

## May intellectual capital influence innovation? A Worldwide empirical study

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### Abstract

The aim of this paper is to try to catch the influence of intellectual capital on innovation. In order to measure the intellectual capital, there were considered three components as being three indexes through we have measure the Intellectual Capital: Human Index Capital, Education Index and the National IQ and Innovation was measured through Innovation Index. Three equations were constructed in order to see if there is an influence or an impact of each dimension of Intellectual Capital on Innovation. Our research was made over a period of 15 years (2005-2020) and the sample is composed by 186 countries. The relationship between Innovation and Intellectual Capital was studied using Panel Least Squared (PLS). The results showed us that in all three cases between Innovation and each component of Intellectual Capital there is a positive relationship.

**Keywords:** intellectual capital, innovation, education, human capital, IQ

**Jel Codes:** C1, J21, J25, O3

### 1. Introduction

Being a topic of major importance nowadays, the study of intellectual capital has become a very important topic in future or existing research. Since the time of its emergence, intellectual property has developed into a system of protection of the results of human creation. Thus, the interest for this has grown significantly and the interest for the economic aspect has become evident. Intellectual capital is considered as a key resource for expanding intelligence, as its name suggests. Over time, it has received a number of definitions, but in the present no consensus has been reached regarding its explanation. However, intellectual capital is the key to all organizations given that it is made up of all the knowledge, experiences, values, skills that an employee has in a company. The economic development is the point for any company and also for any nations since it always. It could be said to be a multidimensional process that can involves changes in the national institutions, companies and the entire world. That's why the concept has been suffer a lot changes (Omiunu, 2019). Nowadays being a top of major importance the study of intellectual capital has become a very important topic for the present and further studies. Since of it was mention it was very developed due to the fact that is was associated most of the time with knowlegde, experience, values, skills not only for the companies but also for the entire economy of a country and also for the entire world. In this way, the interest for this topic has grown significantly and interest for the economic aspect became obvious. But we can not stop by mention only the intellectual capital without the parts that compose it.

We need to know that also the human capital is an important part of this large topic. We say this thing due to the fact that without human force the world can't function. But also there are a lot of controversy because nowadays the technology is gaining more and more ground. But also we need no reinforce the fact that without people the technology wasn't able to be born.

Even if we talk about towns and organizations, there are still individuals and groups that are still trying to grow. In order to be more famous and also to gain profit, they try to grow in order to improve their situation. The concept of innovation, technology transfer, and competitiveness is an integral part of the modern economic growth process, which shows that a long-term sustainable growth can only be achieved through the continuous input of knowledge and research. Due to the endless possibilities of innovation, the world's nations have developed their own long- and medium-term growth strategies.

## 2. Literature review

Nowadays, the new economy or the knowledge economy reflects that kind of economy which pass beyond the stage where knowledge represents the key and there are a lot of factors which influenced this, like: IT progress, the increase of the development speed of the new technologies, competition at global level and now we can mention that the phrase ‘time is money’ was replaced successfully with ‘knowledge is power’ (Achim & Borlea, 2013).

After a short literature review we found out that Intellectual Capital was launched for the first time in 1969 by J.K. Galbraith who said that the intellectual capital means all intellectual activity (Bontis, 1996). But also, we need to know that the concept of intellectual capital was defined and argued for the first time by another author Thomas A. Stewart. This concept is often used in accounting to refer to intangible assets that are also included in the calculation of financial statements. Even if this concept was not presented as such, it is still used since 1964 by Becker.

In trying to measure the national IQ, Lynn & Becker in the book *The Intelligence of Nations*, made a fictive study in order to estimate and compute National IQs but on fictional examples. They supposed to found two nations and form four samples divided in two, one named Utopia and the other named Dystopia. The all information was taken from NIQ- dataset, and named all countries alphabetical but with codes. In order to test their characteristics, they include information about the tests employed and their application for the mentioned sample. In this way, the first variable refers to the IQ-test which was used to measure the intelligence and the other refers to the test on which scale IQs was computed in NIQ-dataset, but we have to mention that both are identical.

