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Full Length Research Paper

An alternative to measure national intellectual capital adapted from business level

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In this paper, a new model to measure the intellectual capital of nations adapted from business level was proposed. In other words, the study obtained an indicator that enhances the picture and position of a nation's wealth. It was based on the observation of hidden capital as implicit generators of long term wealth, considering not only sustainability and social wellbeing, but also intangible assets such as human development, economic structure, international trade, foreign image and innovation. The main contributions and novelties of the model proposed were firstly the use of principal component analysis to obtain objective weightings to build the efficiency indicators and secondly, it was worth highlighting the possibility of expressing the indicator of intellectual capital in monetary terms. This allowed for the said indicator to a country's economic development indicators to be compared.

Key words: National intellectual capital, Skandia navigator, indicators, intangible assets.

INTRODUCTION

The process of measuring and valuing intangibles is a field that has reached maturity in recent years, particularly at macroeconomic level. Companies' interest in this type of indicator was highlighted by authors such as Grant (1996, 1997), Saint-Onge (1996), Brooking (1997a, b), Edvinsson (1997, 2000), Kaplan and Norton (1997), Bontis (1998, 2001), Bontis et al. (1999), Edvinsson and Malone (1999), Roos et al. (2001), Nevado and López (2002) and López and Nevado (2006). However, intellectual capital on a territorial basis began to gain importance in the 1990s, when a large number of studies considering various components of intangible capital were undertaken (Bradley, 1997a, b; Pasher, 1999; Edvinsson and Stenfelt, 1999; Rembe, 1999; Malhotra, 2000; Daley, 2001; Bontis, 2004; Bontis et al., 2002; Bossi et al, 2005 and Yeh-Yun Lin and Edvinsson, 2008).

Following in this same line, this paper proposes a model to measure the intellectual capital in a nation through building an indicator of 'non visible wealth' that makes it possible to obtain a comprehensive value of a country by observing hidden capital as an implicit generator of long term wealth. The uniqueness of the method proposed stems from the superimposition of the business systems of firms on the national accounts. The former define the nature of their hidden assets as intangible, non visible and uncontrollable, but as generators of future value. As such, they can feasibly be monitored by absolute indicators (which in most cases are reported as expenses on accounting statements) filtered by efficiency indicators. As regards the latter, intangible, non visible and uncontrollable capital is vital in order to improve the estimation of wealth in a region, using a similar process to that developed in business whereby efficiency indicators would filter some items considered as expenses or outside the production value of a nation. That is the proposal that is developed in this paper, which will provide a more comprehensive knowledge of countries' economies.

The advantages of this method include establishing a tool that generates comparable efficiency indexes, synthesized into the main strategies for intangible assets to create wealth via knowledge. Furthermore, intangible capitals are assigned a value through monetary items,

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which makes it possible to estimate them in economic terms and ascertain their relationship with the value of production (GDP).

Finally, the index is not only confined to sustainability and social wellbeing, but also includes human development, economic structure, international trade, foreign image and innovation as intangibles. In other words, an indicator is obtained that enhances the picture and position of wealth in a country.

The model that the study proposes is to estimate intellectual capital which allows governments to gather information about the strategies involved and to commit themselves to controlling it with policies aimed at enhancing a country's foreign and domestic image, market openness and flexibility, professional training management, innovation in companies and households and sustainability. Therefore, intellectual capital provides an outlook for the medium and long term based on an integrated strategy of development of the people in a country, the infrastructures necessary to put it into practice and the environment for future development. Once governments have the information and the impact that inhabitants have on wealth has been determined, they will be able to guide said policies towards key objectives. In summary, they can consider the potential of intellectual capital to make their intangibles a source of future wealth, prosperity, wellbeing and growth.

INTELLECTUAL CAPITAL OF NATIONS: MAIN APPROACHES

The study and analysis to measure and valuate intangibles at macroeconomic level is known as "Intellectual Capital of Nations". It must be said that while different proposals and applications exist at firm level, in macroeconomics this field is still embryonic, no methodologies having been verified or enjoying widespread acceptance. Most proposals are confined to systematically compiling data without a comparative framework of reference, which in this case, is considered a first and necessary step towards obtaining a suitable model for measuring intangible capital.

