The impact of human capital on economic growth in EU-28: a Panel Data perspective

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Abstract. *This paper investigates the influence of education and human capital on economic growth in European Union countries before Brexit, for a time span of 14 years in the period 2003 - 2016. A panel data regression model was applied taking into account the impact of human capital on the economic growth from the perspective of education levels and human capital movement. Therefore human capital is described by the variables number of researchers, youth not in education, employment or training, the migration changing rates and the labor force for three different education levels (basic, intermediate and advanced). The dependent variable used in the paper as a measurement of economic growth was considered annual growth rate of Gross Domestic Product. The results show that the hypothesis of the importance and impact of human capital on economic growth is supported.*

Keywords: economic growth, human capital, migration, panel data.

Introduction

Human capital is one of the main economic resources and determinants for the economic development of a country. Through education the labor force obtain advanced skill that can lead to better paid jobs. Therefore investing in pre-training and training workforce are important factors in order to contribute to economic growth. The specialty literature focuses on the importance of human capital for economic advance, highlighting the fact that the human factor affects growth directly, but also indirectly based on its interaction with other relevant factors (Kottaridi et al., 2019).

The human capital is usually measured quantitatively, through variables like years of schooling or enrolment ratios (Barro, 2001). However, these measures are not enough to explain the differences across countries and the qualitative nature of the human factor. The most important challenge faced today is the fast scientific progress and the rapid changes in technology which are usually followed by a change in the structure of the jobs demanded on the labor market. Depending on the particularities of their economies, countries have developed different schooling systems, some focusing on general education, while others on vocational education. However, with the rapid growth of technology, there is an increasing demand for higher levels of education, in terms of formal education, as well as specific technical skills. Based on this, in the present paper we have considered multiple variables to account for the human factor, from a quantitative, but also from a qualitative perspective: number of researchers, labor force with intermediate education and labor force with

advanced education.

Since not only technology is shaping the evolution of the human factor nowadays, but also the social phenomenon of migration and youth unemployment, we have decided to consider also the rate of migration, but also the NEET (not in Education, employment or training).

In this paper we investigate the influence of human capital on economic growth in European Union countries before Brexit from 2003 to 2016. To this end, we have used a multiple linear regression for panel data (Greene, 2002). Our study focuses on the EU, considering the past but also current agenda of the European Union that focuses on education programs to enhance the formal and informal skills of students. In this context, the paper becomes of great significance since one can consider that it assess the effect of the human capital policies on economic growth with the objective of justifying further action or make necessary changes to existing policies.

The rest of the paper is organized as follows: the next section summarizes the main findings from the specialty literature regarding the impact of the human factor on economic growth. The variables used, the econometric model and data analysis are presented in the Methodology section. Section four presents the results of the panel regression model and some final remarks are presented in the conclusion section.

Literature review

Many of economic text books consider economic growth as an increase in production of goods and services of an economy using a comparison between two periods. Economic growth can be measured and expressed by different methods using macroeconomic variables. The most used variable in literature, as a measurement of welfare and economic growth of a country, is Gross Domestic Product, defined as the standard measure of the value of final goods and services produced by a country during a period (OECD, 2009).

The main factors that contribute to economic growth and have a direct impact are human capital, technology, natural resources, and capital good (Boldeanu & Constantinescu, 2015).

The literature regarding the relationship between education and economic growth is extensive and has biased results and conclusions due to the use in empirical estimations of a various variables that measure the quality of human capital and education.

The link between education and growth has been studied from both qualitative and quantitative perspectives. The qualitative aspect of education usually was measured by the score results obtained by students at international tests. Mathematics and scientific skills of students who took the international tests have a strong and consistent effect on economic growth rather than the quantitative aspect of education measured by the variable average years of schooling (Hanushek and Kim, 1995). Barro (2000) also showed that growth is unrelated with male schooling at the primary level, but is significantly influenced by the scores obtained by students at science. Altinok (2007) showed that the qualitative indicator of education (the variable used was compound of scores from seven groups of different international tests) have a positive and highly significant effect on economic growth instead of the quantitative indicator (years of schooling). In accordance with Barro (2000) and Altinok (2007) the same significant influence of the scores obtained on international tests on economic growth was obtained by Son et. al (2013). Therefore the quality of schooling has a significant impact on economic growth, especially for students with skills in mathematics and

science, compared to the results obtained from the quantitative perspective (usually measured by years of schooling), Barro (2000), Hanushek and Kim (1995), Altinok (2007), Delgado et al (2012) and Son et al (2013) showed that years of schooling, has no direct influence on economic growth.

The previous results contrast with findings of Psacharopoulos (1994), Gumus and Kayhan (2012) which showed that there is a connection between school enrollment and economic growth.