After all, the uncorrected IQ-scores had to be adjusted because the 20th century expressed a massive secular increase in IQ-test scores in different countries, especially in Western or developed countries. This phenomenon was firstly found in 1938 by Merrill for a US- sample and after became the Flynn-Effect, named by Richard Flynn (Lynn & Becker, 2019, p. 33).

These effects conduct to the phenomenon of IQ or to the norm-inflation, which manifests itself as an overestimation of IQs if the norms applicated are older than the year of the measurement, or to an underestimation if the scores from a measure is an earlier year and was converted to IQs by using more recent norms (Lynn & Vanhanen, 2012). The final results give the number for the measure of IQ for each country.

The importance of intellectual capital is clear. A system that does not develop the necessary skills to effectively utilize knowledge can lead to the risk of unemployment. This is why it is important that we promote higher education. Being able to accumulate and use human capital is beneficial for many reasons. It can help boost productivity and potential gains.

In 2002, Meisenberg and Lynn conducted a study on the validity of national IQ tests in over a hundred countries. The correlation between the national IQ and the EA shows that these two measures can be used as equal measures of human capital (Lynn, 2010).

Human capital is linked to the economic growth. In 1998, Lucas construct a clear link between human capital and economic growth and explained that the combination of physical and mental capital is the main driver of the economic development. Human capital is considered as a vital part of economic growth. It can improve the productivity of workers and also contribute to the reduction of poverty.

The human factor is also the main driver of innovation. It influences the efficiency of any innovation process. The various factors that influence the innovation process such as technology and capital are also important in cultivating a healthy society. So, developing nations can attract skilled human capital by investing in education and research (Dutta & Landvin, 2014). The study conducted by Galovska in 2018 examined the link between the quality of education and human capital. The author noted that companies should start investing in education to improve their human capital (Galovksa M, 2018). One of the most critical factors that companies have to consider is the importance of innovation. Its positive effects on the company's profitability are numerous (Tseng & Goo, 2005). The innovation process is characterized by the complexity of its tasks and procedures, which can be attributed to the varying levels of knowledge required to carry out its tasks (Aramides & Karacapilidis, 2006).

Another paper made by Hayakawa et. al., aims to analyze how the dualities in and the inequality of human capital can be strengthened and sustained over time through a strategic choice model. We argue that this process is the result of the agents' decisions as they respond to the technological innovation that has brought about the accumulation of human capital. The dualities in human capital arise when people make choices that are bound to increase the productivity of labor and promote growth. This paper shows that if the poor are not able to obtain

education, then the dualities may get worse with inflation (Hayakawa et. all, 2019). Being considered an important part of intellectual capital is also important in determining the capacity of a company to innovate (Broking, 1996; Edvinsson & Malone, 1997).

Like Kianto et al., mentioned in a study in 2017 “innovation in organizations is, first and foremost, a human issue. Since it is people who develop and implement ideas, innovation will depend on effective human resource management” (Kianto et al., 2017).

Other authors mentioned that “innovation is considered to be a source of competitive advantage” (Fonseca et al., 2015) and also innovation scholars have given attention to a lot of strategic factors that may affect the success of innovation activities and also R&D activities (Cassiman & Veugelers, 2006). Fonseca et al., in their study introduced an alternative perspective in what concern the human capital based on the tasks that are made by employees. The researchers analyzed the degree of abstractism and cognitive analytic tasks in order to study how these processes affect the innovation performance of companies. They also suggest that the tension between the innovation process and the organization could lead to the breakdown of it. In 2018, Hippe and Diebolt conducted a study to find out what the human capital of regions is contributing to the current regional disparities in economic development and innovation. They found that the past human capital is a key factor in explaining the current regional gaps in economic development (Diebolt & Hippe, 2018).