Before analysing the different approaches to the intellectual capital of developed nations, it is necessary to establish the concept we are going to work with.

Intellectual capital from a firm 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 (1999), 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 region, the main difference is the quantity of information involved, as well as the peculiarities of the entity being studied (firm versus State). Sánchez (2004) briefly reviews these definitions, highlighting that for Bradley (1997a) 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 capitals, which allow 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 intangible capital, methodologically speaking, completes the definition of the value of a region's production, in the sense that 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 an indicator of country wealth that is more accurate than GDP, such that comparisons may be established between countries considering aspects beyond the simple value of production.

The intellectual capital of a nation requires the organisation of an extensive system of variables that help to discover and manage its invisible wealth. The latest studies undertaken range from those offering a limited scope (for example, inputs or intellectual property rights) to others that contain too many variables, making them difficult to interpret. These studies 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 firm management systems, particularly those based on the Skandia Navigator.
(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.

In the first group, focused on the macroeconomic level, it is worth highlighting the research by Yeh-Yun Lin and Edvinsson (2008). They use the Skandia navigator proposed by Edvinsson (Figure 1) establishing an index of national wealth that sums financial capital or visible wealth and invisible wealth, which would comprise human capital, processes, market and renovation.

These capitals are measured by means of two kinds of indicators: absolute, for example, "patents by habitant" and qualitative, measured on a 1 to 10 scale, for example, "image of nation". The authors recognise certain inevitable subjectivity in the measuring of intangible aspects, as these cannot be obtained by simply adding absolute indicators. In order to integrate quantitative and qualitative indicators the following approach is applied. The maximum quantitative value of the country is considered as 10 and a proportion is

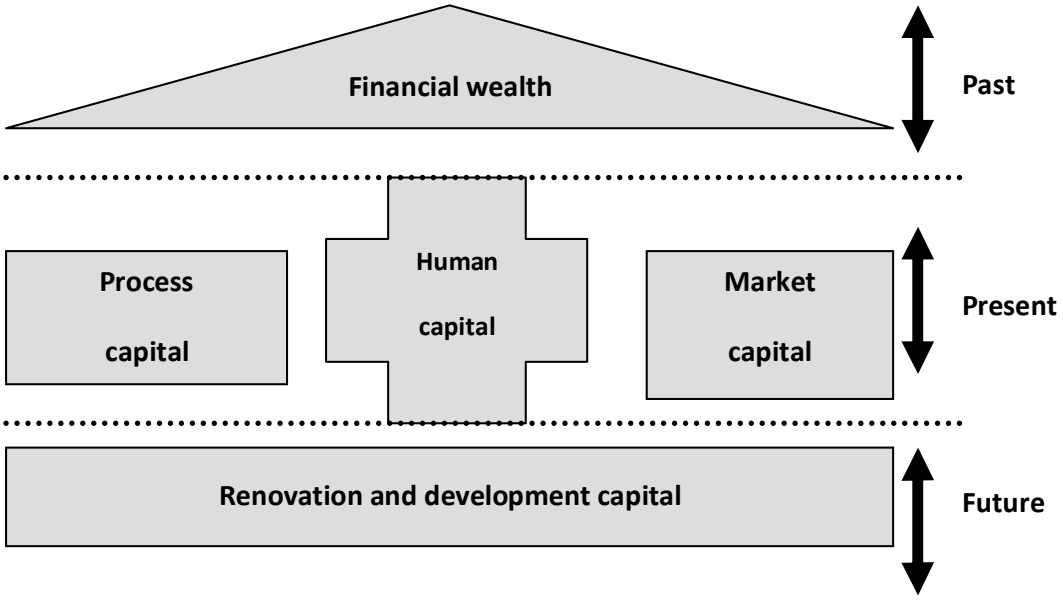

Figure 1. Navigator Skandia for countries. Source: Pasher (1999).

established for the other countries with respect to this. In this way quantitative and qualitative variables are scaled from 1 to 10. It is not explained clearly as the different indicators are integrated to obtain a capital and thus obtain the index of this capital. Everything suggests that the latter is an average of all those indicators. Finally, they calculate a global indicator of intellectual capital by summing the 5 capitals and add financial capital, which is represented by the logarithm of GDP per capita expressed in terms of purchasing power parity of each country. This GDP is calculated in relation to the highest value and transforming it into a 1 to 10 score.

