7. ECONOMIC GROWTH AND INTANGIBLE CAPITALS: AN INTERNATIONAL PANEL DATA MODEL APPLIED IN THE 21ST CENTURY

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Abstract

A country's wealth is not only due to GDP. We must also consider intellectual capital as a generator of future value. In this paper we propose a model to measure and value this capital and its components in order to complement GDP. We developed an empirical application that analyses the importance of each intangible capital according to the level of GDP per capita attained to 72 countries. As a result, economic growth in developing countries displays a stronger relationship with intellectual capital. Within intellectual capital, the human factors and more specifically people's qualifications, has the greatest effect on economic growth. As regards the structural factors, social and environmental capital is the most significant in developing countries, while research, development and innovation capital is in developed nations.

Keywords: economic growth, intellectual capital, indicators, developed and developing countries, wealth

JEL Classification: O47, O57

I. Introduction

The economic development of a country has been associated to its economic growth measured in terms of Gross Domestic Product (GDP). Nevertheless, development involves a process of change that takes place in different ways in different countries and at all levels. Therefore, measures that inform how such development takes place in

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different countries are required. In this sense, it is possible to analyse whether or not there are any similarities between developed and developing countries (in terms of GDP), as well as what action should be taken in order to eliminate the inequalities between them. The national intellectual capital term has become enormously important as a complement to explain such economic development. Economic growth cannot be reduced exclusively to measures in terms of GDP, as indicated by Stiglitz (2003), but must consider other sources of wealth. Yeh-Yun Lin and Edvinsson (2010a), for example, state that "…intangibles are one of the most important sources of prosperity and progress".

Therefore, a nation's wealth cannot be measured only in economic terms as it is necessary to consider other factors such as the real abilities of citizens, the chance of attaining sustainable development and the country's technological potential. In this sense, a couple of contributions aim to uncover the non-measurable elements of economic growth. In a neoclassical framework, the Solow residual (Solow, 1956) considers that long term growth depends exogenously on technological progress and population growth. Another strand of literature has focused entirely on investment in R&D, human capital, knowledge spillovers and their impact on growth. As a result, a debate has arisen regarding endogenous and exogenous growth, with different interpretations insofar as how to reach the stationary state. In this sense, Romer (1986) and Lucas (1988) determine that capital investment and the accumulation of knowledge or human capital are a source of endogenous growth, both indicating that growth diverges. However, Abramovitz (1986) and Baumol (1986) in response, among others, defend unconditional convergence, thus renovating the exogenous growth theory.

Using intangible capital (IC) as a basis, we align this paper with the theory of endogenous growth, the management of said capital turning out to be a diverging factor for economic development. Therefore, the traditional definition of capital as a set of resources with the potential to be invested in the creation of economic value is overly rigid and insufficient to explain the generation of wealth in the knowledge society. Several papers emphasize the importance of intellectual capital, or some of its components, in economic development. Capello & Nijkamp (2009) used human and knowledge capitals, Cooke et al. (2007) used mainly knowledge and Acs *et al*. (2002) innovation. As Stam and Andriessen (2009) put it, "the main motivation for measuring the IC of nations is to get insight into the relative advantage of countries or regions".

On the 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). 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 well-being. Some examples worth highlighting include the Index of Sustainable Economic Welfare proposed by Daly & Cobb (1989), the research by Chen & Dahlman (2005), which assesses the effects of knowledge on economic growth using an array of indicators that consider 92 countries for the period 1960 to 2000, or the research by the World Bank (2006) on 120 countries.

In this sense, we determine in this document the monetary value (per capita at constant dollars) of different intangible capitals considered in national intellectual capital in order

to analyse them in economic terms and consider their relationship with the value of production (GDP per capita at constant dollars, GDPpc). Once governments have the information and the impact that inhabitants have on wealth, they will be able to orient their policies towards key objectives. In summary, they can consider the potential of intellectual capital to make their intangibles a source of future wealth, prosperity, well-being and growth in order to reduce the inequality among countries.

In order to do so, we developed several hypotheses about the behaviour of economic growth at international level. So as to verify these hypotheses, we incorporated measurements of intangible capitals according to a mathematical model. This model values these capitals with an efficiency filter obtained by a principal component analysis. We study the hypotheses by way of a comparative analysis of economic growth and its relationship with the components of intellectual capital. In addition, we defined two clusters according to national GDPpc that allow to differentiate between developed and developing countries. The measurements and conclusions are supported in a data panel model considered for 2000-2008 with 72 countries, for which the different relationships with growth are considered. Moreover, the possible convergence over the sample period is analyzed in terms of wealth, including intangible capital.

