HUMAN CAPITAL: A DETERMINANT OF REGIONAL DEVELOPMENT? AN EMPIRICAL STUDY ON THE EUROPEAN UNION

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Abstract

The paper aims to investigate if human capital is a determinant of regional development accross EU countries. We used a regression model to show that economic growth in the EU countries is influenced by the tertiary educational level of population. Data from EUROSTAT, as tertiary educational attainement of population and GDP per capita in PPS at regional level (NUTS 2), over the period of 2002-2011, were used. We found a moderate validated statistical dependence between the variance of GDP per inhabitant and that of tertiary educational attainment of population accross European regions and a stronger link between them when we used time series of data.

Key words: human capital, regional economic growth, education and development
JEL Codes: J24, R11, I25

1. Introduction

The concept of human capital consists of: native human capital (biological), educational capital, health capital and social skills [15]. The accumulation of human capital plays a key role for economic growth in countries and regions. In the specific literature of economic growth the link between human capital and economic performance is well documented and discussed in several empirical studies exploring the impact of human capital-generally measured by formal education- on economic growth.

The objective of the paper is to demonstrate the influence of human capital (educational capital of population) on regional economic growth (expressed by regional GDP per inhabitant) accross EU countries.

The paper is organized as follows: a short literature review on the link between human capital and economic growth, a section dedicated to methodology and data, followed by the main findings of the study, and finally, conclusions and references.

2. Human capital and economic growth: a short literature review

According to Schultz(1961), skills and knowledge that people acquire during their formal schooling represent a form of human capital. OECD (2001) refers to human capital as "the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being". Laroche et al. (1999) defined human capital as the aggregation of the innate abilities and the knowledge and skills that individuals acquire and develop throughout their lifetime.

The concept of human capital was largely used in the studies of Becker (1962, 1997) and Mincer (1958, 1962, and 1974) who affirmed its links with economic growth and by emphasizing its importance in explaining earnings differentials.

Several studies explored the relationship between accumulation of human capital and economic output. Schultz, Barro (1991), Mankiw et. al(1992), Bils and Klenow(2000), identified a significant contribution of human capital (measured by the schooling rate) at the GDP growth. Robert Barro (2001) emphasized the role of education on economic output, by using the variable 'quantity of education', measured by years of school attainment, and the variable 'quality' expressed by scores on internationally comparable examinations.

Barro and Sala-i-Martin (1995) found that the average schoolling years have a significant positive impact on the economic output. Mamuneas, Stavides and Stengos (2002) concluded that the sensitivity of the human capital to the economic output is diferentiate between countries, is positive for developed countries and for developing and underdeveloped is lower or zero.

Other authors concluded that the impact of various levels of education in the economic growth depends on the level of a country's development, with tertiary education being most relevant for OECD countries [18].

In the OECD countries, several studies highlighted the positive impact of the human capital on the GDP per capita growth. The absolute value of the differences between the human capital stocks in rich and poor countries is the right factor determining the convergence of the poor countries towards the rich countries [6].

According to Izushi&Huggins (2004), regions with a higher level of investment in tertiary education tend to have a larger concentration of information and communication technology (ICT) sectors and research functions.

The researchers of the Lisbon Council (2011) concluded that the regions of Europe vary in human capital performance more among themselves than countries do, based on close comparison of *Human Capital Leading Indicators* at the regional level. *Human Capital Leading Indicators* are key indicators correlated to the local prosperity: *the number of complex jobs in the regions, the number of jobs available for young people and the easy with which young people can find employment, the ability to get unemployed back to work* and *the intensity of investment in research and development and the volume of local patent application.*

3. Methodology and data

We admite that economic output is a linear function of human capital, other factors remaining constant, in order to demonstrate and evaluate the link between human capital and economic output:

$$f(x) = c_1 + c_2 \cdot x \qquad (1)$$

where: *x* -independent variable,
and:

$$y = f(x) + \varepsilon \qquad (2)$$

where y is the dependent variable and ε is the error.