In order to assure the validity of the variables selected in the measurement of the four capitals (human, market, processes, and renovation), LISREL is applied using "Amos 5", which allows to prove the validity of the measurement model.

The work details the data sources used for each indicator, although the data bases of the OCDE and the World Competitiveness Yearbook are the main two. With respect to the obtained results, due to information limitations, they apply the model to 40 countries over a period of 12 years, from 1994 to 2005, using 29 indicators. The Scandinavian countries are those that have a greater degree of intellectual capital; more specifically, they establish a ranking in which Sweden occupies the first place, Finland the second followed by Switzerland, Denmark, the United States, Norway and Iceland.

Furthermore, research on competitiveness considers other initiatives expressly related to macroeconomics using the national accounts as a basis. As regards this approach, it is worth highlighting the research by the World Bank (2006), which is a cross between benchmarking with competitiveness indicators and models inspired basically by the Skandia navigator. It considers factors that go beyond GDP per capita, like the natural capital of a country, its production and intangible capital. This last asset is the result of the sum of human capital, institutional infrastructure and social capital. That is, it takes into account the educational and labour development of the inhabitants of a country; networks of work between state institutions (justice, services, health, security…), their efficiency and coverage; the confidence of inhabitants in their own country and their ability to work towards a common objective.

It even includes aspects related to the legislation in the other two types of capital and how laws and policies boost and exploit them or only exploit and waste them. It also considers elements that are well-know but not used, such as wealth, international reserves and the financing of a country.

In this study the results obtained with data from the year 2000 for a sample of 120 countries show that 5% of the wealth of the world can be attributed to natural capital, followed by 18% to production, while intangible capital accounts for 77% of the wealth. It is also indicated that Switzerland is the richest country on the planet, while Ethiopia is deemed the poorest. As regards the conclusions, the study determines that the gap between rich and poor countries is wider under these new measurements.

One of the conclusions of the above research is that both visible and non visible assets must be considered in order to be able to measure national wealth. As regards the latter, the study also states it is necessary to establish

ways of measuring them both quickly and in such a way as they can be compared. In this sense, the tendency is to unify models towards those based on the Skandia Navigator but with different considerations regarding the capitals that make up intellectual capital.

Generally speaking, we can deduce from all the applied research that there is no clear methodology or a reference framework to measure national intellectual capital, as is the case in the business world.

AN ALTERNATIVE TO MEASURE INTELLECTUAL CAPITAL AT NATIONAL LEVEL

After reviewing the various 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 firm level to macroeconomic level, making any necessary adjustments. The study thereby establish some visible intangible assets and some hidden ones, the latter being the basis for the main models, such as the Skandia Navigator, Integrated Analysis and Balanced Scorecard, in order for regions to obtain tools for managing intellectual capital and to not confine the research to merely measurement and evaluation.

Using this approach, national intangible capital is defined as an immaterial element that generates future benefits and which can be controlled by 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 of the intellectual capital of a country, but even when their definition is changed to investment, they remain insufficient, 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 determine, as well as ascertaining whether or not this new wealth is more disperse than the wealth measured traditionally by means of production value.

Therefore, the intangible 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, by means of the 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. In this sense, the structure for measuring intangible capitals is summarised in Figure 2, which includes the various capitals in each group. While the majority of the research carried out at macroeconomic level to date focuses on the utilisation of visible capitals only (traditional approach), in this case emphasis is placed on hidden capitals, including human, structural and non explicit capitals.

