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ORIGINAL SCIENTIFIC PAPER

Empirical Investigation of the Impact of Tertiary Education on the Economic Growth of the European Union Countries

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ABSTRACT

The relationship between tertiary education and economic growth of the EU countries in the period 2000-2012 was examined in this paper, by using a developed econometric model in which the multiple regression method was applied and based on relevant data. The empirical research conducted did not confirm the starting hypothesis that the share of the highly educated in the structure of employees between 30 and 34 years in the EU countries in the period 2006-2012 had a positive impact on GDP per capita growth rate over this time interval. The search for the cause of the results obtained in this way should start from the selected observation period, which is characterized by the years before and immediately after the economic crisis of 2008 and 2009. Also, there is an assumption that the education systems of EU countries do not sufficiently follow real development in the labor market, that is, they do not sufficiently educate people who are able to commercialize university-acquired knowledge for innovation and economic growth. In this light, the reorganization of the system of functioning of higher education as an increasingly important segment of state support for modernizing the higher education system and increasing its degree of efficiency in the modern conditions of adherence becomes a very popular topic.

Key words: *tertiary education, economic growth, economic growth factors, EU countries*

JEL Classification: I250

INTRODUCTION

Stable economic growth in the long run is an important material assumption of economic and social prosperity of countries. The list of drivers of economic growth is very broad. One of the main drivers of long-term economic growth is human capital, which represents a set of knowledge, skills and competences, levels of health status and many other components.

The education system is the foundation upon which human capital construction is based. In this system, higher education is the platform on which the process of human capital construction under contemporary production conditions is based. It creates highly qualified professionals who are essential drivers of economic growth and development.

Education as a component of human capital has always attracted the interests of researchers around the world. In the field of economics, the question of the relationship between the level of education of the population and economic growth is particularly important for economic policy

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makers. The answer to the question is whether the level of education drives economic growth or it differs, both in theoretical and empirical literature.

The aim of this research is to examine the impact of education on the economic growth of EU countries in 2006-2012.

The composition of the work consists of six sections. Following the introduction, the second section of the paper provides an overview of significant theoretical and empirical studies of the interrelationships between education and economic growth of individual countries. For the purpose of empirical confirmation of the alternative hypothesis about the positive and negative impact of the growing share of persons who completed tertiary education in the population aged between 30 and 34 on the economic growth of EU countries in the period 2001-2012 is presented in the third section of the paper. Also, as part of this section, a multiple regression model is being developed to investigate this impact. Exploration of the research and discussion results is presented in the fourth section of the paper. Concluding considerations are in the following fifth section and the list of used literature in the sixth section of the paper.

REVIEW OF SIGNIFICANT RESEARCH

In principle, there are two different approaches to looking at the link between education and economic growth. The first approach starts from the view that human capital is not an input like any other, but a key driver of advancing innovation (Nelson & Phelps, 1966). Identical views can be found in Doms et al. (1997), Caselli & Coleman (2001), Fabiani et al. (2005), Falk (2005), Bayo-Moriones & Lera-Lopez, (2007) and many others.

Another approach was developed by Lucas (1988) arguing that economic growth is based on the accumulation of human capital. He was followed by Becker, Murphy & Tamura, 1990, Rebelo, 1992, Mulligan & Sala-i-Martin, 1992, Baro & Lee, 1992.

There are a number of respectable empirical studies of education as drivers of economic growth. For illustrative purposes, Bassu and Bhattarai (2009, in Deniz et al., 2011) conducted a survey on a sample of 47 countries between 1960 and 2007 which showed that in economically developed countries, economic growth was positively correlated with investment in education, while this link was negative in economically less developed economies with lower investment in education. On the other hand, Krueger and Lindhal (2001, in Deniz et al., 2011) present their results on how average school years affect economic growth, and find that there is a positive and significant relationship between education and economic growth, especially in low-income countries levels of education of the population.

Acosta-Ormachea and Morozumi (2013) question whether a change in the structure of public spending can stimulate economic growth. Their results showed that the reallocation of public spending between expenditures for national defense, economic infrastructure, health and social protection had no effect on economic growth. However, when changes in the structure of public expenditure involve an increase in investment in education, then there is robust evidence of an association with economic growth.

