



## Causal Relationship between Human Capital and Economic Growth in European Countries (EU-28): Panel Analysis

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**ABSTRACT:** The main *objective* of this study is to examine the empirical relationship between education, labor, and innovation as a proxy human capital and GDP per capita in European countries (EU-28). *Our hypothesis* is that (1) human capital is positive (significantly) related to the GDP per capita. (2) The human capital plays the same role of physical capital in increasing the real GDP per capita. The statistical methods utilized are the Panel Data (fixed and random effect) Model for (EU-28) through the period from 1995 to 2017. *Findings*, there is a strong relationship between human capital and real GDP per capita in (EU-28), this the human capital plays an important role in those countries, according to the endogenous economic theory, especially, (MRW model). Also, the paper concludes that human capital plays the same role of physical capital in increasing the real GDP per capita.

**Keywords:** Economic Growth, Human Capital, Panel Data, European countries.

**JEL classification:** A13, B23, C23, C33, E24, I18, I28, J24, O15

### I. INTRODUCTION

Human capital is a key factor for the growth process and development. Human capital (development and stock) has a direct and indirect effect on economic growth. The direct effect, individuals with more skills are more productive and innovative, it leads to the creation of new products and improving the productivity of factors; human capital enhances the adoption of technology from other countries through the absorption of new ideas and equipment imports [15]. Human capital also has indirect effect through interaction with the productive structure of countries, where a country's specialization in technologically advanced activities improves the positive impact of human capital on economic growth (For more details see also, (Romer, 1990; Benhabib and Spiegel, 1994; Teixeira and Fortuna, 2011; Silva and Teixeira, 2011; Bodman and Le, 2013) [23, 8, 13, 28, 9].

The current empirical literature on the relationship between human capital and economic growth or GDP per capita led to conflicting results due to differences in the indicators and methodologies used. In the section literature, we present many types of studies, first studies related to education and growth, second health and growth, and third the economic growth effects of both human capital components [1].

Therefore, the main objective of this study is to highlight the role of human capital (development and stock) on GDP per capita (constant 2010 \$) in EU-28 through 1995 to 2017 by using a Panel data model. For this purpose, the paper is organized as follows: Section 2 focuses on the empirical literature related to the relationship between human capital and economic growth or real GDP per capita. Section 3 estimates the

impact of human capital on GDP per capita (constant 2010 \$) and presents econometric results. Section 4 for conclusions.

### II. LITERATURE

Over the last decades, numerous economic studies have focused on human capital (development and accumulation) and its impact on the economy. *In the 50s and 60s* of the last century, Schultz, Mincer, and Becker, among others, invented and developed the term 'human capital', and studied its impact on economic development [7]. They investigated those specific activities which promote skills and increase the production potential of the workforce, which is conducive to economic growth. The research, focusing on the influence of human capital on growth relates also to the ideas underlying the models which analyzed the impact of technological progress. Major works which have later found applications to the theory of new ideas with the learning-by-doing process, because of the experience gained in production activity. Romer regarded the role of scientific research on economic development [1].

*In the late 80s of the 20th century*, the Solow model considered the cornerstone of growth theory [23], was further developed by Lucas [6] using the human capital concepts, and to the traditional production factors a new key factor was added – the human factor. After the UN introduced the System of National Accounts (SNA) as a standard of statistical reporting in a series of countries cross-country comparisons of statistical data became feasible. From the 70s until the present research has intensified to foster the supply of comparable statistical information for almost all countries to facilitate the

empirical estimation of various theoretical models and growth models.

**In the early 90s** Mankiw, Romer, and Weil (Mankiw, *et al.*, [19] tried to answer the question of whether the Solow model emphasizes by international statistical data on roundly 100 countries. Following the approach introduced by Lucas and using the statistical series compiled by Summers and Heston, they complemented the production factors in the original model by variables describing the level of human capital in the various countries. After an econometric estimation of the improved, model they managed to explain about 80% of the variance of income per capita in the countries considered, and their study was the first empirical proof of the validity of the neoclassical growth theory. In the twenty years to follow a number of economists studied theoretically and empirically the link between the variables representing the level of human capital, and economic growth [28].