The simple linear regression equation is:

$$y = c_1 + c_2 x \qquad (3)$$

where: c_1 and c_2 are regression parameters.

The regression parameters will be estimated through the Least Squares Method (LSM).

If $\hat{c}_1$ and $\hat{c}_2$ are the estimators of c_1 and c_2, then:

$\eta_i = \hat{\varepsilon}_i = y_i - \hat{c}_1 - \hat{c}_2 \cdot x_i$ (4) and the expression $\sum \varepsilon_i^{\,2} = \sum (y_i - \hat{y}_i) = \sum \eta_i$ tends to be minimum, in other words, the value of $W(\hat{c}_1, \hat{c}_2) = \sum (y_i - \hat{c}_1 - \hat{c}_2 \cdot x)^2$ has to be minimum.

The goal is to find c_1 and c_2 that minimize the error, ε. The values of c_1 and c_2 can be obtained by solving a system of linear equations. We used the E-Views software estimate the values of c_1 and c_2.

We used data from EUROSTAT, regional data bases. For human capital measure, we used tertiary educational attainment of population, namely persons aged 25-64 with tertiary education attainment (%), and Regional GDP (in PPS per inhabitant), as a measure of the economic output from 245 European regions (NUTS 2), over the period of 2002-2011. Regions with incomplete data series and countries comprising of one region (i.e. Estonia, Cyprus and Luxembourg) were excluded.

4. Main findings

In table 1 are displayed the regression results by applying the equation (3) to data series of 245 European regions for the year 2011.

The value of c_1 is 13,314 and it represents the point where the independent variable (human capital) is zero, meaning that, the economic output could be 13,114 PPS per inhabitant, when educational attainment is zero, at a standard error of 1,027. The value of c_2 is 0,0005, meaning that, at an increase of educational attainment with one unit, the Regional GDP per inhabitant will increase with 0,0005 units, at a standard error of 4,40E-05.

The value of R-squared coefficient (0,29) shows that only 29% of the variation of Regional GDP could be explained by the influence of the tertiary educational attainment.

The value of Prob, for both regression estimators (c_1 and c_2) is 0.0000 $\langle$ 0,05, (the significance threshlod), therefore is very unlikely that the estimators, $\widehat{c}_1$ and $\widehat{c}_2$ to be originated from a population with $c_1 = 0$ or $c_2 = 0$, meaning that c_1 and c_2 are statistically different from zero (they are statistically significant).

The value of adjusted R-squared coefficient is 0,28 is close to the value of of R-squared coefficient, showing that the sample is representative for a concise reflection of the reality.

The value of F-statistic is 99,33 $\rangle$ 3,936 (the critical value of $F_{0,5,1,243}$). Therefore the nule hypothesis (H_0) is rejected and the regression model is validated. Furthermore, Prob(F-statistic) =0,0000 $\langle$ 0,05, in other words the linear regression model is statistically validated.

As a conclusion of the above lines, a moderate statistical link between educational attainment and economic output is identified accross European regions for the year of 2011.

Table 1
European regions, 2011- Regression results

Dependent Variable: X
Method: Least Squares
Date: 09/20/14 Time: 09:03
Sample: 1 245
Included observations: 245
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y	0.000525	4.40E-05	11.92997	0.0000
C	13.31476	1.027898	12.95339	0.0000

R-squared	0.290164	Mean dependent var	25.88776
Adjusted R-squared	0.287243	S.D. dependent var	8.833163
S.E. of regression	7.457392	Akaike info criterion	6.864418
Sum squared resid	13513.89	Schwarz criterion	6.893000
Log likelihood	-838.8913	Hannan-Quinn criter.	6.875928
F-statistic	99.33264	Durbin-Watson stat	0.566952
Prob(F-statistic)	0.000000		

Source: author's computation by using E-Views software, based on 2011 EUROSTAT regional data

In order to have an accurate image of the above link between human capital and economic output, we test the hypotehis of homoskedasticity by using the White test (Table 2). We notice that the model is heteroskedastic, due to the fact that Obs*R squared is 14,17 $\rangle$ $\chi^2_{0,05,2}$ (5,99). This means that the errors variance is not constant, and it differs from an observation to another.