Sylwester (2000) comes to the conclusion that investment in education is positively correlated with future economic growth, and negatively correlated with current economic growth, suggesting that the effects of investment in education on economic growth can be realized over time. The results of his research also show that the link between investment in education and economic growth is more pronounced in OECD countries and that it is weaker in less developed countries.

The results of Pritchett's research (2001, in Deniz et al., 2011) show that there is no significant correlation between investment in education and economic growth.

Chen and Feng (2000) based their research on a survey conducted in 29 Chinese provinces in 1978-1989 and they have come to the conclusion that higher education is the most important

factor for economic growth. Therefore, these authors advocate a policy of rewarding the best individuals in the education sector, in order to motivate other individuals to invest more and more effectively in their education.

Barro (2001, in Abhijeet et al., 2010) conducted a survey on a sample of 100 countries in 1965–1995. He came to the conclusion that economic growth was positively correlated with the initial levels of average adult male schooling. In contrast, economic growth was not significantly linked to the education of women in secondary and upper levels. He also concluded that highly educated women were not well placed in the labor market in many countries and therefore did not contribute to economic growth.

Abhijeet et al. (2010) explains that the link between education and economic growth depends on public spending, tax structure, production technology parameters. Survey results have shown that the link between education levels and economic growth is non-linear, that is, growth in investment in education is not always accompanied by accelerated economic growth.

Vu, Hammes and Im (2012) distinguish between the impact of university and vocational education on economic growth. By empirically exploring the link between education and economic growth, they determine the existence of a two-way relationship: education encourages economic growth and growth increases education as per capita income rises. These authors refute the dominant view in science that tertiary education is a significant factor in stimulating economic growth over vocational education. They point out that vocational education provides practically applicable work skills and therefore contributes to higher productivity than university education, and thus it increases per capita income. On the contrary, the effect of university education on economic growth is often neglected and is caused by the higher relative costs of university education.

The key argument relied on by the evidence of a negative relationship between the indicators analyzed lies in the distinction that exists between the number of years of education and the quality of education. Actually, by increasing the number of years of education does not mean, a priori, a higher level of quality of higher education. Moreover, it is often the opposite because of the fact that a larger education system often imposes the need to hire additional workers on lower criteria, or increase the number of students per teacher.

Some authors analyze higher education in certain specific areas as a factor influencing economic growth. For illustrative purposes, Murphy, Shleifer & Vishny (1991) indicate that engineering education makes a greater contribution to development than higher education in the field of law. Tiago (2007) proves that the enrollment rate in the faculties of engineering and computer science has a significant impact on economic growth. Tsai, Hung & Harriott (2010) appeal to government subsidies for technology studies, as research shows that increasing the number of graduates in engineering, mathematics and computer science is a significant factor in improving the quality of the workforce, and thus driving economic growth.

DATA AND METHODOLOGY

Starting from the above explanations, we further examine whether or not the growing proportion of people completing tertiary education in the population aged between 30 and 34 had a stimulating role in generating economic growth in EU countries in 2001-2012.

In this sense, the hypothesis was made:

> Ho: The economic growth of EU28 countries is positively correlated with the participation of persons who successfully completed tertiary education in the population aged between 30 and 34 in the period between 2001 and 2012.

The alternative hypothesis is:

H: The economic growth of EU28 countries is negatively correlated with the participation of persons who successfully completed tertiary education in the population aged between 30 and 34 in 2001-2012.

In accordance with the defined hypothesis, we opted for the multiple regression method. Specifically, we want to see how the dependent variable (in this case, the rate of economic growth) changes under the influence of the independent variable (the share of the highly educated in the total number of employees in the population between the ages of 30 and 34).

The model we want to construct in our research will be enriched with additional variables that we also believe to have an impact on the real rate of economic growth and we want to control their impact on economic growth in the observed countries (Figure 1 and Table 1).