To sum up, empirical studies of the growth effect concerning human capital are quite mixed and the literature results depend not only on proxy variables used for human capital but also on the empirical methodology. For more details see also, [22, 7,12, 27, 8]. Therefore, this paper attempts to examine the impact of human capital on the economic growth or GDP per capita (constant 2010 \$) in the high-income countries through the period from 1998 to 2017.

### III. METHODOLOGY

#### A. Model Specification and data sources

Based on the literature review, the human capital's effect on the economic growth has been debated since 1980 in the endogenous growth models developed by Romer, Lucas, and Barro. From this time until now, the economists have carried out a series of empirical studies; for example, Mankiw, Romer, and Weil (1992) known as MRW modulus; to the convergence analyzes suggested by Barro and Sala-i-Martin (1992); also, to the panel models, consecrated to cross-country data analysis (Islam, 1995), Elsevier B.V (2015), Revenga (1997), Pavcnik (2003), Barro, Sala-i-Martin, (2003), Psacharopoulos & Patrinos (2004), Fajnzylber &

Fernandes (2004), Makdasi *et al.* (2007), World Bank, (2008), Salehi-Isfahani *et al.* (2009), Angel-Urdinola & Tanabe, (2012) Almeida (2012) [24].

In this section, we are going to study empirically the effects of human capital on economic growth in the European countries. To attain such a target, we will follow the approach of Mankiw, Romer & Weil (1992, 2004) [19, 415]. We retain the Cobb-Douglas production function:

$$Y_t = K_t^\alpha H_t^\beta (A_t L_t)^{1-\alpha-\beta} \quad (1)$$

with,  $L_t = L_0 e^{nt}$  et  $A_t = A_0 e^{gt}$  (2)

where:  $Y$  is the real output,  $K$  is the stock of physical capital,  $H$  is the stock of human capital,  $L$  is the labor,  $A$  is the factor reflecting the level of technology and the efficiency in the economy,  $n$  is the rate of the labor force growth,  $g$  is the rate of technological progress supposed constant, the subscript  $t$  indicates time. It is assumed that  $\alpha + \beta < 1$  which implies that there are decreasing returns to all capital. (If  $\alpha + \beta = 1$ , then there are constant returns to scale in the reproducible factors; Also, if  $\alpha + \beta > 1$  which implies that there are increasing returns to all capital). We add the subscript of the time and the individual, we can write the following relation:

where,  $g$  and  $\delta$  are supposed constant for all the countries and in the time and their sum is equal to 0.05 (Mankiw *et al.*, 1992). The variable  $Ln(A_{0i})$  involves the structural factors and the factors of the economic environment possessing an influence on economic growth. In our case, we took into consideration the factors of economic policies, to know the level of inflation and government expenditures. This equation (2) shows how income per capita depends on population growth and accumulation of physical and human capital.

The most methodological problem is to choose the proxy indicator used to measure human capital since the amount of influence is affected by the indicator chosen for this purpose. All the models in the literature provide the opportunity to highlight some limits either from the election of the indicators used, either in their form of expression (as pace, level or logarithm) or the method of calculation [21].

**Table 1: Shows the variables which use in the panel model.**

Variable	Description		proxy of
GDPP	Gross Domestic Product GDP per capita (constant 2010 US\$)		Economic growth
FCEXP	Final consumption expenditure (constant 2010 US\$)		physical capital
GFC	Gross capital formation (constant 2010 US\$)		
GEXPEDU	Public spending on education total (% of GDP).	education	human capital
SEP	School enrolment rate, primary total (% gross)		
SES	School enrolment rate, Secondary total (% gross)		
SET	School enrolment rate, Tertiary total (% gross)	labor	
UNER	Unemployment, total (% of total labor force, modeled ILO estimate).		
LEB	Labor force participation rate, total (% of total population ages 15+) (modeled ILO estimate)	innovation	
HTEXPER	High-technology exports (% of manufactured exports)		
PATRES	Patent applications, residents		
LAG1GDPP	First lag for the GDP per capita (2010 US\$)		
LAG1GDPP	Second lag for the GDP per capita (2010 US\$)		

And "i" indicates the countries (i = 1, 2, 3, ..., N) and "t" represents the time (t = 1, 2, 3, ..., T). We took the first difference for all variables.