Using this conceptual framework as a basis, an integrated ad hoc model is designed on a global scale, which is based on both the models of firm intangible capital management and also competitiveness analysis, under the theoretical and conceptual view of national intangible capital as an 'invisible value' of that space which represents the new wealth of nations.

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 the business approach must undoubtedly be transferred to the reporting systems for national accounts, as regards intellectual capital.

In accordance with considerations made in other models (Rembe, 1999; Roos et al., 2001), in the first place, it is worth establishing the vision of a country and its activities and projects and hidden intangible capitals as a whole by means of a National Index of Knowledge Capital (NIKC), identifying the indicator for each and allocating them to the capitals already defined.

Following this method, two large groups of capital are identified: human and non human capital. Structural or non human capital, due its very nature, will undergo the most changes in the case of nations. Apart from these two capitals, 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):

$$NIKC = Human + Structural + Non\ Explicit \quad (1)$$

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:

$$Human = Knowledge + Skill + Development \quad (2)$$

On the other hand, structural capital covers various intangible capitals related to the socio-economic framework of a country through:

(a) 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.
(b) Relation or trade capital, which captures the quality of the balance of trade.
(c) Marketing or image capital, which contemplates a country's domestic and foreign image and international relations.
(d) 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.
(e) Social and environmental capital, which is determined by the social commitment of the social welfare state in

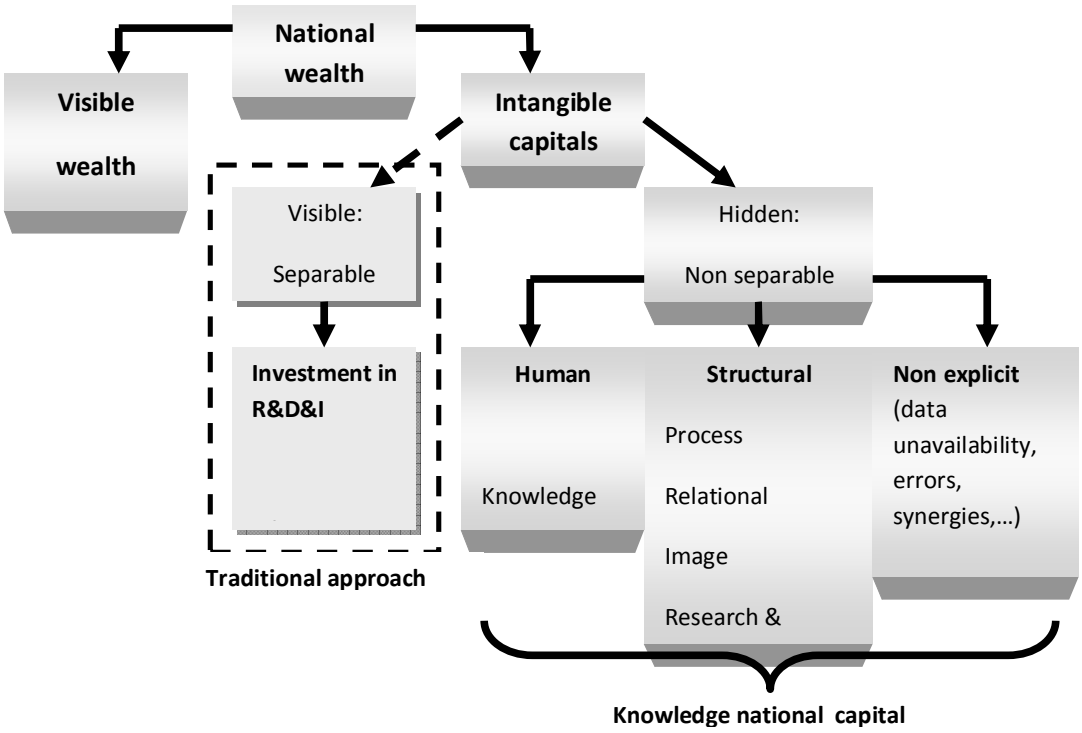

Figure 2. Structure for measuring intangible capitals. Source: Own elaboration.