The opposed results of the studies regarding the relation between economic growth and human capital and education conducted to inconsistent findings and created difficulties in defining a set of variable that measure the human capital.

Starting from the concept of human capital in literature are many definitions regarding this topic. Human capital, for example, according to Oxford Dictionary is “the skills, knowledge and experience of a person or group of people, seen as something valuable that an organization or country can make use of”, or defined by the OECD as the “knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being”.

Due to the fact that human capital is more complex it cannot be seen only from the perspective of skills, knowledge and experience. Also, because there was a need for an indicator that allows comparisons between countries in term of human capital, the Human Capital Index was developed. This index contains 51 indicators from the four pillars: education, health and wellness, workforce and employment. The Human Capital Index allows rankings between countries and represents a basis for future policies and measurement regarding workforce planning (WE, 2013).

Considering these aspects our analysis includes as a measurement of human capital the following variables: researchers in research and development, labor force for all three aggregated levels of education and migration.

Methodology

To observe the relationship between economic growth and expenditures on education we used a panel data multiple regression model. The benefits of panel data are that offer perspectives on both dimensions time and cross-sectional variables.

Most authors used panel data in order to show the link between education and economic growth. Altinok (2007) used a panel data regression model on a unbalanced panel data with growth rate of GDP per capita as dependent variable in relation with two aspects of education: quality of education measured by the scores obtained by the students at international tests (the variable was compound of scores from seven groups of different international tests), and quantity of education measured by years of schooling. Also, in respect with Barro (2000) and Atinok (2007) results, Son et al. (2013) used a panel data on GDP per capita growth and the average number of education for all levels, number of years of schooling in tertiary level, scores obtained at skill tests, and life expectancy rate and inflation rate to show what influences the dependent variable.

The model we use analyzes the link between human capital and economic growth includes six variables from two reliable sources: World Bank and Eurostat (only for crude rate migration for which World Bank has incomplete series). We have chosen as dependent variable the GDP annual percentage growth rate representing the variable that measures the economic growth of a country. The independent variables employed in the analysis are:

- number of researchers per million persons represents the number of researchers engaged in Research & Development (R&D), expressed as per million. According to World Bank metadata “researchers are professionals who conduct research and improve or develop concepts, theories, models techniques instrumentation, software of operational methods. R&D covers basic research, applied research, and experimental development”.
- crude rate migration as variable of human capital movement (in case of this variable if its value is positive it means that the country has more immigrants, if negative the country has more emigrants)
- NEET (Not in education, employment, or training) corresponding age between 15 to 29 years
- labor force with basic education which is computed as the percentage of the working age population with a basic level of education who are in the labor force (basic education includes primary education or lower secondary education)
- labor force with intermediate education which is computed as the percentage of the working age population with an intermediate level of education who are in the labor force (intermediate education includes upper secondary or post-secondary non tertiary education)
- labor force with advanced education which is computed as the percentage of the working age population with an advanced level of education who are in the labor force (advanced education includes short-cycle tertiary education, a bachelor’s degree or equivalent education level, a master’s degree or equivalent education level, or doctoral degree or equivalent education level)

A panel data regression model comprises two dimensions components: time and individual, and is described as the following linear relationship (Greene, 2002):

$$y_{it} = \beta_{i0} + \sum_{k=1}^k x_{it} \cdot \beta_{kit} + \varepsilon_{it} \quad \text{Equation 1}$$

Where: $i = 1, \dots, N$, N represents the number of individuals (or the cross-sectional dimension); $t = 1, \dots, T$, T represents the number of periods (or the time dimension).

There are three types of main estimations for panel data regression models: pooled regression models (where all the two dimensions are taken in consideration, this type of estimation is usually useful when the OLS estimation has few observations and by pooling the cross-sectional dimension with the time dimension it can lead to an increase of the explanatory power of the estimates), fixed effects and random effects (Greene, 2002).

Considering the general model for a panel data linear regression our regression model for panel data can be described as it follows:

$$\begin{aligned} \text{GNIGrowth}_{it} = & \beta_{it} - \alpha_1 * \text{D.ResearcherInRDperMillionPeople}_{it} + \alpha_2 * \\ & \text{D.CrudeRateMigration}_{it} + \alpha_6 * \text{NEET}(15 - 29 \text{ years})_{it} + \alpha_3 * \\ & \text{LaborForceBasicEducation}_{it} + \alpha_4 * \text{LaborForceIntermediateEducation}_{it} + \alpha_5 * \\ & \text{LaborForceAdvancedEducation}_{it} + \varepsilon_{it} \end{aligned} \quad \text{Equation 2}$$

The results were estimated using Stata version 13.0. We used different abbreviations in order to ease the code writing: for the time-invariant individual or panel identifier is *CodID* in our case this refers to the Country, for the time variable we named it as *Year*.