Therefore, our regression is based on the following relation:

$$GDPP_{it} = C(1) + C(2) * FC EXP_{it} + C(3) * GFC_{it} + C(4) * GEXPEDU_{it} + C(5) * SEP_{it} + C(6) * SES_{it} + C(7) * SET_{it} - C(8) * UNER_{it} + C(9) * LEB_{it} + C(10) * HTEXPER_{it} + C(11) * PATRES_{it} + LAG1GDPP_{it} + LAG2GDPP_{it} + \varepsilon_{it} \quad (3)$$

All these variables are extracted from the yearly data from the World Bank database (WDI), IMF, OECD and UNESCO as published on their official websites. Also, statistics of the related states that have been published on their official websites have been used as a source of data related to certain years. We estimated econometrically the last equation with the method of panel data for a sample of EU-28 countries during the period 1995-2017, as follows:

#### (A) Estimation and results

The econometric analysis of panel data renders an account, both individual and temporal dimensions of the observations. A high number of observations permit us to take account of the individual differences of performances that is due to the influence of other factors that are considered in the regression. The wealth of information in the estimation of panel data models leads to the following consequence: an important observed number of individuals allow great precision of the estimates. While we estimate a sample with panel data, the first thing that it is suitable to verify that is the homogeneous or a heterogeneous specification of the generating process of the data. After that, we apply the individual-specific test to determine if we can suppose that the studied model is perfectly identical for all countries or each country have some specificities [20].

#### (i) Estimation:

We estimate the Panel Data (Fixed Effects and Random Effects) Model for the above variables in the equation, but the results included autocorrelation between independent variables because the Durbin-Watson Statistic = 0.2 less than 2, so we took two lags for the dependent variables and use them as independent variables to delete the autocorrelation, generating equation 19 which does run in Eviews 10. The results suggest that both the models are well specified in the equation 20 and 21. The table 2 presents the Eviews output for Panel Data Models in the EU-28 countries.

$$GDPP_{it} = C(1) + C(2) * FC EXP_{it} + C(3) * GFC_{it} + C(4) * GEXPEDU_{it} + C(5) * SEP_{it} + C(6) * SES_{it} + C(7) * SET_{it} - C(8) * UNER_{it} + C(9) * LEB_{it} + C(10) * HTEXPER_{it} + C(11) * PATRES_{it} + C(12) * LAG1GDPP_{it} + C(13) * LAG2GDPP_{it} + \varepsilon_{it} \quad (4)$$

#### The results model:

The **fixed effects model** has an R-squared around of 0.998 and Durbin-Watson stat= 1.84 with the default level for all variables. It also, presents that there are variables which is not significant (Intercept, Final consumption expenditure, School enrolment, Primary % gross, and School enrolment, Secondary % gross, Unemployment rate % labor force, Labor force participation, High-technology exports %, and Patents residents), its probability more than 0.05. The Fixed Effect Model output can be written in the equation 20, as follows:

$$GDPP = 3717.797 + 1.13 * LAG1GDPP - 0.27 * LAG2GDPP - 1.932e - 09 * FC EXP - 9.376e - 09 *$$

$$GFC - 521.12 * GEXPEDU + 11.74 * SEP + 10.11 * SES + 22.94 * SET - 27.92 * UNER + 3.62 * LEB - 11.07 * HTEXPER - 0.18 * PATRES \quad (5)$$

The **random effect model** has an adjusted R-squared of around 0.998 and Durbin-Watson stat= 1.96 with the default level for all variables. It introduces results that, there are coefficients are not significant (Intercept, School enrolment, Primary % gross, School enrolment, Tertiary % gross, Unemployment rate % labor force, Labor force participation, and Patents residents). The Random Effect Model output can be written as the equation 21 as follows:

$$GDPP = -1427.58 + 1.35 * LAG1GDPP - 0.36 * LAG2GDPP - 6.027e - 10 * FC EXP + 1.76e - 09 * GFC - 103.76 * GEXPEDU - 1.47 * SEP + 7.95 * SES + 4.48 * SET - 0.34 * UNER + 20.99 * LEB + 23.46 * HTEXPER + 0.010 * PATRES \quad (6)$$

Also, we run **Correlated Random Effect -Hausman Test** to choose which model is appropriate Null hypothesis: there is no difference between fixed effects model and random effects model. The probability of Chi-Sq. Statistic = 0.0000 is less than 0.05, it means the model is significant and there is no difference between two model, so the appropriate model is Fixed Effects Model. It is a good result, where the R-squared is 0.998 and Durbin-Watson stat= 1.844 in the model fixed effects model with the default level for all variables [9].