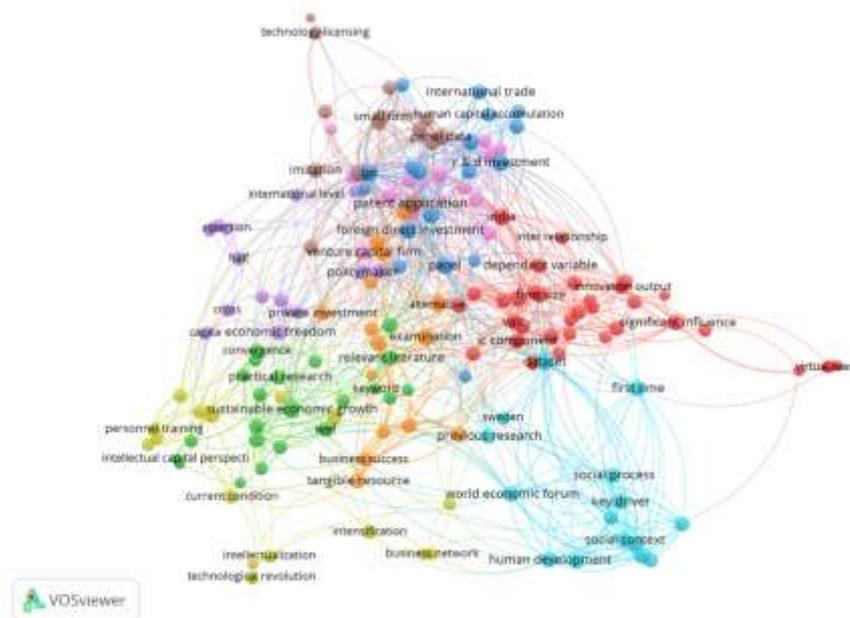
Guloglu and Tekin in 2014 examine the possible causal relations between R&D expenditures and economic growth in high-income countries. We find that the number of patents granted for technological innovations leads to higher economic growth. A reverse causality relation exists between the rate of economic growth and innovation. It shows that the increase in output accelerates the rate at which technological change occurs (Guloglu & Tekin, 2014).

A study conducted in 2011 by Winters examined the effects of higher education institutions and the human capital level on the quality of life within the US metropolitan areas. The paper revealed that the presence of higher education establishments greatly influenced the level of human capital within a region. Human capital and higher education institutions have the same effects, but they can also be separated by their quality of life measures (Winters, 2011). This study conducted in 2020 by Achim et al. explores the link between economic crimes and intelligence. For this study, they used a sample of 182 countries and time period 2012 to 2017.

Their study shows that intelligence has a significant impact on the level of financial crimes and economic crimes. It shows that intelligent people tend to respect the law and implement government policies in order to prevent these crimes. The results of the study reveal that for high income countries, intelligence is considered the main factor that influences the economic and financial crimes. For low income countries, intelligence is not considered the main factor that influences the crimes (Achim et al., 2020).

In 2009, Neagu et al. conducted a study on the evolution of knowledge based society and the knowledge economy. The paper aims to provide a conceptual framework for analyzing the various indicators related to knowledge-based economy. They found that the main difference between rich and less rich nations is the intangible assets that are related to knowledge (Neagu et al., 2009).

Higher education is an integral part of society, and its activities are influenced by the country's socioeconomic conditions and global trends. A study conducted in 2017 revealed that the efficiency of Ukraine's Higher Education System undermines the country's reform efforts. The authors introduce various theoretical and practical approaches for the formation of an organizational and economic structure for higher education in Ukraine. They discuss the various problems of the system and suggest various strategies and methods to improve its efficiency (Kumaiev et al., 2017). In order to reinforce our aspects mentioned before we will present a bibliometric map to show the relationships between our variables.



**Figure 1.** Intellectual Capital and Innovation

**Source:** authors work

In order to make this map first we selected all the approximately 2000 articles published in Web of Science Core Correlation and then we had introduced the data into Vos Viewer. When we have selected the papers, we choose the titles which were on our topic but also the abstract because we wanted to show as well as possible the relationship between our variables.

### 3. Data and methodology

The sample used in this paper is constructed from 185 countries and the analyzed period is 2005-2020. The data we collected from World Bank but the values were refined to a common scale of 0-100 and then in order to make the empirical study we used statistical program Eviews.