The heteroskedasticity of the model can have several causes. One could be the nature of the surveyed economic phenomen, i.e. economic growth depending on educational attainment, which differs from a European region or country to another due to the particularities of data series (territorial series). Another explanation could be the complexity of the dependent variable, regional GDP per capita. The variation of this variable is depending on several economic factors: regional business environment, public/governamental policies, institutions, inflation, investments, employment.

Table 2
Heteroskedasticity test
Heteroskedasticity Test: White

F-statistic	7.428644	Prob. F(2,242)	0.0007
Obs*R-squared	14.17143	Prob. Chi-Square(2)	0.0008
Scaled explained SS	14.76337	Prob. Chi-Square(2)	0.0006

Source: E-Views software results, based on 2011 EUROSTAT regional data

We further have tested the model with average values of tertiary educational attainment and regional GDP per capita for 245 European regions, over the period of 2002-2011. The results are displayed in the Table 3. We noticed that the model is statistically validated (the Prob.values of both parameters are lower than 0,05; the value of Prob(F-statistic) is lower than 0,05 and F-statistic is higher than 5,99). The dependency between human capital and economic output is stronger than in the first case, the value of R-squared is 0,34 higher than 0,29 (Table 3) and in a proportion of 34%, the variation of regional GDP per capita could be explained by the variation of educational attainment of population.

It remains the problem of the models' heteroskedasticity which can be explained through similar considerations as above and, furthermore, it is evidenced that average values are not appropriate measures that could explain a complex economic phenomenon (i.e. economic growth).

Table 3

European Regions, 2002-2011, average data- Regression results

Dependent Variable: X
Method: Least Squares
Date: 09/20/14 Time: 10:21
Sample: 1 245
Included observations: 245
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y	0.000556	4.52E-05	12.31103	0.0000
C	10.24903	0.968865	10.57839	0.0000

R-squared	0.340174	Mean dependent var	22.66317
Adjusted R-squared	0.337458	S.D. dependent var	8.062527
S.E. of regression	6.562627	Akaike info criterion	6.608789
Sum squared resid	10465.54	Schwarz criterion	6.637371
Log likelihood	-807.5766	Hannan-Quinn criter.	6.620299
F-statistic	125.2787	Durbin-Watson stat	0.622435
Prob(F-statistic)	0.000000		

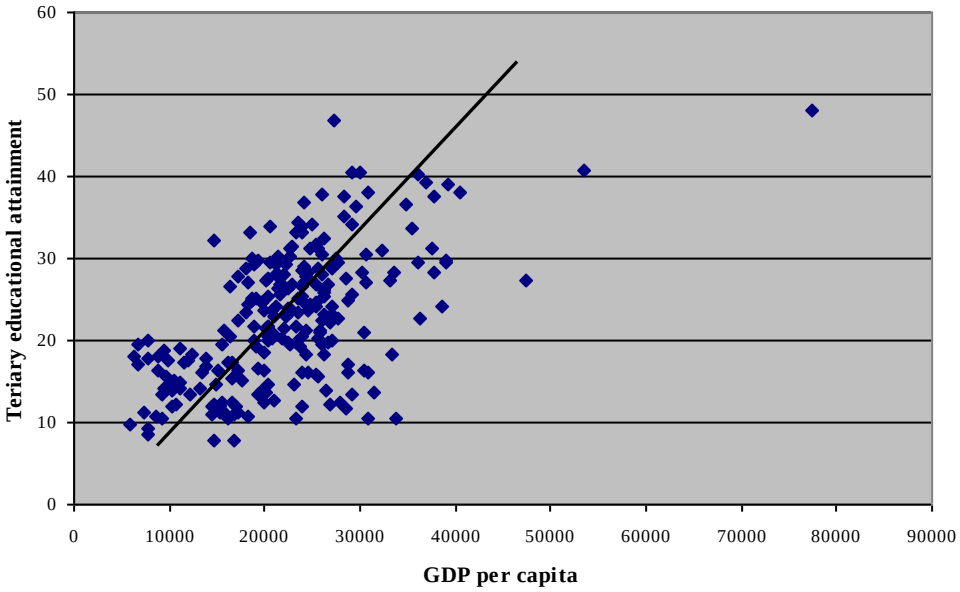
Heteroskedasticity Test: White

F-statistic	7.714066	Prob. F(2,242)	0.0006
Obs*R-squared	14.68329	Prob. Chi-Square(2)	0.0006
Scaled explained SS	13.95516	Prob. Chi-Square(2)	0.0009

