The human capital in the knowledge society. Theoretical and empirical approach

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Abstract: *We live today in a changing society based on the globalization and better valorisation of the human capital. The human capital is the central driver force for competitiveness and development of the new technology and patent and a necessary factor for their efficient use in the new society. In order to reach the competitiveness objective, the European Union member countries seek to develop their human capital value by increasing investment in education, science and technology development. Based on the panel econometrics techniques, this paper explores the statistical correlations between human capital components and national competitiveness within the EU economic context.*

Key words: human capital, knowledge society, innovation, competitiveness, globalization, education, science

Introduction

There is a large body of literature dedicated to the knowledge society, human capital and their interaction. A key value of human capital is knowledge as the result of learning and internalisation of information, data and experience. In the knowledge society, the driving forces are education, science and innovation. Therefore, we find human capital at the core of the modern knowledge society. Bontis (1999, cited by Bontis et all, 2000, p. 89) argues that "human capital is important because it is a source of innovation and strategic renewal". Human capital, introduced first by Adam Smith and later developed as a concept by Gary Becker and Jacob Mincer may be defined as "the knowledge, skills, competence and other attributes embodied in individuals that are relevant to economic activity" (Hartog, 1999, p. 1). A consistently increasing body of specialists, policy makers and governmental entities recognize now the importance of the human capital for the progress of the society and success of nations. A significant property of the human capital is that it exceeds several times the value of the physical capital. For example, in USA, the stock of human capital is over $750 trillion, much greater than the roughly $70 trillion of physical and financial assets owned by American households. (Schulz, 2012, p.2-3). Also, the human capital has a high degree of versatility, coming from different theoretical approaches: (a) "firm specific human capital" creating competitive advantage in the firm relation with other firms, with a relative effect of reducing the innovation degree, (b) "industry-specific human capital" playing an important role in the innovation level within that industry and (c) "individual specific human capital" referring to the knowledge that is largely applicable to the progress of society (Dakhli and Clerco, 2004)

The knowledge society, for the first time referred to by Peter Drucker in 1969, cannot exist without human capital because knowledge is the result of people learning, of internalization of information, data and experience facilitated by the digital technology. The knowledge society has the ability to develop knowledge and produce "new meaning", that implied creativity, and two type of knowledge difficult to obtain without highly developed people. The pillars of the knowledge society are: education, information technology and communications (ITC), science, new technology and innovation.

There is a consistent correlation between knowledge and learning, as various studies in the field revealed. Brine (2006) highlighted the importance of the relationship between learning – especially long live learning – on one side and knowledge society and the set of policy in the European Union on the other side. Lundvall and Johnson (cited by Conceição and Heitor, 2002) considered that there are two forms of knowledge: "knowledge creation and knowledge destruction". The new knowledge society replaced the old knowledge following a destruction process and then replacing it with the new creative knowledge based on innovation.

The Lisbon Strategy, introduced by the special European Council in Lisbon in March 2000, stipulate that EU must become "...the most dynamic and competitive knowledge economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion and respect for the environment"(Kok, W. et al., 2004, p.6). In this paper we analyze the relation between the knowledge society and the human capital. Using a panel methodology and a data series form UE countries, we test the following hypothesis: The higher the level of human capital within a country, the higher the country's level of innovation is.

Measurement in the knowledge society and the human capital theory

The level of human capital within a country correlates with the country's performance in innovation. While innovation is an important part of knowledge society, measuring the human capital is actually an important part of knowledge society.

According to the 2005 UN report: "The Index of Knowledge Societies (IKS) is a summary measure of the performance that countries register in the three main dimensions described in the previous parts of the Report: assets which are represented by: a large pool of young and educated people, and the development of the means through which information can flow; advancement is the degree to which a Member State nurtures and advances its human and informational resources and the foresightedness which is the degree to which a Member State grows and develops along its path to a Knowledge Society, while minimizing the impact of negative externalities on people and the natural environment a country displays in its quest to become a Knowledge Society". Each dimension is measured by a number of quantitative indicators. (UN, 2005, p149).