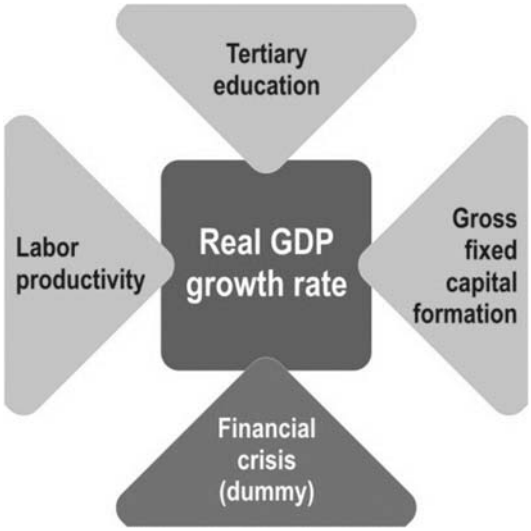

Figure 1. Impact model
Source: Authors

Table 1. List of variables in the model

Parameters	Parameters description
Independent 1	Tertiary educational attainment, age group 30-34 (%)
Control variable 1	Gross fixed capital formation (% of GDP)
Control variable 2	Labor productivity per hour worked (annual % change)
Control variable 3	Financial crisis (dummy)
Dependent	Real GDP growth rate (annual % change)

Source: Authors

Data on the growth rates of real gross domestic product in EU countries are taken from Eurostat. The calculation of the real growth rate of gross domestic product makes it possible to monitor the dynamics of the level of economic activity, both between different economies and over different time periods. The real rate of economic growth further excludes the impact of inflation on quantifying the level of economic activity at national level.

Independent and control variables

Participation of persons who have successfully completed tertiary education in the population aged 30-34 (%) is used as an acceptable and very suitable approach for quantitative and qualitative analysis. Specifically, European statistics, in the area of higher education, monitors

this information in its official annual reports. Higher participation of the highly educated in this age structure speaks of raising the level of education of the observed country.

The first in the list of control variables is Gross fixed capital formation (as percentage of GDP). It is a concept used in official national accounts such as the United Nations System of National Accounts (UNSNA), National Income and Product Accounts (NIPA) and the European System of Accounts (ESA). Statistically, this variable shows the value of the acquisition of new or existing fixed assets by economic entities, the state and households (excluding entrepreneurs) reduced by the amount of alienated fixed assets. In short, it represents a component of GDP that is focused on investment, not personal consumption. There are numerous studies that trace the link between fixed capital investment and economic growth (Romer 1987; DeLong & Samers 1991, 1992, 1993). We particularly highlight the results of an empirical study in which, on the basis of data from 65 countries, from 1960 to 2000, a positive relationship was found between the average fixed capital investment rate and the average GDP per capita growth rate per employee (Sorenson & Whitta-Jacobsen, 2010).

The second in the list of control variables is labor productivity per hour worked (annual% change). This data is taken from Eurostat and labor productivity per hour worked is calculated as the ratio between real gross domestic product (at constant 2005 prices) and engaged labor. Engaged work is expressed by the total number of working hours recorded in one national economy. Measuring labor productivity per hour provides a better insight into productivity levels, as compared to the conventional method of productivity per worker, since it eliminates the difference between full-time and part-time employees as a component of the workforce in different countries and different time periods. Productivity growth is a result of capital growth, higher quality of workforce and advancement of technology. All these factors are connected to a work ethic and culture, the treatment of entrepreneurship in the economy, the ability of workers and managers to adapt quickly to any change.

The third control variable is the global financial crisis that occurred during the analyzed period. Specifically, the global economic crisis, which began in the United States in late 2008, quickly spilled over to the continent of Europe. We witnessed that not only the global financial system was threatened with its emergence. Almost all sectors of the economy in Europe were exposed to the consequences of its emergence. All economies within the European Union were exposed to the negative impact of the financial crisis. In some EU Member States, the economic growth rate in 2008 was lower or even negative. In 2009, all EU countries experienced a negative economic growth rate. This is precisely the reason why we introduced an artificial binary variable in our research. In this paper, the financial crisis takes the form of an artificial binary variable, which we refer to as DumVar. The correctness of the decision to choose 2009 as a crisis year is also confirmed by the value of the artificial variable (financial crisis) in the observed period –it was the same in 2008 and 2009 and its value was 1, and in other years its value was 0.