Source: autor's computation by using E-Views software, based on 2002-2011 EUROSTAT regional data

The graph (Figure 1) shows us the demonstrated link between GDP per capita and tertiary educated people in European regions, during 2002-2011, as average data.

Figure 1 The link between GDP per capita and tertiary educated people in European regions, during 2002-2011, average data



Source: author's interpretation of 2011 EUROSTAT regional data

We further tested the model in the case of an European country, with a sufficiently high number of regions (NUTS 2) for statistical significance. In the case of Germany (country with the highest number of regions, 36) the results are exposed in the Table 4.

Table 4
Germany, 2002-2011, average data-Regression results

Dependent Variable: X
Method: Least Squares
Date: 09/20/14 Time: 10:34
Sample: 1 36
Included observations: 36
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y	8.10E-05	0.000113	0.716140	0.4788
C	21.97701	3.299983	6.659735	0.0000

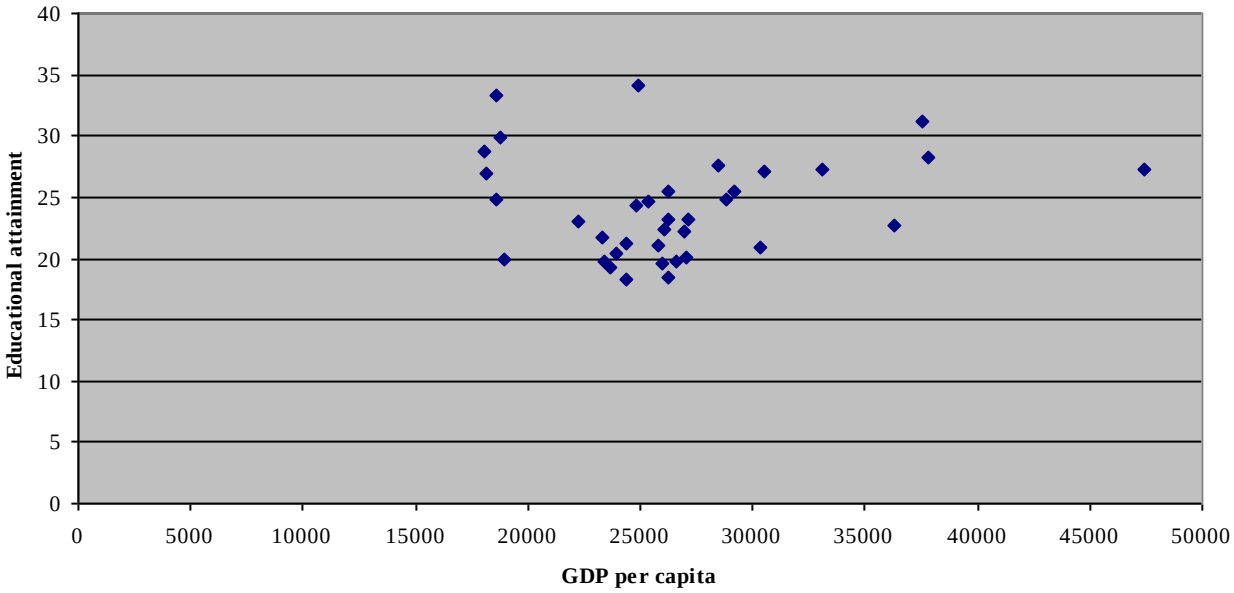
R-squared	0.014438	Mean dependent var	24.12488
Adjusted R-squared	-0.014549	S.D. dependent var	4.147933
S.E. of regression	4.177998	Akaike info criterion	5.751494
Sum squared resid	593.4928	Schwarz criterion	5.839468
Log likelihood	-101.5269	Hannan-Quinn criter.	5.782199
F-statistic	0.498076	Durbin-Watson stat	1.630983
Prob(F-statistic)	0.485154		