Regarding the Human Capital, the World Economic Form Report 2013 proposed four distinct Enabling Environment domains with 51 indicators: Educations, Wealth and Wellness, Workforce and Employment and Enabling Environment, different as compare to the European Union Hyman Capital Index.

A synthesis of the measurement of Knowledge society and Human capital is presented on Table1.

Table 1 - The measure the knowledge society and the human capital

Measurement for knowledge society	Measurement for human capital
1. *The Index of Knowledge Society* (UN, 2005) composed from three indices:	*The Index of Human Development (ONU):* contain four group of areas: Education (12 indicators); the Wealth and Wellness (14 indicators) the Workforce and Employment (16 indicators); the Enabling Environment (9 indicators) (WEF, 2013) The European Human Capital Index that looks at countries' abilities to develop and deploy their human capital and cover four areas: *human capital endowment, human capital utilisation* and *human capital productivities* (P.Ederer, 2006).

-*Assets* measured by: expected schooling and proportion of people below age 15; diffusion of newspapers, the Internet, main phone lines and cellular phones;	-*Educational enrolment* indicate the number of persons enrolled at a certain level of education in a certain year and its division on primary, secondary, vocationally and tertiary level; The gross enrolment ratio is the number of persons enrolled at a certain education level, divided by the relevant age group. This two indicators are a better estimation of the stock of human capital *Private and governmental expenditure on education as a percentage of GD*P (Bas van Leeuwen, 2007, Human capital and Economic Growth in India Indonesia and Japan A quantitative analysis 1890-2000, Netherlands)
- *Advancement measured by*: public health expenditure, research and development expenditure, (low) military expenditure, pupil/teacher ratios in primary education, and a proxy of the "freedom from corruption" indicator;	-*The percentage of the population of 15 years and older who have been enrolled; average years of education per capita*[1] as estimators of the stock of human capital. More recent paper (2001) use the net enrolment ratios which keep track of repeaters, and adjust them for later entries into the specified education levels. (Barro and Lee ,1993; 2001)
-*Foresightedness* measured by: low child mortality rates, equality in income distribution (GINI Index), protected areas as percentage of a country's surface, and CO2 emissions per capita.	-The experts of World Bank consider that *the years of schooling of an individual*, capture the average amount of formal education received by the people as a proxy for measure the explicit knowledge.
	Dakhli and Clerco (2004) measured the human capital based on three indicators: citizen overall knowledge, economic resources and physical well-being

[1]Acording to Barro and Lee , "the number of years of schooling for the population aged 15 and above, st , is constructed as:

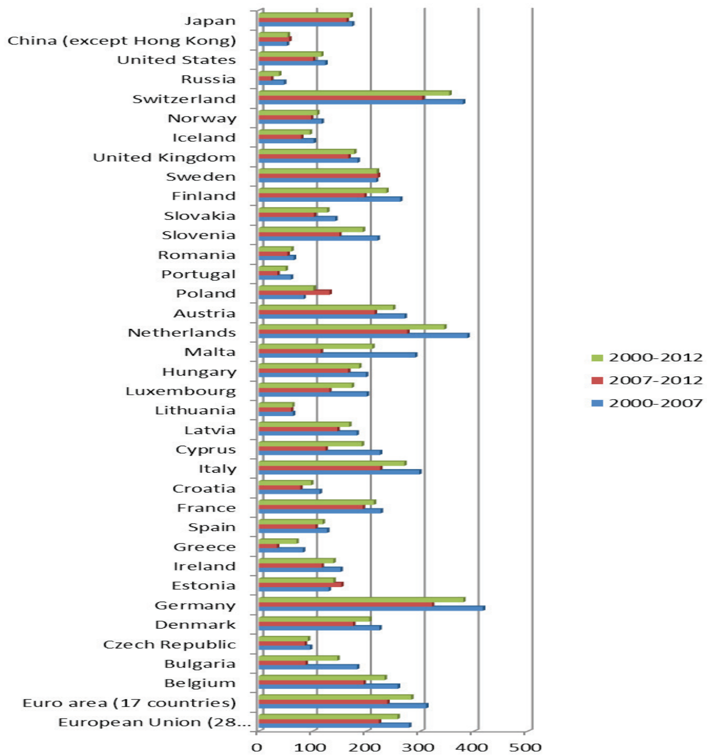
$$st = \sum l_t^g s_t^a$$

where : l_t^g is the population share of group g in population 15 and above and s_t is a : the number of years of schooling of age group a— (a =1: 15–19 age group, a =2: 20–24 age group, … , a =13: 75 and above)" see Barro and Lee, 2011 A new data Set of Educational Attainment in the World, 1950-2010, NBER Working paper Series, 15902, 2010, p.7, http://www.barrolee.com/papers/Barro_Lee_Human_Capital_Update_2011Nov.pdf, Journal of Development Economics, Elsevier, vol. 104(C), pages 184-198Accessed 17,07,2014

A first observation regarding previous indicators is that they provide incomplete dimensions of the complex reality as the diversity of the measure highlight. There are several questions that still need answers. First, we look to the R&D activities as creating and using knowledge and we ask whether the R&D financing effort pays back to the development of this knowledge. Therefore, we analysed the total number of patent applications by billion EUR of total R&D expenditure (GERD). This number provides a view of the R&D investment efficiency. The resulting data presented in Chart 1, show the influence of the 2008 world economic and financial crisis over the total number of patent applications by billion EUR of total R&D expenditure. The impact of the crisis is negative in all countries, with the exception of Japan and China, the total number of patent applications by billion EUR of total R&D expenditure being smaller in 2008-2012 comparing to 2000-2007.

Chart 1

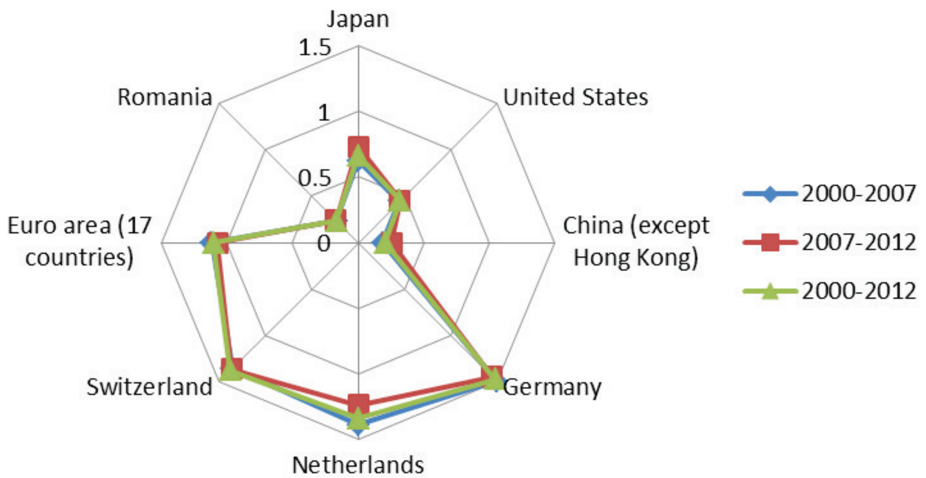
Total number of patent applications by milliard EUR of total R&D expenditure (GERD) by countries during 2000-2012 periods, before and after crisis



Source of data: Authors computation using the Eurostat data bases [pat_ep_ntot]

Germany, Switzerland, Netherland report the highest level of this indicator, followed by Italy, Austria, Finland. In the last places we find Portugal, Romania, Lithuania and Greece in EU as well as Russia and China from outside EU. By comparing with average EU 28 between 2000-2012, the highest number of patent applications by billion EUR of total R&D expenditure are reported by Germany (1.475), Switzerland (1.374) and Netherland (1.338) comparing to only 0.661 Japan, 0.4499 USA and 0.2085 China. Romania is close to China with 0.234 (Chart 2).