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 + Social/environmental (3)

Finally, non explicit capital, as explained previously, 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.

The next stage of this research, once the measuring system has been determined, is to establish the indicator scorecard in order to be able to determine the intangibles included in Equations 2 and 3. In order to do so, two types of indicators are used: absolute indicators (AI) and efficiency indicators (EI). 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. This process of filtering expenses was inspired by the process presented for the first time for Skandia by Edvinsson and Malone (1999), later modified in the method of Integrated Analysis by Nevado and López (2002) and López and Nevado (2006).

$$C = \sum_{c=1}^{m} AI_c \cdot \sum_{i=1}^{k} w_i \, EI_{ic} \quad (4)$$

where human or structural capital, C, is estimated by one or more absolute indicators m, filtered by k efficiency indicators and synthesized into one sole indicator, weighted in accordance with a subjective weighting w.

In this paper, the procedure followed to allocate weights to efficiency indicators is based on the development of a principal component analysis 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 (CP) as indicators available:

$$CP_i = \sum_{i=1}^{k} u_i EI_i \quad (5)$$

where u_i are the characteristic vectors of each principal component; and EI_i, the efficiency indicators (variables) under consideration.

Once these components have been obtained, the study proceeded to build one sole indicator of efficiency by weighting each component in accordance with the percentage of variance retained by each.

$$\mathrm{EI_c} = \sum_{\mathrm{i=1}}^{\mathrm{k}} \mathrm{w_i} \mathrm{C}P_{\mathrm{i}} \quad (6)$$

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:

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

As a result, following a similar procedure to that proposed by Alfaro and López (2008), the study have obtained 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.

Now the method has been developed, we decided to apply it, but always with one fundamental limitation: the availability of statistical information. In this sense, the most complete data base in the world that is the closest to this approach is compiled by the World Bank Group (WBG). Notwithstanding, it must be complemented in some cases by information from other sources, namely the data bases of the structure of 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. Note: Sources in brackets if not WBG, year in brackets if not 2006 due to unavailability of data. The need for scores from absolute indicators at this level is a problem that if solved would improve the estimation. In this sense, for example, the budget for environmental expenditure or labour force compensation in a country would complement human and environmental capitals. As regards efficiency indicators, it would be positive to have, among others, indexes of higher education graduates, entrepreneurial motivation, organisation connections to the Internet, workers in high technology sectors, etc.

As a result of these limitations, a scorecard is designed (Table 1), which includes an open system of indicators to estimate intangible capitals on a national scale in accordance with the proposed method. Following the intellectual capital approach, the first column defines the intangibles to be estimated as generators of long term benefits. The study then justifies 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. Always efficiency or relative indexes are comparable, whereas the absolute indexes and the final values of intangibles may only be compared in relative terms (GDP and per capita).

The main differences, advantages and disadvantages that can exist between the model proposed by Yeh-Yun Lin and Edvinsson (2008) and the proposal model in this paper are:

(1) All the foregoing models consider the existences of visible and non visible national wealth, albeit using two different approaches to addressing them. The proposal model believes the two should not be summed to obtain a synthetic index of intellectual capital. On the other hand, Yeh-Yun Lin and Edvinsson (2008) consider that visible wealth or financial capital should be added to non visible wealth to determine total wealth.
(2) The proposal contemplates three dimensions more to make up intellectual capital that the Yeh-Yun Lin and Edvinsson model. On one hand, the Social-Environmental and Image dimensions are included due to their utility as generators of sustainable wealth for a country. The methodologies based on competitiveness indicators, not referred to in this study due to space limitations, already refer to these dimensions, which are also necessary, not only to manage a nation, but also to make comparisons. Finally, the third dimension is represented by non specified capital, although this is not taken into account in the empirical application. Nevertheless, this estimation would be possible with a dynamic approach for each country.
(3) The implementation of models involves establishing intangible capitals and the indicators to measure them. However, these indicators are treated differently. In Yeh-Yun Lin and Edvinsson (2008), all indicators, both qualitative and quantitative, are translated into percentages. As a result, the comparisons are carried out in percentages due to intangible capitals not being able to be valued. However, the proposal model distinguishes between absolute or monetary and relative or efficiency indicators, that correct to first ones. Efficiency indicators measure knowledge management. The option entails an important difference, obtaining comparisons in dollars per capita or as a percentage of GDP. This therefore, makes it possible to analyse both capital management and quantity.
(4) Diverse methods of adding indicators and obtaining an index for each capital are used. Yeh-Yun Lin and Edvinsson (2008) used an average while the proposal model uses a statistical technique (principal components). Considering that it has a minor cost, is faster and less subjective, as efficiency indicators are synthesized into a unique indicator for each capital based on considerations attributed according to the weight in the variance of their principal components.
(5) Divergence in the obtaining of a global indicator of intellectual capital. Yeh-Yun Lin and Edvinsson (2008) propose an average of the indexes obtained for each of the capitals including the financial one. However, the proposal would not include financial capital to obtain the index of national intellectual capital. However, in the study model, if the value of intellectual capital to the

Table 1. Scorecard for knowledge capital of nations.

Intangibles	Indicators		
	Theoretical justification	**Absolute (AI)**	**Efficiency (EI)**
Human capital			
Knowledge	Qualifications	Education expenditure Capital formation Internal human capital (UNESCO)	Literacy index (adjusted gross school enrolment) (UNESCO)
Skill			
Development	Motivation and employability	Non residential wage mass and remittances. Human capital exported	Activity rate (UN)
	Excess employability		Adjusted migration (ONU, 2005)
Process capital			
Reporting and management systems	System/structure quality	Capitalisation/Market-value over resident firms as of 31st December	Adjusted firm start-up time Line index: adjusted mobile and land lines/inhabitant Internet users per 100 inhabitants
Organisational structure	Level of management: technology		
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 (WEF)
Research, development and innovation capital			
Innovation, research and development	Level of innovation and development	Investment in R&D&i (UNESCO)	Line Index: adjusted mobile and land lines/inhabitant
	Technological level		Internet users per 100 inhabitants

Table 1. Contd.

Social and environmental capital			
	Environment		CO_2 emissions per capita (2004)
	Sustainability		Hectares of green areas/habitant (2005)
Social and environmental responsibility		Health expenditure (WHO, 2005)	Life Expectancy Index
	Quality of life, welfare society		Access to health system in rural areas
			Access to water

Source: own elaboration.

tangible value of production (GDP) were added, it would obtain the real wealth of a country (visible and non visible). It is necessary to know that Yeh-Yun Lin and Edvinsson (2008) speak of an efficiency index. However, in the proposal, absolute indicators are corrected by efficiency indicators, which allows for the estimate intellectual capital in monetary terms and as a percentage of GDP.

(6) Finally, these papers also analyse the positive relationship between national intellectual capital and GDP. In addition, the differences between "rich" and "poor" countries are even greater when non visible wealth is considered. In other words, the wealthiest nations are even more efficient in terms of knowledge than poor nations. As a result, intangibles are widening the global gap in development.

NATION RANKINGS

Finally, it is interesting to compare the results of the model proposed in this paper to those from two consolidated proposals, namely those in the World Bank (2006) and Yeh-Yun Lin and Edvinsson (2008). In order to do so, the study first proceeded to calculate the value of intellectual capital in the nations considered by all three papers. The model estimates the value of each country's intangibles, which if added to the tangible value of product (GDP), provide, in accordance with the proposed model, the real visible and non visible wealth of a country. Table 2 displays the results in per capita terms in the last column. Analysing the results of the National Index of Knowledge Capital per capita (NIKC p.c.), the countries that recorded the highest scores were Switzerland, Norway, Sweden, United States, Denmark, United Kingdom and Ireland, whereas India, Philippines, China, Thailand and Brazil registered the lowest scores. Scores are generally speaking quite similar. All the studies show that the highest level of intellectual capital is recorded in the most developed nations. If we compare the rankings from the World Bank (2006), Yeh-Yun Lin and Edvinsson (2008) and the model proposed for the countries included in all three studies (Table 2), results are very similar. This similarity is corroborated, as Spearman's rank correlation coefficient between the rankings takes a value of0.93 when we compare the proposed model and the ranking from Yeh-Yun Lin and Edvinsson (2008).