Figure 2 illustrates the movement of the variables thus selected in the model. Data for 2013 and 2014 were used for the observed period 2001-2012 because a positive time shift of 1 and 2 years with respect to the main independent variable was performed. Tertiary educational attainment, age group 30-34. Values are shown as EU28 averages.

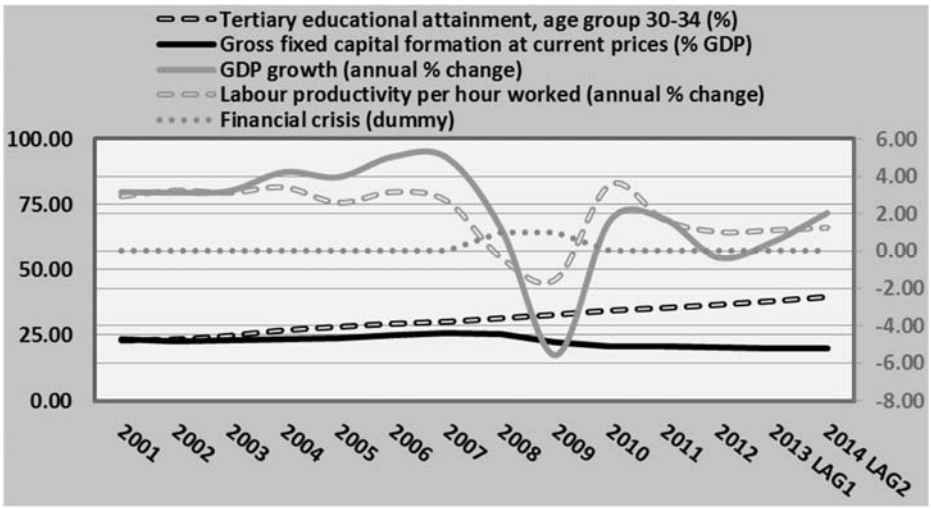

Figure 2. Moving average values of model variables for EU28

There is a slight but constant divergence of Tertiary educational attainment, age group 30-34 and Gross fixed capital formation, which shows the increasing influence of human capital in the economic structure of the EU 28.

In the study presented, we will use a fixed effect statistical model (FE). When using FE we assume that something within the countries may affect the predictor or outcome variables and we need to control this. This is the rational view behind the assumption of the correlation between the entity's error term and predictor variables. FE removes the effect of those time-invariant characteristics from the predictor variables so we can access the predictor net effect.

Another important assumption of the FE model is that those time-invariant characteristics are unique to the entity and should not be correlated with other entities characteristics. Each entity is different therefore the entity's error term and the constant (which captures individual characteristics) should not be correlated with the others entity's error terms (Wooldridge, 2003).

If the error terms of two entities are correlated, then FE is not suitable for prediction. In this case the model should be replaced by random-effect modeling (RE). For testing suitability of predicted model (FE vs RE) we used the Hausman test (Greene, 2010).

RESEARCH RESULTS

We begin our analysis with summary of descriptive statistics in Table 2.

Table 2. Descriptive statistics and variable names

Variable	Obs	Mean	Std. Dev.	Min	Max
Real GDP growth rate	308	.0209416	.039242	-.177	.11
Gross fixed capital formation	308	.2147175	.0413092	.106	.36
Tertiary educational attainment	306	.3027026	.1083365	.089	.511
Labor productivity per hour worked	297	26.65084	16.65616	3.6	64.9
Financial Crisis Dummy	308	.1818182	.3863223	0	1

The mean real GDP growth rate is 2% and the standard deviation is almost two times greater. The explanatory variables (dependent variable and control variables) also showed great deviation. This could be one of indicators for using a fixed effect model in some future regressions of this paper. We suppose that every country has some characteristics which have

influence on real GDP growth differently. The meanings are based on observations from all countries and that could be the reason for great standard deviation. When we use fixed effect model to get entity error it is correlated with other predictors in entity. Those entity errors are unobserved, time invariant characteristics of every country.

Table 3 represents correlation matrix between independent variable and predictors.