II. Methodology and hypotheses formulation

In the referenced and other specialised literature we can find different proposals and models to evaluate the intellectual capital of nations. Nevertheless, there is no widespread agreement on the best way to estimate this, although there are certain coincidences in the structure that must have (López *et al*., 2010; Alfaro *et al*., 2011a).

In this sense, we develop an international model to estimate intellectual capital and its components. This model is applied to 72 countries over the period 2000-2008. The results make it possible to estimate the different relationships between the components of intellectual capital and economic growth in terms of GDPpc, using an economic data panel model. This allows us to contrast different hypotheses in order to establish considerations about international economic growth. Furthermore, we can make several recommendations towards generating future value and, therefore, growth using policies targeting intellectual capital.

Thus, countries rich in intangible assets fare better in terms of national wealth than those whose assets are limited to land, tools, and labour (Malhotra, 2003; World Bank, 1998). This allows us to establish the first general hypothesis:

H1: Intellectual capital and its components are more closely tied to growth in developing countries than in developed economies.

There has also been research that has explored the inter-relationships among the independent variables: national human capital, national process capital, national market capital, national renewal capital and the dependent variable, national financial capital for a sample of 10 Arab countries (Bontis, 2004). This paper made two proposals of models of national intellectual capital. One considers that national intellectual capital accounts for nearly one-fifth of the explanatory power of financial wealth of the Arab region. The second establishes that human capital is the pre-eminent antecedent for

the intellectual wealth of a nation. We can therefore establish the second general hypothesis to be verified as:

> **H2: Human capital is more important than structural capital for growth in both developed and developing nations.**

On the other hand, Yeh-Yun Lin and Edvinsson (2010b) have carried out a study of the components of national intellectual capital considering that human and renovation capitals better forecast the long term development of intellectual capital, whereas process and market capitals would be better for short term levels. In this sense, a study of a country by means of the components of its intellectual capital could yield its long and short term development possibilities and also whether or not the country in question could get into trouble (crisis) or grow. Bearing this in mind, we consider two specific hypotheses related to human and innovation capitals:

> **H3: In human capital, qualifications have a very significant relationship with growth, both in developed and developing countries, but more in the latter.**

> **H4: Research, development and innovation capital is more important in the growth of developed countries than developing countries.**

Also, other research has shown how certain components of intellectual capital can impel growth in some countries, but can also become saturated in others. For example, Inglehart (1997) and Neuhaus (2005) have shown that democracy and trade openness effectively boost the economy in certain circumstances. In this sense, Ståhle and Bounfour (2008) established that in certain developed countries there are drivers that are saturated, whereas in other countries these same drivers can be interesting for growth, giving computer usage as an example. This situation implies that it is difficult to analyse intellectual capital and that results cannot be extrapolated to all contexts. As a result, it is necessary to find similarities in the development of economies (developed, developing and in transition) and study the dynamics of intellectual capital (relationships, tendencies, weight of the components, etc). In this sense, the hypotheses to verify would be the following:

> **H5: Leading countries in terms of wealth display saturated capitals for growth, particularly process capital and also marketing and image capitals.**

> **H6: In developing countries, social and environmental capital is the most important capital for economic growth.**

When these hypotheses are verified, we will obtain the main conclusions and future lines of action of the paper, analysing the effect of the different elements of intellectual capital in international economic growth.

III. An international model to estimate intellectual capital and wealth

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 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 determine national intellectual capital. In order to do so, the changes in reporting systems made in the microeconomic approach must undoubtedly be transferred to the reporting systems for national accounts, as regards intellectual capital.

We begin with the following equation in order to define the wealth (W) of a nation (n) as economic production (GDP) plus National Intellectual Capital (NIC).

$$W_n = GDP_n + NIC_n \quad (1)$$

Following this method, two large groups of capital are identified as intangibles: human capital (HC) and structural or non human (SC) capitals. Structural capital, due its nature, will undergo the most changes in the case of nations.

$$NIC_n = HC_n + SC_n \quad (2)$$

Human capital encompasses knowledge, skills and personal development towards achieving objectives (that is, Qualifications – QHC). It also includes cultural values, national labour market conditions and resource inflows from workers abroad (that is, the labour market –MHC).