Source: autor's computation by using E-Views software, based on 2002-2011 EUROSTAT regional data

As we notice from Table 4, the link between human capital and regional GDP per capita is very weak, the value of the R-squared coefficient is 0,014, meaning that only in 1,4% of cases the variation of GDP per capita could be explained by the variation of tertiary educational level of population. But, important is that the model cannot be statistically validated due to the higher values than 0,05 of Prob. and Prob (F-statistic). Furthermore, F-statistic is lower than 5,99 (the critical value).

In accordance with the above conclusion, the graphical representation (Figure 2) highlights the weak liaison between regional GDP per capita and educational attainment in the German regions during 2002-2011.

Figure 2 The link between GDP per capita and and educational attainment in the German regions during 2002-2011



Source: author's interpretation of 2011 EUROSTAT regional data

In order to find further and detailed evidence of the link between regional human capital and economic output, we tested the linear regression model on time data series at given regions level. We have chosen first a well developed European region (Köln from Germany) and than the less developed (North -Eastern region of Romania).

For the Köln region of Germany, the model is statistically validated only as a whole, but for the c_1 parameter (C in the table 6) the value of Prob. is higher than 0,05. In other words, this parameter is not significantly different from zero. The link between human capital and economic output is very strong, the value if R-squared is 0,6575, meaning that 65,75% of the regional GDP per capita can be explained by the variation of educational attainment of population. The model is heteroskedastic as a result of using the White test (Table 6), meaning that the variance of the dependent variable (regional GDP per capita) is not constant at any level of independent variable (human capital).

Table 6
Köln region, Germany, 2002-2011, regression results

Dependent Variable: X
Method: Least Squares
Date: 09/20/14 Time: 10:46
Sample: 1 10
Included observations: 10
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y	0.000669	0.000140	4.769566	0.0014
C	6.038338	4.279338	1.411045	0.1959

R-squared	0.657534	Mean dependent var	25.54000
Adjusted R-squared	0.614725	S.D. dependent var	1.782134
S.E. of regression	1.106179	Akaike info criterion	3.216557
Sum squared resid	9.789055	Schwarz criterion	3.277074
Log likelihood	-14.08278	Hannan-Quinn criter.	3.150170
F-statistic	15.35997	Durbin-Watson stat	2.067909
Prob(F-statistic)	0.004424		

Heteroskedasticity Test: White

F-statistic	0.911277	Prob. F(2,7)	0.4449
Obs*R-squared	2.065789	Prob. Chi-Square(2)	0.3560
Scaled explained SS	1.065385	Prob. Chi-Square(2)	0.5870

Source: autor's computation by using E-Views software, based on 2002-2011 EUROSTAT regional data

In the case of a less developed region (Table 7), the link is very strong (the R-squared is 0,92), the model is overally validated, exception for c_1 parameter (C in the table 7) due to the value of Prob., higher than 0,05 (the significance threshold). As in the other cases, the model is heteroskedastic, meaning that the variance of the dependent variable (regional GDP per capita) is not constant at any level of independent variable (human capital).

Table 7
North-Eastern region, Romania, 2002-2011, regression results

Dependent Variable: X
Method: Least Squares
Date: 09/20/14 Time: 10:57
Sample: 1 10
Included observations: 10
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Y	0.001486	0.000148	10.06423	0.0000
C	1.032602	0.876019	1.178744	0.2724

R-squared	0.926809	Mean dependent var	9.860000
Adjusted R-squared	0.917660	S.D. dependent var	1.851246
S.E. of regression	0.531213	Akaike info criterion	1.749549
Sum squared resid	2.257497	Schwarz criterion	1.810066
Log likelihood	-6.747743	Hannan-Quinn criter.	1.683162
F-statistic	101.3034	Durbin-Watson stat	1.242804
Prob(F-statistic)	0.000008		