Meanwhile, when we compare the model to the results from the World Bank (2006), said coefficient takes a value of 0.91, which reveals the presence of a high level of agreement among the rankings. Therefore, the results lead us to conclude that the model proposed could be considered a coherent alternative for measuring national intellectual capital.

In the same line, the studies reach the conclusion that intellectual capital divergent that is, there is an intellectual gap if this measure of wealth in nations as complementary to GDP were considered.

CONCLUSIONS

In economics, it is becoming increasingly necessary to consider aspects that go beyond output in order to measure wealth and social wellbeing. However, there is no agreement at present over the measures that could be used to perform such a calculation. As a result, in this paper, a model to determine the intellectual capital of nations based on an adaptation of a business model was proposed. More specifically, various hidden capitals have been considered in order to provide a more truthful picture of the real economic potential of nations by means of a

Table 2. Nations rankings and national index of knowledge capital.

Country	World Bank ranking	Yeh-Yun Lin and Edvinsson ranking	NIKC ranking	NIKC p. c.
Argentina	22	30	29	3951.37
Australia	15	8	10	61650.24
Austria	7	9	14	48810.3
Belgium	10	13	12	52465.66
Brazil	23	28	30	3878.42
Chile	24	22	22	10712.28
China	33	33	32	1640.33
Denmark	2	4	5	75035.78
Finland	12	2	9	66908.79
France	9	16	11	54835.77
Germany	5	11	15	42511.1
Greece	19	23	18	30119.05
Hungary	25	20	23	8723.64
India	34	34	34	571.74
Ireland	16	12	7	70680.54
Italy	14	19	17	34125.42
Japan	6	10	13	49075.57
Korea	21	17	20	22367.42
Malaysia	29	21	24	8700.15
Mexico	26	32	27	5786.63
Netherlands	11	7	8	67977.74
New Zealand	18	15	19	25900.99
Norway	8	6	2	120304.56
Philippines	32	24	33	817.14
Portugal	20	25	21	18788.54
Russian Federation	30	31	26	7353.14
South Africa	27	26	25	8497.32
Spain	17	18	16	37600.45
Sweden	3	1	3	82801.41
Switzerland	1	3	1	160968.46
Thailand	31	27	31	2595.26
Turkey	28	29	28	4651.24
United Kingdom	13	14	6	74509.91
United States	4	5	4	82730.61
Correlation coefficient	0.89	0.93	0.91	

National Index of Knowledge Capital (NIKC), identifying indicators for each and assigning them to the capitals defined.

Following this approach, the study aim to classify and conceptualize the structure of intangibles in a nation, distinguishing between visible and hidden, with measuring efforts focusing on the latter. In order to achieve this, a model based on aggregating human, structural and non explicit capitals is proposed. Human capital includes knowledge, skills and personal development towards accomplishing goals. Structural capital comprises various intangible capitals: process capital, relation or trade capital, marketing or image capital, research, development and innovation capital (R, D & I) and social and environmental capital. Non explicit capital completes the picture by capturing variable estimation errors, omission of relationships, synergies and/or unavailable intangible capitals. Finally, this approach is an alternative to exclusively considering visible assets such as technology or education, traditionally considered references for the structural and human perspective of a nation.

On adapting the model, further research was performed into the allocation of filters (indexes) to economic aggregates (absolute indicators) which generate value, underlining the nature of capital being observed and the availability of statistics to develop it. In addition, the model used allows weightings to be assigned objectively

in order to obtain a synthesis of efficiency indicators. Moreover, the results include an estimation of the value of each country's intangibles and for each type of capital, which together with the tangible value of production provide, according to the proposed approach, the real (visible and non visible) wealth of a country.

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