	18.70	40.31	2
Paraguay	44.25	21.48	37.54	3
Peru	52.32	13.55	40.90	2
Philippines	48.44	17.17	39.23	2
Poland	51.65	13.26	40.34	2
Portugal	66.23	27.29	54.76	1
Romania	47.37	17.49	38.57	2
Russian Federation	52.27	19.81	42.71	2
Slovak Republic	48.00	17.62	39.05	2
Slovenia	60.13	16.87	47.39	1
South Africa	47.60	19.15	39.22	2
Spain	91.53	45.74	78.04	1
Sweden	64.10	19.46	50.95	1
Switzerland	56.50	23.40	46.75	1
Tanzania	33.16	28.11	31.67	3
Thailand	49.31	20.72	40.88	2
Tunisia	45.74	18.84	37.82	2
Turkey	43.14	21.34	36.72	2
Uganda	39.50	26.54	35.68	3
Ukraine	52.27	12.78	40.64	2
United Kingdom	60.98	21.42	49.33	1
United States	65.81	23.18	53.25	1
Uruguay	53.64	12.06	41.39	2
Venezuela. RB	48.82	18.48	39.88	2
Zambia	39.87	25.90	35.76	3

TABLE 8. PRINCIPAL COMPONENTS FOR THE STRUCTURAL INDICATOR AND THE NATIONAL EFFICIENCY INDEX.

Country – 2006	PC 1	PC 2	PC 3	PC 4	PC 5	Structural NEISC	Aggregated NEIIC
Variance Weight in NEISC (%)	85.78	7.66	3.21	2.49	0.87		
Argentina	45.57	58.18	49.98	51.42	46.06	46.82	46.46
Armenia	32.95	58.18	54.84	48.42	45.37	36.08	38.02
Australia	64.20	55.93	53.44	49.40	46.04	62.70	61.92
Austria	65.89	56.61	54.51	48.88	47.84	64.23	61.36
Bangladesh	25.28	58.98	49.13	48.57	45.97	29.38	28.30
Belgium	61.01	55.78	53.22	48.49	47.44	59.93	58.06
Bolivia	30.85	57.50	54.08	52.66	46.19	34.31	31.68
Botswana	29.49	59.36	47.04	49.11	49.60	33.00	36.97
Brazil	39.90	65.32	53.52	53.45	52.63	42.73	43.60
Bulgaria	54.26	55.10	48.17	56.91	46.75	54.13	50.79
Chile	47.88	59.11	52.91	50.01	46.56	48.94	47.74
China	38.95	65.49	48.85	49.49	44.63	41.61	41.57
Colombia	41.27	60.22	53.70	53.53	45.92	43.46	43.40
Costa Rica	45.49	70.33	52.35	50.29	47.94	47.75	48.57
Croatia	54.65	57.07	51.04	54.20	47.67	54.65	53.58
Czech Republic	56.89	57.94	51.50	53.44	45.95	56.62	53.57
Denmark	68.66	54.10	49.64	47.04	46.36	66.20	61.77
Ecuador	39.14	62.03	52.94	53.73	46.55	41.76	36.79
Egypt. Arab Rep.	34.98	59.41	52.33	46.78	45.75	37.79	34.05
El Salvador	38.39	58.42	50.93	50.35	45.30	40.68	41.08
Estonia	61.07	56.23	50.38	56.78	47.27	60.13	55.71
Finland	66.45	59.16	55.09	51.72	45.63	64.98	60.71
France	63.48	57.57	52.01	47.83	46.10	62.12	59.01
Georgia	36.94	59.75	55.48	50.38	44.74	39.68	40.62
Germany	65.87	56.10	52.14	49.11	47.38	64.11	59.86
Ghana	22.28	51.18	50.25	52.64	48.41	26.37	29.91
Greece	56.17	58.51	54.34	48.62	46.78	56.02	55.36
Hungary	53.39	59.62	47.99	52.23	46.53	53.60	51.89
Iceland	71.77	56.46	47.27	45.17	46.40	68.93	63.53
India	31.92	61.37	50.31	46.82	46.17	35.26	36.67
Indonesia	32.72	65.97	53.58	48.99	49.01	36.48	38.01
Ireland	63.72	59.45	50.19	45.45	44.65	62.34	63.68
Israel	57.12	57.33	50.71	50.41	46.80	56.67	55.50
Italy	65.83	53.01	50.96	53.25	46.25	63.89	60.68
Jamaica	51.31	53.69	48.62	54.41	46.17	51.44	48.79
Japan	65.65	59.38	54.64	53.27	46.75	64.34	58.65
Jordan	41.64	53.40	52.41	48.83	46.94	43.11	46.24