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

- Process capital (PrC), 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 (RC), which captures the quality of the balance of trade.
- Marketing or image capital (MC), which contemplates a country's domestic and foreign image and international relations.
- Research, development and innovation capital (RDC), which explicitly measures innovation, research and development possibilities through investment and how efficiently existing resources are exploited.
- Social and environmental capital (SEC), 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.

The next stage is to establish the indicator scorecard in order to be able to determine the intangibles considered in equation 2. Finally, overcoming the main problem related

to obtaining information, two kinds of indicators are used: absolute indicators (AI), in monetary terms, and efficiency indicators (EI), on a percentage scale. In order to obtain the latter, we have used the method developed for the first time for Skandia by Edvinsson and Malone (1997) and later modified in the method of Integrated Analysis by López & Nevado (2006) and Alfaro *et al*. (2011b), that it can be analysed in the last paper.

In this sense, using information referring to 72 countries, selected considering statistical data availability limitations, we have estimated national intellectual capital and its components in per capita terms at constant dollars. This allows us to compare the values of intangible capitals across different countries. In order to do so, we prepare a database using information from the World Bank Group (WBG), the United Nations (UN) and the World Economic Forum (WEF) for the period 2000-2008. More specifically, we have considered years: 2000, 2005 and 2008 in order to construct a panel data model.

IV. An international panel data model: relationship between growth and intangible capitals

Using panel data information for the 72 countries in the years 2000, 2005 and 2008, we studied the relationship between the components of intellectual capital and growth in terms of GDPpc. More specifically, we have considered three models in which the endogenous variable is GDPpc and we have analysed its relationship with the different components of human capital (regression 1), the components of structural capital (regression 2) and human and structural capitals as a whole (regression 3). In this sense, we have used Pooled Least Squared method with constant coefficients for information restrictions. For each regression, we estimate the effect (coefficient or elasticity) on growth of each capital.

In addition, in order to show the different effect of the economic level of the countries on these relationships, we have estimated them considering the 72 countries (Table 1) and the countries defined according level of GDP. Cluster 1: Developed countries with 20 components (Table 2), and Cluster 2: Developing countries with 52 elements (Table 3).

The results displayed allow us to verify the established hypotheses. In particular, the first hypothesis considered that intellectual capital and its components are more closely linked to growth in developing countries, an assumption that is verified because, in terms of development, intellectual capital is better in cluster 2 (Table 3) than in the cluster 1 (Table 2). This affirmation is based on the higher values of the determination coefficient in the relations considered for developing countries that show highest relationship in this group of countries.

Differentiating components, a more significant relationship is clearly seen in the human capital components for the three cases considered. More specifically, the elasticity values on economic growth obtained in regression 3 are higher for human capital. For example, the elasticity value is 0.8 for the 72 countries compared to 0.048 for structural capital. These results verify the greater relevance of human capital, as hypothesis 2 considered. Moreover, as the hypothesis 3 stated, it is also clear that the qualifications of the inhabitants of a country, is the most important for the economic growth. Thus, for

example, in regression 1 for developing countries, elasticity was 0.14 for qualifications but only 0.006 for labour market conditions.

The effect of structural intangible components on economic growth is different depending on the cluster to which countries belong. Generally, if we applied the model to all 72 countries, all the components register a significant relationship that we show with the t statistic of regression 1 (Table 1). By cluster of countries, it is worth highlighting the greater significance of research, development and innovation capital in the economic growth of developed countries. In this sense, the elasticity of this capital in that group of countries, as forecast in hypothesis 4, is higher than the value for developing countries. This shows that this capital is more important in developed countries than in developing countries.

Nevertheless, when we consider only the sample of developed countries, process and image capitals are not significant. In this case we can interpret that these intangibles have reached the maximum in these countries and for this reason, improving them does not contribute to economic growth. This means that these capitals are saturated and, consequently, the best policy consists in maintaining the level of these capitals (hypothesis 5). In developing countries, social and environmental capital shows a more significant relationship with economic growth (hypothesis 6). Therefore, aside from what we have said previously about qualifications, it is necessary to harness the basic policies at structural level to especially secure growth, in developing countries.

In order to complete the study, we explored whether or not intellectual capital constitutes a divergence factor for economic growth in terms of wealth (W). That is to say, if in these terms, developed countries grow more in this period. Concretely, convergence exists if poor economies tend to grow faster than rich ones.