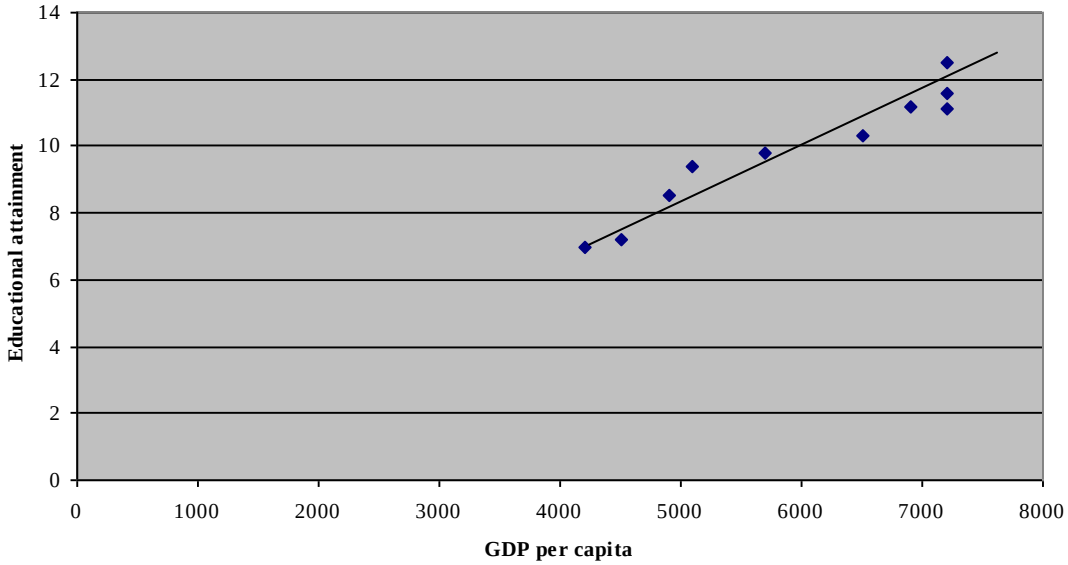
Heteroskedasticity Test: White

F-statistic	0.042186	Prob. F(2,7)	0.9589
Obs*R-squared	0.119096	Prob. Chi-Square(2)	0.9422
Scaled explained SS	0.037044	Prob. Chi-Square(2)	0.9816

Source: autor's computation by using E-Views software, based on 2002-2011 EUROSTAT regional data

In line with the above considerations, Figure 3 shows us the the graphical representation of the regression equation.

Figure 3 The link between GDP per capita and educationa attainment in Nord Eastern Region of Romania, 2002-2011



5. Conclusions

We intended to demonstrate the link between human capital and economic output at regional level accross EU countries. We tested a simple linear regression model to show that there is a statistically validated link between the two variables.

Firstly, we tested the model accross 245 European regions (territorial data series) for the year of 2011 and for average data for the period of 2002-2011. The findings show a moderate link between the variables and a heteroskedastic model.

Secondly, when testing the model for a well developed European country (Germany) by using average data, we found that there is a weak and not validated link between human capital and economic output.

Thirdly, we tested it for time series in the case of two regions, one well developed (Köln, Germany) another less developed (North-Eastern region of Romania). We found, in both cases, the poor explanation power of the model: it is validated only as a whole and it remained heteroskedastic. This analysis of time series at a region level highlights a stronger link between the two variables than when we tested the model with territorial data series.

In all the tested cases, we found that our linear regression model is heteroskedastic, the errors variance is not constant, and it differs from an observation to another. Several explanations could be pertinent for this finding. Mainly, we have to mention, that economic results are influenced by a large number of factors (i.e. political, economical, social, institutional) whose impact differ from a country/region to another.

We are aware that further improvements of the model explaining the economic growth through the educational attainment of the population can be made, by adding, for example, other independent or control variables.

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