#### 3.1. Dependent variable: Innovation

One of the main factors that contribute to the nation's economic development is innovation. This concept has been widely used as a tool to add value and achieve competitive advantage (Dutta et al., 2018; Kaynak, Altuntas & Dereli, 2017).

Various indicators are used to measure and compare the level of innovation in different national economies. One of these is the Global Innovation Index, which is produced by the IBB, the World Intellectual Property Organization, and Cornell University (de Miranda et al., 2021).

So, following de Miranda et al., (2021) we saw a good way to measure the innovation at macroeconomic level through Global Innovation Index (GII), that's why we choose GII as being our dependent variable.

#### 3.2. Independent variable: Intellectual Capital

In order to strength the results that found out other authors and to see if there is in an influence of the intellectual capital on innovation we have made a study where we used the variable National IQ (IQ) , Human Index Capital (HIC) and Education Index (EI) as measures the Intellectual Capital.

In this way, we choose as independent variables: IQ, HIC, EI and the control variables are represented by: Corruption Perception Index (CPI), Technology Adoption (TA), Research and Development (R&D) , Intellectual Property (IP), Number of Journals (JRN), Global Cyber Security Index (GCI) and Foreign Direct Investments (FDI).

The relationship between intellectual capital and innovation is estimated through the following regression:

$$\text{Global Innovation Index}_{i,t} = \beta_0 + \beta_1 \text{Intellectual Capital}_{i,t} + \beta_2 \text{Control1}_{i,t} + \dots + \beta_6 \text{Control2}_{i,t} + \varepsilon_{i,t}$$

Where intellectual capital is expressed as IQ, HIC, EI and HDI of the country i in year t; Innovation is expressed as GII; control variables are represented CPI, RD, IP, FDI, JRN, GCI and ta ;  $[\beta_0, \beta_1, \dots \beta_6]$  are the regression coefficients, and  $\varepsilon$  represent the error term.

In this way, our research hypothesis is:

*‘There is an influence of Intellectual Capital on Innovation?’*

#### 4. Empirical evidence

In order to run our regression and in the final our model, first, based on our results after running the Redundant Fixed Effects-Likelihood Ratio tests and running the Hausman Test we selected between fixed and random effects the suitable effects for our model.

We have used Panel Least Square in order to test our variables and the results are presented in next tables:

**Table 1.** Method Panel Least Square - Relationship between Global Innovation Index and National IQ

Variable	Coefficient	Std. Error	t-Statistic	Prob.
National IQ	0.227883	0.054906	4.150419	0.0001
Number of Journals	0.133099	0.121554	1.094976	0.2749
Corruption Perception Index	0.235529	0.067246	3.502478	0.0006
Technology Adoption	0.213744	0.075028	2.848857	0.0049
Constant	17.39109	3.470184	5.011575	0.0000

**R-squared = 0.480247**

Note: significant for any acceptance (10%)

**Source:** author’s processing

Based on Table 4, all the probabilities are lower the significant acceptance level, 10% except the control variable JRN which will be taken put from our model. From the point of view of the model goodness-of-fit, the R-squared is equal to 0.4802 and indicates that the dependent variable GII depends in proportion of 48.02 % from the independent variable. In this way, the states researched hypothesis is accepted, meaning that the Intellectual Capital measured through IQ has an impact on the Global Innovation.

**Table 2.** Method Panel Least Square - Relationship between Global Innovation Index and Human Index Capital

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Human Index Capital	0.317601	0.092702	3.426030	0.0008
Research and Development	0.006643	0.086044	0.077200	0.9386
Corruption Perception Index	-0.312825	0.118925	-2.630440	0.0096
Intellectual Property	0.294211	0.121371	2.424052	0.0167
Global Cyber Security Index	0.827157	0.039595	20.89033	0.0000
Number of Journals	-0.194938	0.093607	-2.082507	0.0393
Constant	-9.173366	4.721224	-1.943006	0.0542

**R-squared = 0.798968**

Note: significant for any acceptance (10%)

**Source:** author's processing

In what concern the table presented above we can see that also here the control variable RD that is not significant for our model HIC. It has a probability higher than our significant acceptance level, 10% and it has a negative coefficient. In what concern the negative coefficients we have negative values for control variable CPI and also for the constant term. But in this case, we can observe that the probabilities for these variables are lower than our significance level established being at 10% and this means that these variables are significant for our model. More than that, we can see that the lower probabilities are registered for control variable GCI (0.0000) and it has positive coefficients. This can lead us to a conclusion that the intellectual property and Global Cyber Security Index have an importance on human capital and its role in the world, fact reinforced by the value of R-squared (78,880%). Saying these things, the states researched hypothesis is accepted, meaning that the Intellectual Capital measured through HIC has an impact on the Global Innovation and the results are presented in the table 3.