Table 1

Growth and Intangibles: Total Panel Data

Components	Regression 1		Regression 2		Regression 3	
	Coefficient (Elasticity)	T-Stat	Coefficient (Elasticity)	T-Stat	Coefficient (Elasticity)	T-Stat
Qualifications (QHC)	15.54272 (0.804)	49.15132			14.67855 (0.803)	43.84944
Motivation and employability (MHC)	18.44895 (0.056)	12.60838				
Process (PrC)			0.083239 (0.047)	3.925446	0.056509 (0.048)	5.543384
Relational (RC)			1.670248 (0.062)	5.644141		
External and internal Image (MC)			0.050209 (0.0096)	2.247112		
R&D and Innovation (RDC)			9.360531 (0.114)	3.800079		
Social and Environmental (SEC)			14.22958 (0.555)	14.34199		
R^2	0.936433		0.937913		0.943563	

Source: Own elaboration. Pooled Least Squares. Total panel observations: 216 (3x72).

Table 2

Growth and Intangibles: Cluster 1 (20 Developed Countries)

Components	Regression 1		Regression 2		Regression 3	
	Coefficient (Elasticity)	T-Stat	Coefficient (Elasticity)	T-Stat	Coefficient (Elasticity)	T-Stat
Qualifications (QHC)	10.42243 (0.5627)	11.2674			10.63764 (0.6080)	12.7506
Motivation and employability (MHC)	18.52413 (0.0586)	8.9648				
Process (PrC)			0.01423 (0.0102)	0.5958^{NS}	0.061902 (0.0664)	4.1831
Relational (RC)			2.5018 (0.1160)	7.4415		
External and internal Image (MC)			0.0219 (0.0056)	0.893^{NS}		
R&D and Innovation (RDC)			9.38492 (0.1372)	2.9643		
Social and Environmental (SEC)			6.87269 (0.2814)	4.8956		
R^2	0.807018		0.896350		0.822162	

Source: Own elaboration. Pooled Least Squares, observations: 60 (3x20). NS: Non Significant at 0.05.

Table 3

Growth and Intangibles: Cluster 2 (52 Developing Countries)

Components	Regression 1		Regression 2		Regression 3	
	Coefficient (Elasticity)	T-Stat	Coefficient (Elasticity)	T-Stat	Coefficient (Elasticity)	T-Stat
Qualifications (QHC)	17.24606 (0.1395)	34.10848			15.0415 (0.1279)	22.2634
Motivation and employability (MHC)	14.02332 (0.0059)	2.30513				
Process (PrC)			0.0302124 (0.0009)	3.213555	0.334958 (0.0153)	3.59098
Relational (RC)			2.692577 (0.0050)	5.944523		
External and internal Image (MC)			3.199121 (0.0175)	8.314262		
R&D and Innovation (RDC)			7.982503 (0.0092)	4.762460		
Social and Environmental (SEC)			17.85262 (0.1117)	26.98342		
R^2	0.929062		0.957342		0.934468	

Source: Own elaboration. Pooled Least Squares. Total panel observations: 156 (3x52).

Non-linear approach, by Barro & Sala-i-Martin (1996), estimate a coefficient as speed of instantaneous convergence of an economy towards its steady-state position and it is invariant to the length of the sample. We use this approach, following equation 3, where, in our case, 'y' is NIC, GDP or W; 'T' the length of the observation interval, 'i' indexes countries or economies, 't' indexes time, βj (j = 0,1) the coefficients (β_1 is the convergence coefficient) and 'ε' is the error term with distribution N(0, σ^2_ε). Main results are showed in Table 4.

$$(1T)\cdot\log\left(\frac{y_{i,t}}{y_{i,t-T}}\right)=\beta_0-\left[\left(\frac{1-e^{(-\beta_1\cdot T)}}{T}\right)\cdot\log(y_{i,t-T})\right]+\varepsilon_{it} \quad (3)$$