Table 3. Correlation matrix between variables

	Real GDP growth rate	**Gross fixed capital formation**	**Tertiary educational attainment**	**Labor productivity per hour worked**	**Financial Crisis Dummy**
Real GDP growth rate	1.0000				
Gross fixed capital formation	0.4172	1.0000			
Tertiary educational attainment	-0.1991	-0.3394	1.0000		
Labor productivity per hour worked	-0.2044	-0.4392	0.5671	1.0000	
Financial Crisis Dummy	-0.5240	0.0642	0.0810	0.0117	1.0000

The simple correlation with growth rate of GDP and other predictors are all modest. Interestingly, the correlation of real GDP growth rate is not even positively associated with the share of the population aged 30-34 who have successfully completed university (Tertiary educational attainment).

There is not strong correlation between independent variables which is good for our future regressions. According to Tabachnick and Fidell (1996), the independent variables with a bivariate correlation of more than 0.70 should not be included in multiple regression analysis.

First we will run simple linear regression. The dependent variable we use is the real GDP growth rate. The independent variables are gross fixed capital formation, the share of the population aged 30-34 who have successfully completed university (Tertiary educational attainment), labor productivity per hour worked - EUR per hour worked and we also include our dummy variable which represents financial crisis. The following regression is given in Table 4.

Table 4. Simple linear regression

Source	**Df**	**MS**	Number of obs 295			
Model	4	0.054567333	F(4, 290) 66.57			
Residual	290	0.000819759	Prob > F = 0.0000			
Total	294	0.001551018	R-squared = 0.4787 Adj R-squared = 0.4715 Root MSE = .02863			
Real GDP growth rate	**Coef.**	**Std. Err.**	**t**	**P> |t|**	**[95% Conf. Interval]**	
Gross fixed capital formation	0.4284406	0.0451483	9.49	0	0.3395806	0.5173005
Tertiary educational attainment	-0.0005963	0.0190053	-0.03	0.975	-0.0380022	0.0368095
Labor productivity per hour worked	4.65E-06	0.0001281	0.04	0.971	-0.0002474	0.0002567
Financial Crisis Dummy	-0.0562147	0.004346	-12.93	0	-0.0647685	-0.047661
_cons	-0.0601828	0.0124848	-4.82	0	-0.0847552	-0.0356105

The number of R-squared which is 47, 87 % of the variance of the dependent variable is the real GDP growth rate, explained by our regression model. Adjusted R-Squared has similar interpretation but we take into account the numbers of variables we have in our regression model. We are basically interested to find out if there is any evidence between our independent

variable and dependent variable controlling for the other variables. We must formulate a null hypothesis in order to prove this. The null hypotheses tests the following model: "There is no relationship between the Real GDP growth rate and the share of the population aged 30-34 who have successfully completed university controlling for the gross fixed capital formation, labor productivity per hour worked (annual % change) and dummy variable which represents a financial crisis."

The multiple regression coefficients have a ceteris paribus interpretation. First what we noticed in this regression is that the p-value for the share of the population aged 30-34 years old who have successfully completed university (Tertiary educational attainment) and labor productivity per hour worked (annual % change) are particularly high and suggest no significant effect of them. Other variables are significant.

We have two main reasons to believe that a model made with OLS regression does not work. The first one is that our independent variable does not have a significant p value, and also one of the control variables does not have a significant p value. Secondly, for the panel data, it is more acceptable to use the Fixed Effect or Random Effect regression model.

In panel data, countries are observed at several points in time. Two basic models for panel data analysis are The Fixed effect model and Random effect model. The panel data are useful when we suspect that the dependent variable depends on independent variables which are not observable but correlated with observed independent variables. If those omitted variables are constant over time, with a panel data estimator we will be able to consistently estimate the effect of our observed independent variables.

Econometric model

We have a multiple regression model for 28 countries i = 1, ...28 which is observed at several time periods t = 1, ...11.

$$y_{it} = \alpha + x'_{it}\beta + c_i + u_{it} \qquad (1)$$

Where: yit is the dependent variable, α is intercept, x'it is a K-dimensional row vector of explanatory variables, β is K-dimensional column vector of parameters, ci is country specific effect and uit is error overall term.