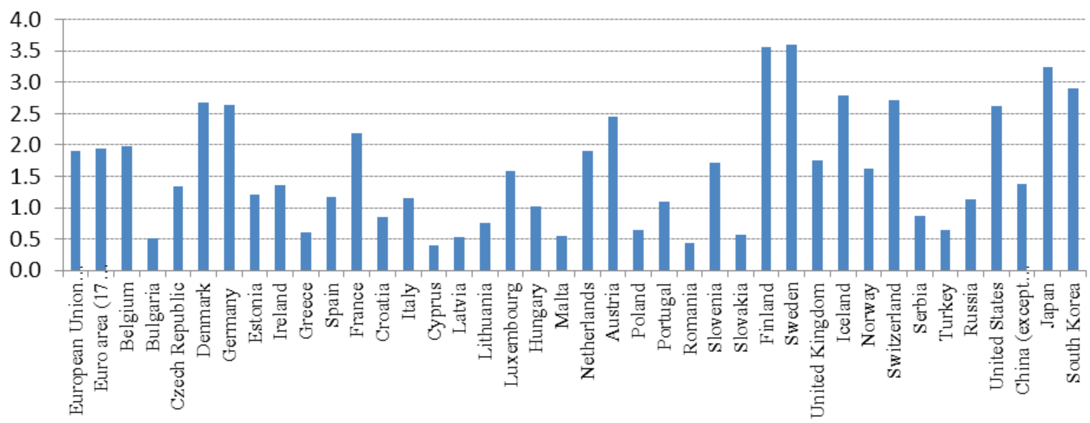
Chart 2 - Total number of patent applications by milliard EUR of total R&D expenditure (GERD) by countries as compare to UE 28 during 2000-2012 periods, before and after crisis



Source of data: Authors computation using the Eurostat data bases [pat_ep_ntot]

The R&D sustaining effort measured as percent from GDP show that the Lisbon target objective of 3% has been only met by Finland and Suede, the rest of the EU member countries being between 0.4 in Romania and 3.6 in Finland. Outside EU, Japan gives a maximum of 3.2, followed closely by USA and South Korea, while China reports an average of 1.4 (Chart 3).

Chart 3 - Total intramural R&D expenditure (GERD) by sectors of performance (all sectors expressed as percentage of GDP) average period 2000-2012



Source of data: Authors computation using the Eurostat data bases [rd_e_gerdtot]

The impact of financial crisis generated a different trend after 2008. Between 2008 and 2012, the average level increased to a maximum level 3.8 in Finland, in Denmark from 2.5 to 3, in Germany from 2.5 to 2.8 while Romania increased from 0.4 to 0.5, EU space from 1.9 to 2.1, USA from 2.5 to 2.7, Japan from 3.2 to 3.4 and in China from 1.2 to 1.7 (Annex 1). The policy makers from these countries show understanding of the importance of R&D as the main force of technological changes and progress of the countries and as a driver of the economic growth.

Literature review

David and Foray (2003) provide an introduction to fundamental issues in the development of new knowledge-based economies. After placing their emergence in historical perspective and proposing a theoretical framework that distinguishes knowledge from information, the authors characterise the specific nature of such economies. They go on to deal with some of the major issues concerning the new skills and abilities required for integration into the knowledge-based economy; the new geography that is taking shape (where physical distance ceases to be such an influential constraint); the conditions governing access to both information and knowledge, not least for developing countries; the uneven development of scientific, technological (including organisational) knowledge across different sectors of activity; problems concerning intellectual property rights and the privatisation of knowledge; and the issues of trust, memory and the fragmentation of knowledge.

De la Fuente and Ciccone (2003) examine the rationale for putting investment in human capital at the forefront of policies aimed at promoting economic growth and social cohesion, as is done in the strategy outlined in the Lisbon Summit for turning the EU into the most competitive and dynamic knowledge-based economy in the world. SOn the whole, their findings suggest that investment in people is both a crucial growth factor, particularly in the current context of rapid technological change, and a key instrument for enhancing social cohesion, and are therefore supportive of the policy strategy set out in Lisbon