Table 4

Convergence Analysis

Concept	2000	2005	2008	2000	2005	2008
Total – Average	11,541.031	14,590.920	12,027.659	10,647.750	14,310.734	17,111.416
% GDP	108.39	**101.96**	**70.29**			
Correlation with GDP	0.675	0.737	0.670			
Beta convergence (T-Stat) **R^2**	--	0.0141 (2.4934) **0.087**	0.0212 (5.005) **0.298**	--	-0.0067 (-1.22)^{NS} 0.0200	0.0001 (0.03)^{NS} 0.00001
Cluster 1-Average	38,532.42	46,993.59	38,126.88	27,434.14	37,918.08	44,064.34
% GDP	140.454	123.934	86.525			
Correlation with GDP	0.660	0.776	0.644			
Beta convergence (T-Stat) **R^2**	--	0.0539 (1.961)^{NS} **0.2196**	0.0138 (0.99)^{NS} 0.0575	--	0.0408 (1.752)^{NS} 0.1735	0.0213 (0.96)^{NS} 0.0571
Cluster 2-Average	1,159.726	2,128.343	1,989.498	4,191.443	5,230.984	6,744.905
% GDP	27.669	40.687	29.496			
Correlation with GDP	0.918	0.874	0.909			
Beta convergence (T-Stat) **R^2**	--	0.0056 (0.56)^{NS} 0.0065	0.0156 (2.014) **0.0842**	--	0.0019 (0.19)^{NS} 0.0007	0.0040 (0.51)^{NS} 0.0054
Beta convergence W (T-Stat) **R^2**				--	-0.0001 (-0.28)^{NS} 0.0012	**0.0081** (2.018) **0.0585**

Source: Own elaboration. NS: Non Significant at 0.05.

If we observe convergence in GDPpc terms did not exist in any case. However, in terms of the value of intangibles there is convergence in worldwide intellectual capital, albeit very weak over the period 2000/2005 with a very low determination coefficient (R^2 = 0.087), but more significant (R^2 = 0.298) for the period 2000/2008.

Later, we study conditional convergence. In this way, we restrict the convergence study to a set of economies for which the assumption of similar steady-state is not unrealistic (where technologies, institutions, income, intangibles… are more similar). Them, we estimate convergence by cluster analysed. The previous result can be supported on two

different grounds. In the first period, convergence takes place between developed countries with more significant values for this cluster, however in the total period, convergence is observed in the group of developing countries.

Finally, if we study absolute convergence in wealth terms for the 72 countries, we can conclude that intangibles do not constitute a clear convergent factor for the moment. The rate of convergence (coefficient 0.008) was 0.8% for the period observed as a whole, but with irrelevant significance because the value of the determination coefficient is 0.058. These values can be justified only by the general impoverishment of the world-wide population in intangible terms. Furthermore, it is interesting to analyse as the valuation of intangibles anticipates the worldwide recession, with a strong fall being registered in terms of GDP (it fell to 70.29% in 2008 from 101.96% in 2005, Table 4). That is to say, worldwide wealth decreases strongly in 2008, but due to the capacity to generate future value not to production value.

V. Conclusions

This paper analyses the impact of the different components of national intellectual capital on the economic growth of a country. For this reason, and so that the results can be compared across countries, we have measured GDP and the different components of national intellectual capital in per capital terms and constant dollars.

In this sense, we propose a model of intellectual capital valuation that serves as a complement to GDP to determine the wealth of a nation. With these valuations, we analysed the relationship between intellectual capital components and economic production (GDPpc). In this sense, we verified different hypotheses that allow to analyse the effect of possible policies of investment in intangible capitals for international economic growth.

Thus, in order to analyse the wealth or development of a country, we must consider both tangibles in the short term (GDP), and also intangibles in the long term (intellectual capital). In addition, by including the future capacities of gains in wealth, we can anticipate recessive or expansive phases. Indeed, we observed that as worldwide wealth decreased strongly in 2008 due to a decrease in its capacity to generate future value, not to GDP.

Intellectual capital is very important for the economic development of all countries, but particularly for developing economies. Considering its components, human capital is especially important for growth in all countries and human resource qualifications for developing countries. Moreover, research, development and innovation capital is more important for developed countries than for developing countries. Therefore, in developed economies this capital is the most important structural capital for future growth, whereas image and process capitals are not so important because they are saturated. In developing countries, it is social and environmental capital that is the most important structural capital for their growth, which is why policy-makers must be particularly careful when designing strategies to invest in this capital and also human capital.

Finally, the theory behind the research undertaken in this paper on intangible capitals and economic growth can be considered an endogenous development theory, because

convergence in terms of wealth for this decade is not evident and is supported by the general impoverishment of intangibles in 2008, more than by development reasons. Therefore, intellectual capital is a key factor for growth, but development in this sense corresponds to each country.

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