**Table 3.** Method Panel Least Square - Relationship Global Innovation Index and Education Index

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Education Index	0.250491	0.047585	5.264096	0.0000
Number of Journals	0.060776	0.050719	1.198286	0.2315
Research and Development	0.270265	0.041762	6.471505	0.0000
Corruption Perception Index	0.192663	0.053840	3.578421	0.0004
Global Cyber Security Index	0.012885	0.016813	0.766415	0.4439
Technology Adoption	0.144298	0.052253	2.761514	0.0060
Intellectual Property	-0.019206	0.051020	-0.376435	0.7068
Constant	16.48154	3.459910	4.763575	0.0000

**R-squared = 0.566715**

Note: significant for any acceptance (10%)

**Source:** author's processing

In the table 6 which presents the relationship between innovation and intellectual capital measured by Education Index we can see that we have three variables which have probabilities higher than our acceptance significant level (10%) and they are JRN GCI and IP. Variable IP also has a negative coefficient, so in this case the all three control variables will be taken out from the model. The lower probabilities are associated for the dependent variable, education and for research and development expenditures. This means that the higher the level of education is, the higher the degree of innovation will be. The R-squared is equal to 0.5667 and indicates that the dependent variable GII depends in proportion of 56.67% from the independent variable studied. In this way, the researched hypothesis is accepted, so this means that Intellectual Capital measured through Education Index has an impact on global innovation level.

## 5. Conclusions

Intellectual capital is considered as a key resource for expanding intelligence, as its name suggests. Over time, it has received a number of definitions, but at present no consensus has been reached regarding its explanation. However, intellectual capital is the key to all organizations given that it is made up of all the knowledge, experiences, values, skills that an employee has in a company. The assessment of intellectual capital can be performed for several situations, namely: in order to assess the value of the company, for the necessity of registering in the country or in other states, for the sale or purchase of the company or some components of the intellectual capital, in order to account for intangible assets, for combating piracy, attracting investors, etc. Thus, we observe the wide applicability of intellectual capital in both the economic sector and other related fields.

In our study the attention was focused on macroeconomic level. That's why we have research and we have out that there are some indexes which can help us to through Intellectual Capital can be measured. Human Capital Index, Education Index, National IQ and Human are the ones chosen by us in order to measure the IC. Human Index Capital was introduced by Human Capital Project and through it, was able to identify the productivity gaps in various countries and to encourage better investments in human capital. The goal of the Human Capital Index is to demonstrate how education and health outcomes for children are related to the productivity of the future generation. The National IQ was introduced by Lynn & Becker in the book *The Intelligence of Nations*, made a fictive study in order to estimate and compute National IQs.

We have focused the attention in our study on Innovation. First definition for this concept was given in 1934 by Schumpeter by also as IC it is in a continue development and in a continue trying to be found an unanimous definition. First we have made a bibliometric map where we selected approximately 1000-2000 articles for each concepts about we choose to discuss. When we have selected these articles we also choose to analyze the abstracts where were given the principal ideas and after graphics representations we saw that there is a relationship between our concepts. But of course, our results couldn't be based only on this maps. For true and correct results there was necessary an empirical study. In this way, we selected 186 countries and we construct four equations in order to catch the influence of intellectual capital on the economy. The model was tested through Panel Least Squared and all of these for equations show us that our models are viable and our hypotheses were accepted. Concluding all our findings we can say that Intellectual Capital measured through IQ, Human Index Capital Education Index influence the Innovation measured through Global Innovation Index.

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