Country – 2006	PC 1	PC 2	PC 3	PC 4	PC 5	Structural NEISC	Aggregated NEIIC
Kazakhstan	38.60	62.63	48.90	50.73	43.39	41.12	42.77
Kenya	25.66	54.52	45.38	47.12	47.55	29.22	32.03
Korea	63.13	58.62	47.18	55.32	46.06	61.93	57.33
Latvia	53.60	55.23	48.41	55.49	45.67	53.54	51.01
Lebanon	34.61	57.07	51.24	56.21	45.20	37.49	39.01
Lithuania	52.35	51.72	41.77	50.89	46.91	51.88	50.05
Luxembourg	77.05	53.14	55.87	46.53	47.09	73.52	67.62
Macedonia. FYR	41.91	55.97	54.36	54.14	44.77	43.71	42.57
Malawi	19.20	41.21	55.94	51.51	48.14	23.12	28.40
Malaysia	55.54	67.63	49.12	54.21	45.40	56.14	52.34
Malta	53.15	68.82	45.94	49.06	53.10	54.02	53.62
Mauritius	46.16	62.28	49.62	49.72	47.14	47.60	45.74
Mexico	44.24	63.08	52.43	49.87	45.26	46.09	45.40
Mongolia	32.00	52.98	52.11	49.38	46.21	34.80	37.57
Namibia	28.00	59.23	47.44	48.19	49.20	31.70	34.40
Netherlands	71.16	54.17	45.99	50.84	47.33	68.34	62.74
New Zealand	65.92	53.75	50.20	52.43	48.01	64.00	62.19
Nigeria	23.49	50.03	46.04	49.57	46.64	27.09	26.19
Norway	74.82	53.89	52.60	48.77	46.19	71.61	66.62
Pakistan	30.40	58.70	50.35	49.44	44.77	33.80	34.02
Panama	43.46	59.86	55.33	51.69	45.06	45.32	45.17
Paraguay	34.43	63.42	53.06	53.39	46.44	37.82	39.14
Peru	37.28	61.98	54.29	53.10	47.91	40.20	41.91
Philippines	37.52	73.70	45.94	49.12	44.04	40.90	41.86
Poland	49.79	53.16	44.61	50.80	47.43	49.89	48.38
Portugal	58.46	56.70	53.04	51.10	45.57	57.86	57.32
Romania	50.65	54.76	47.21	55.99	45.42	50.94	48.42
Russian Federation	48.11	58.23	49.83	56.19	44.18	49.11	48.18
Slovak Republic	53.21	57.40	52.11	53.29	46.68	53.44	50.41
Slovenia	57.77	53.35	46.99	52.69	50.18	56.90	54.94
South Africa	37.56	56.56	44.54	49.88	45.22	39.61	40.84
Spain	60.52	56.51	54.14	50.42	48.74	59.66	64.12
Sweden	72.12	54.23	51.88	53.44	47.03	69.42	64.47
Switzerland	70.38	55.79	51.96	46.16	47.72	67.87	62.40
Tanzania	23.77	47.17	54.00	48.46	47.57	27.35	30.31
Thailand	42.57	64.85	50.97	49.07	45.35	44.73	44.89
Tunisia	42.97	57.45	52.51	47.43	46.08	44.53	44.05
Turkey	44.83	56.48	50.74	50.19	44.80	46.04	44.64
Uganda	22.92	48.90	49.74	48.05	46.80	26.60	30.83
Ukraine	45.74	55.62	47.89	55.15	45.38	46.80	46.26

Country – 2006	PC 1	PC 2	PC 3	PC 4	PC 5	Structural NEISC	Aggregated NEIIC
United Kingdom	69.34	56.61	47.26	49.06	46.58	66.96	62.35
United States	69.30	58.44	51.97	49.62	46.15	67.22	63.55
Uruguay	45.76	57.56	50.46	51.26	47.39	46.96	46.74
Venezuela. RB	38.90	63.62	54.86	55.98	50.93	41.84	42.59
Zambia	23.06	47.20	53.23	51.82	46.74	26.80	30.94