#### C. Diagnostic Tests:

The econometrics literature places a good deal of emphasis on procedures for interrogating the quality of a model's specification. These procedures address the assumptions that may have been made about the distribution of the model's error term, and they also focus on the structural specification of the model, in terms of its functional form, the choice of regressors, and possible measurement errors [16]. The diagnostics tests indicate that the residuals are normally distributed, homoscedastic and serially uncorrelated and the parameters appear to be stable in the level and first difference.

#### Unit roots tests:

We carry out the unit roots tests where the null that there is a unit root assumes a common unit root process for Im, Pesaran and Shin (IPS) test and ADF - Fisher Chi-square, and assumes individual unit root process for the Levin, Lin and Chu (LLC) technique. \*\* Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality. All the statistical significance of the variables at 1%, 5% and 10% respectively. We can say all variables stationary at the default and first difference.

#### Results:

The Eviews output indicates that there is a strong relationship between GDP per capita (constant 2010 US\$) and education, labor, and innovation as a proxy of human capital. It can appear in the high R-square = 0.998 for panel data analysis and the probability of model (ProbF-statistic) is equal zero.

The impact of school enrolment, for the *primary and tertiary* stages of education (gross%) on GDP per capita (constant 2010 US\$), under the fixed effects model is significant, on the other hand, school enrolment,



secondary (gross %) is not significant, where an increase in the school enrolment, primary (gross %) by 11.74% leads to rise at 1 US\$. Also, a high in *school enrolment, tertiary* (gross %) about 22.94% leads to an increase in GDP per capita (constant 2010 US\$) about one dollar. AS same as, a rise in school, secondary (gross %) about 10.11% leads to increase in GDP per capita (constant 2010 US\$) about one dollar, but it is not significant. Also, *the public expenditure on education as percentage* is a significant, where the decrease in the public expenditure on education as percentage by 5.21 % leads to an increase in GDP per capita (constant 2010 US\$) about one dollar.

For the labor force, the increase in the labor force participation roundly 0.01% moves the GDP per capita (constant 2010 US\$) to up about one dollar, but it's not significant in this model, on the other hand, the decrease in the unemployment rate about 0.6 % leads to a rise in the GDP per capita (constant 2010 US\$) about one dollar.

For the innovation, the decrease in the high-tech exports as a percentage on manufacturing exports by 0.011 % leads to an increase in GDP per capita (constant 2010 US\$) about one dollar, but it not significant. In the other hand, the decline in the number of patents application, residents about 175 leads to an increase in GDP per capita (constant 2010 US\$) by 100 dollars. It means that the innovation not significant on affects on GDP per capita.

For the physical capital, the gross capital formation (constant 2010 US\$) increases about 9.37E-09 dollar leads to rise in the GDP per capita (constant 2010 US\$) roundly one dollar, also, the impact is slightly stronger under the fixed effects model of the increase in final consumption expenditure approximately 1.93 E-09 dollars leads to decrease in the GDP per capita (constant 2010 US\$) roundly one dollar, which disagrees with the effective demand on the Keynesian theory, but it is not significant. Finally, the significance of the intercept  $\alpha$  presents that there is a difference between the European countries (EU-28).

#### IV. CONCLUSION

Regarding the *impact of education on real GDP per capita*, we find that school enrollment primary and secondary are positive and significant effect on real GDP per capita. But school enrollment tertiary is not significant. As a contract, we find the public expenditure on education as percentage has a negative effect on real GDP per capita. For the impact of *Labor force on real GDP per capita*, have a big problem about the data on the labor market for wages and efficiency of the labor market, so we use labor force participation (which is not significant) and the unemployment rate (is significant), which is a negatively correlated with real GDP per capita. With regards innovation, the number of patents application, residents not significant, the high-tech exports as a percentage on manufacturing exports has a negative effect on GDP per capita.

Finally, the real final consumption expenditure (significant and a strongly correlated with real GDP per capita) and real gross capital formation (not significant) as a proxy to the physical capital.

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