Results and discussions

In order to analyze the relationship between human capital and economic growth we employed all three types of panel data regression models. First step of the analysis was to draw conclusions from the summary results statistics shown below in **Error! Reference source not found.** For the fixed effects model and random effects model the descriptive statistics and the coefficient of determination are computed for the following three types of variation:

Overall variation – it shows the variation over both time and cross-sectional dimensions.

Between variation – it shows the variation over the cross-sectional dimension, namely referring to individuals (denoted as *CodID*).

Within variation – shows the variation over the time dimension (*Year*).

Table 1. Summary statistics

Variable	Variation	Mean	Std. Dev.	Min	Max
GDP growth	overall	2.12	3.82	-14.81	25.12
	between		1.35	-0.66	4.57
	within		3.58	-16.55	22.67
Number of Researchers	overall	3111.78	1649.99	677.83	7821.84
	between		1595.43	925.18	7409.09
	within		511.58	1382.06	5191.93
NEET age 15-29 years	overall	11.59	4.35	3.44	25.05
	between		3.96	4.51	20.48
	within		1.95	5.70	17.67
Crude rate migration	overall	2.14	6.54	-25.20	22.20
	between		4.94	-9.54	15.53
	within		4.37	-23.48	19.79
Labor force with intermediate education	overall	67.03	4.90	56.97	81.41
	between		4.56	59.35	77.89
	within		1.96	60.48	72.47
Labor force with basic education	overall	36.10	11.23	13.96	67.88
	between		11.11	16.07	60.48
	within		2.62	27.80	44.47
Labor force with advanced education	overall	79.34	3.72	71.49	89.97
	between		3.46	73.45	85.87
	within		1.49	74.97	83.56

Source: Authors' calculation.

Considering the results from Table 1 representing the summary statistics of our variables of interest we observe that for the number of researchers there are big differences between countries and small differences over time within a country. A similar result but with a lower intensity we have obtained in case of NEET with age between 15 and 29 years and the labor force variables for all three major levels of education for which we observe that there are moderate differences between countries and small differences over time within a country.

An interesting result was obtained for the crude rate migration for which its variation across countries is nearly equal to the variation observed over time within a country. This means that if two countries are drawn randomly from our data, the difference of crude rate migration is expected to be nearly equal to the difference for the same countries in two

randomly selected years.

Before estimating the panel data regression model, one needs to evaluate the stationarity of the variables involved. For this we have applied Levin – Lin – Chu panel unit root tests for each variable (Table 2).

Table 2. Summary results for the stationarity tests

Variable	P-Value for the variable in level
Researchers (first difference)	0.0000
Crude rate migration (first difference)	0.0000
NEET age 15-29	0.0000
LabourForceBasicEducation	0.0729
LabourForceIntermediateEducation	0.0020
LabourForceAdvancedEducation	0.0000

Source: Authors' calculation.

All the variables used in the model are stationary for a 5% level of significance (the null hypothesis stating the presence of unit root is rejected), except for the variable "Labor force basic education" which is stationary however at 10% level of significance.

The value of R-Square has different values for the fixed effects model compared with the one with random effects. In case of the fixed effects model the R-Square is larger for the variation within, which because there is an influence on the economic growth of the independent variable over time. Considering the random effects model R-Square is larger for the between variation because there is an influence on the economic growth of the independent variable over the individuals.

The value of Rho can be explained in two ways depending on the type of the estimated model. Considering the fixed effects model for which we have a value, Rho shows which is proportion of the variation explained by the individual-specific term which is a component of the error term (this value is a constant term that doesn't vary over time). In the case of random effects model, Rho represents the fraction of total variance due to error term (Baum, 2006). So the variation of the individual-specific term is explained by the constant term in proportion of 1.569% and 98.431% is explained by the error term.

Table 3. Summary results from the panel data regression models

GNI growth	Pooled regression	Fixed effects regression	Random effects regression
R-Square	0.1728	-	-
R-Square within	-	0.2543	0.1739
R-Square between	-	0.1018	0.3425
R-Square overall	-	0.1075	0.1723
Rho	-	0.47725	0.01569
No of Observations	364	364	364
No of Countries	28	28	28

Source: Authors' calculation.

The results from the multiple regression model for all three models: pooled, fixed and random effects model are presented in Table 4.