Boarini et al (2012), under OECD logo state that "in recent years, many researchers and organisations have taken steps to produce more comprehensive measures of the stock of human capital. These measures have been developed to serve different analytic purposes and have typically relied on a variety of approaches. Notwithstanding these differences, several statistical offices have expressed a common interest in developing monetary measures of the stock of human capital as a useful complement of physical measures of the quantity and quality of education. They review a number of national initiatives in this field, identifies some of the conceptual and statistical challenges that should be addressed in order to improve the quality of the existing monetary measures of human capital, and suggests developing experimental satellite accounts for education, with different level of complexity, to better understand how human capital is produced and the linkages between education and its non-monetary outcomes"

Barro (1996) analysed the relation between human capital and economic growth by using a cross countries method, showing "a significantly positive effect on growth from the years of schooling at the secondary and higher level for males aged 25 and over (0.0118 [0.0025]). On impact, an extra year of male upper–level schooling is therefore estimated to raise the growth rate by a substantial 1.2 percentage points per year. (In 1990, the mean of the schooling variable was 1.9 years with a standard deviation of 1.3…. Male primary schooling (or persons aged 25 and over) has an insignificant effect… More surprisingly, female education at various levels is not significantly related to subsequent growth." (Barro, 1996, p.15-16)

Dakhli and Clerco (2004, p.117) tested the role of human capital and social capital in fostering innovation at the county level using a sample that include 59 countries from five continents and found that a "country's relative number of R&D-related professionals is positively related to its overall level of human capital (r ¼ :571; p < :001) as well as to our human capital dimension 'educational attainment' (r ¼ :592; p < :001)".

Presentation of the model

Data and sample

Taking into consideration the diversity of indicator that should measure the human capital and the knowledge society, it was a challenging task to select a representative data set to test the research hypothesis: the higher the level of human capital within a country, the higher, the country's level of innovation is.

The selected data indicators are as follows: the expenditure of R&D as percent of GDP (noted as RD_Exp), the number of the patent (noted as Patents), total number of patent applications by billion EUR of total R&D expenditure –GERD (noted as Pat_applic), total public expenditure on education as % of GDP(noted as Exp_edu), the total graduates (ISCED 5-6) per 1 000 of population aged 20-29(noted as Graduate).

The first indicator is the number of the patent, composed as the sum of domestic ownership of foreign inventions in patent applications to the EPO by priority year at the national level and foreign ownership of domestic inventions in patent applications to the EPO by priority year at the national level.

The second indicator is the expenditure of R&D as percent of GDP which reveals the national effort to increase the stock of knowledge, new products and technologies.

The fourth indicator is total number of patent applications by billion EUR of total R&D expenditure (GERD), showing a significant view of how effective the R&D expenditures are.

The fifth indicator is total public expenditure on education as % of GDP, offers information about the national effort to grow the intellectual capacity of the people.

The last indicator is the total graduates (ISCED 5-6) per 1 000 of population aged 20-29 is used as a proxy for the creation capacity of new meaning, considering that the "tertiary education is central to the creation of the intellectual capacity on which knowledge production and utilization depend and to the promotion of the lifelong-learning practices necessary to update individual knowledge and skill."(World Bank, 2002, p.xvii).

The sample data covers the period 2000-2012 and all the 28 European countries and the source of data is Eurostat database.

Table 2 shows results for statistical descriptions of the model variables: mean, median, the maximum and minimum value, standard deviation, skewness and kurtosis and J. Bera coefficient. The statistical analysis of the model reveals significant differences with a relative large standard deviation. Also, there is an asymmetry on the right side for the data series, while Kurtosis increases from 2.37% (Graduate) to a maximum of 10.17 (Patents).

Table 2 - Descriptive statistics of the data

	EXP_RD?	PATENTS?	PAT_APPLIC?	EXP_EDU?	GRADUATE?
Mean	1.431926	926.8986	179.9271	5.321351	56.80473
Median	1.17	120.5	171.565	5.27	54.6
Maximum	4.13	8437	537.65	8.8	110.5
Minimum	0.25	1	26.7	2.88	18
Std. Dev.	0.932081	1657.631	95.83837	1.114108	19.93616
Skewness	0.904333	2.63907	0.756227	0.741584	0.375617
Kurtosis	2.977322	10.17098	3.420064	3.669651	2.374515
Jarque-Bera	40.35207	977.8083	30.38901	32.66136	11.78553
Probability	0	0	0	0	0.002759
Sum	423.85	274362	53258.42	1575.12	16814.2
Sum Sq. Dev.	256.2884	8.11E+08	2709573	366.1647	117247.9
Observations	296	296	296	296	296
Cross sections	27	27	27	27	27

Source of data: Authors computation using the Eurostat data bases

All the data series were used in logarithm terms and are stationary on difference of order one.