Table 4. Results from the multiple regression models for panel data

GDP growth	Pooled regression	Fixed effects regression	Random effects regression
Researchers (first difference)	0.00206	0.00199*	0.002056*
Crude rate migration(first difference)	0.25326**	0.19707**	0.2495352**
NEET age 15-29	-0.13588*	-0.72636**	-0.1574586**
LabourForceBasicEducation	-1.11864**	-0.19253*	-0.1214376
LabourForceIntermediateEducation	0.09178	0.30097**	0.0986826**
LabourForceAdvancedEducation	0.22167*	0.20175	0.2245388**
Constant	-16.0122	-18.92115	-16.35011**
F(6,27)/Wald chi2(6)	5.36**	18.76**	73.51**

** P-value<0,01 *P-value<0,05

Source: Authors' calculation.

To choose between the fixed versus random effects estimated models we used the Hausman test which his null hypothesis is that random effects models are consistent and fixed effect models are inefficient, in our case we reject null hypothesis so the fixed effects model is a better option to our estimates.

Table 5. Fixed vs. Random Effects

Hausman Test	
chi2(6)	53.17**

* *P-value<0,01

Source: Authors' calculation.

The results confirm the link between economic growth and human capital, a direct and significant impact on economic growth for the variables: number of researchers, crude rate migration and labor force with intermediate education.

In case of labor force with intermediate education an increase of one percentage point in the share of the working age population with an intermediate level of education who are in the labor force will lead to a 0.3 percentage points increase in GDP annual growth rate. In contrast labor force with basic education has a negative impact on economic growth, leading to a drop with 0.192 percentage points in GDP annual growth rate. The advanced education has no significant impact this results is in accordance with the findings of Barro (2000) and Son et al (2013), which may suggest that highly educated labor force is being used inefficiently due to job-education mismatches that usually generates frustration and leads to labor low productivity rates (Leuven and Oosterneek, 2011; Sam, 2018; Simonescu and Naroş, 2019).

Not in education, employment, or training with the corresponding age between 15 to 29 years determine a negative and significant influence on economic growth, which leads to a decrease with approximately 0.73 percentage points in GDP annual growth rates.

Research and development as shown in the literature (Goschin, 2014; Khan, 2015) has a relevant and positive impact to economic growth. It appears that a change on the short time in the number of researchers has a low impact on the GDP growth (of only 0.002 percentage points), but one has to consider that the variable in level is in absolute terms (number of researchers per million persons).

Table 6. Goodness of fit tests

Serial Correlation	$F(1, 27) = 20.163^{**}$
Heteroskedasticity	$\chi^2(28) = 638.44^{**}$
Cross-sectional dependence	Pesaran's test of cross sectional independence = 37.952 ^{**}

**P-value<0,01 Source:

Authors' calculation.

From table 6. it can be observed that the estimated model does not confirm the assumptions of goodness of fit test. The homoskedasticity restriction is not confirmed due to the fact that the p-value of the Modified Wald test for groupwise heteroskedasticity in fixed effects model is less than the significance level of 0.01. The value of Wooldridge test for autocorrelation in panel data shows the presence of serial correlation and the value of Pesaran test of cross sectional independence shows that there is cross-sectional dependence, which in both situations is not a problem for a micro data panel with time series lower than 20 years (Torres-Reyna, 2007).

Conclusion

The relationship between economic growth and education is a highly debated topic and shows how important are decision and policy makers in order to bring new and consistent policies in order to prepare and plan the workforce. Through literature the link between workforce, education and economic growth was visible and highly studied.

Our analysis contributes to the literature through its focus on the link between economic growth and human capital from the perspective of education and human movement for the EU countries. The major limitations of the present research relate to the variables used, due to the fact that most education variables regarding human capital and workforce are scarce and mostly affected by break-in series. To this respect, it has been stated the importance of a complex and comparable indicator (OECD Insights, n.d.; Son et al, 2013, United Nations, 2016) that measures the human capital.

The study confirms the relationship between economic and growth human capital from both quantitative, but also from qualitative perspectives. The variable used number of researchers, labor force with intermediate education and labor force with advanced education, labor force with intermediate education have different impact on GDP annual growth rate. In case of labor force we observe that the percentage of the working age population with an intermediate level of education that are in the labor force will lead to a 0.3 percentage points increase in GDP annual growth rate. In contrast labor force with basic education has a negative impact on economic growth, an increase of workforce with basic education leading to a drop in GDP annual growth rate. Although we did not find a statistically significant influence on economic growth of labor force with advanced education, this is in line with the findings of Barro (2000) and Son et al (2013). Also, as it was expected youth not in education, employment, or training with the corresponding age between 15 to 29 years have a negative impact on economic growth, which can be linked with the previous variable, educated workforce. This leads to the following question: is educated labor force adequately planned for the actual market requirements? This question arises due to the fact that in literature it is demonstrate the job-education mismatch of educated workforce (Leuven and Oosterneek, 2011; Sam, 2018) and also that people with higher education usually choose to work after they graduated which leads to lower chances of finding a job than the people with higher education who have prior work experience (Simionescu and Naroş, 2019).

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