The results of the panel model

In order to highlight to the links between knowledge society indicators and human capital in EU, the panel data technique has been employed. This technique allows us to capture non-time varying unobservable and other unobservable factors that might explain structural differences at the level of each individual country, regarding the level of human capital and innovation capacity existing in EU member countries. Taking in consideration that data spans from year 2000 to 2012 and 28 countries, the fixed effects panel model has been selected for the scope of the research.

The model is Pooled Last Squared with cross fixed effects and cross section fixed dummy variable, where the independent variable was the number of patents (Patents) as expression of innovation pillar for the knowledge society. The dependent variables are indicators that could measure the human capital (R&D expenses as % of

GDP (Exp_RD), total number of patent applications by billion EUR of total R&D expenditure (Pat_applic), graduate per 1000 of population aged 20-29 (Graduate) and total public expenditure on education as % of GDP (Exp_edu).

The model equation is:

dlog(Patents) = -1,482617 + 0,600283dlog(Exp_RD)) +0,592436dlog(Pat_applic)) +
(-2,5283) (3.238719) (4.34552)
[0.0124] [0.0015] [0.0000
+0,377216 log(Graduate (-4)) -1,059209dlog(Exp_edu(-2))+ε_{it}
(0.377216) (-2.358725)
[0.0149] [0.0196]

where i =1.....28 represents the country and t is time index.

The tests for fixed effects indicate that the two statistics value (1.043533 and 32.30209) and the associated p-values not reject the null hypothesis that the cross-section effects are redundant. The forms of statistics of the next two tests (for significance of the period dummies in the unrestricted model against restricted specification and for the joint significance of the all effects) strongly reject the null hypothesis of no period effects and the restricted model in which there is only a single intercept (see Annex 3).

As we expected, the model data shows a positive and statistically significant correlation between the actual number of patents and R&D effort at national level, between number of patents on one side and both number of patent applications by billion EUR of total R&D expenditure and graduate per 1000 of population aged 20-29 with a 4 years lags, legitimate if we take into consideration the experience build-up within this period, for young researchers, on the other side. Theoretically unexpected is the negative correlation between number of patents and the total public expenditure on education as % of GDP. One explanation is the relative heterogeneity of the countries regarding education expenses and the worst level of the European Human Capital Index (only Sweden register a – the best score -8 as compare to 4 the best score possible- P. Ederer, 2006, p.3 and P Ederer at all, 2007). In order to verify this hypothesis, an in-depth analysis depending on the economic development level of each country is necessary. Also, there are significant differences between EU15 countries (with negative coefficients on transversal effects) and emergent countries, with the exception of Poland and Baltic area (with positive coefficients on transversal effects). Also, the model highlights time differences, one possible explanation being the 2007-2011 financial and economic crises, closely followed by sovereign-debt crisis.

Conclusions

Human capital is an important section of the knowledge society and the level of knowledge employed by the respective society correlates with the amount of human capital within the same society. Although the investment in education still needs clarification from the statistical viewpoint, we found that human capital strongly influences the innovation level of knowledge society as well as their efficiency.

The investment and their return depend on country specific. From the positive values of the coefficients within the model we conclude that the developed economies record a high level of returns while investing in human capital. At the same time, the corresponding coefficients for emergent economies are negative values. This shows a relative low level of return from the investment in human capital, in these emergent economies. Possible explanations are various, including loss of a great part of the mature human capital due to its migration from emergent economies to developed economies, as well as the fact that developed economies concentrate more on exploiting traditional forms of capital rather than human capital. Further research needs to be done in order to clarify this aspect.

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