The T (T = 11) observations for each country are summarized by the following matrices:

The T observations for individual i can be summarized as:

Dependent variable y_i, is represented by:

$$y_i = \begin{bmatrix} y_{i1} \\ \circ \\ \circ \\ y_{i5} \\ \circ \\ \circ \\ y_{i11} \end{bmatrix}, \rightarrow y_i = [11 \times 1]$$

As we have 4 independent variables in regression Independent variable X_i, it is represented by:

$$X_i = \begin{bmatrix} x'_{i1} \\ \circ \\ \circ \\ x'_{i5} \\ \circ \\ \circ \\ x'_{i11} \end{bmatrix}, \rightarrow X_i = [11 \times 4]$$

For the overall error, term matrix is:

$$u_i = \begin{bmatrix} u_{i1} \\ \circ \\ \circ \\ u_{i5} \\ \circ \\ \circ \\ u_{i11} \end{bmatrix}, \rightarrow u_i = [11 \times 1]$$

Let's denote the last country in set *i* with ***N, (N =28)***, last year in set *t* with ***T, (T=11)*** and ***K*** in dependent variables in regression ***(K=4).*** Now we can write NT observations for all countries and time periods as:

$$y=\begin{bmatrix} y_1 \\ \circ \\ \circ \\ y_i \\ \circ \\ \circ \\ u_{28} \end{bmatrix},\rightarrow y=[NT\times 1] \qquad X=\begin{bmatrix} X_1 \\ \circ \\ \circ \\ X_i \\ \circ \\ \circ \\ X_{28} \end{bmatrix},\rightarrow X=[NT\times K] \qquad u=\begin{bmatrix} u_1 \\ \circ \\ \circ \\ u_i \\ \circ \\ \circ \\ u_{11} \end{bmatrix},\rightarrow u=[11\times 1]$$

The data generation process is described by linearity: $y_{it}=\alpha+x'_{it}\beta+c_i+u_{it}$, where $E[u_{it}]=0$ and $E[c_i]=0$.

The model is linear in parametersα, and β, individual effect ci and overall error uit.

Independence: $\{X_i, y_i\}_{i=1}^{N}$, (independent and identically distributed).

The observations are independent across individuals but not necessarily across time. This is guaranteed by random sampling of countries.

Strict Exogenicity: E [uit|Xi, ci] =0

The overall error term is assumed uncorrelated with the explanatory variables of all past, present and future time periods of the same individual. This is a strong assumption which for example rules out lagged dependent variables. This also assumes that the overall error is uncorrelated with the individual specific effect. Further assumptions allow us to distinguish the random effects model and the fixed effects model (Schmidheiny, 2011).

The Random vs. fixed effects model

In the random effect model, the individual-specific effect is a random variable that is uncorrelated, with the explanatory variables.

Unrelated effect: E(ci|Xi)=0. This assumption says that the individual-specific effect is a random variable that is uncorrelated with the explanatory variables of all past, present and future time periods of the same individual. This is a very strong assumption that economists usually do not like. From this we can early conclude that the random effect model would not be used in this paper. Later on, we proved this by an appropriate test.

In the fixed effects model, the individual-specific effect is a random variable that is allowed to be correlated with the explanatory variables.

Related effect: $\boldsymbol{E(c_i|X_i)\neq 0}$.

Variance Effect: $\boldsymbol{V(c_i|X_i)=\sigma_c^2<\infty}$; $\boldsymbol{V(c_i|X_i)=\sigma_{ci}^2(X_i)<}$

This assumes constant variance of the individual specific effect.

Identifiability rank $\ddot{X}=K<NT$ and $E(\ddot{x}'_i\ddot{x}_i)$ where a typical element is $\ddot{x}'_{it}=x_{it}-\bar{x}_i$ and $\bar{x}_i=1/T\sum_t x_{it}$. This assumes that the explanatory variables are not perfectly collinear, that all regressors have non-zero within-variance. Hence xit cannot include a constant or any other time-invariant variables (Schmidheiny, 2011).

Results for the fixed effect regression model

Considering all the aforementioned facts, we do fixed-effect multiplication regression for independent, dependent and control variables. The results are shown in Table 5.

Table 5. Multiple regression using the fixed effect model

Fixed-effects (within) regression Group variable : Country R-sq: within =0.5814 between =0.3052 overall =0.0040 corr(u_i, Xb) =-0.9347				Number of obs 295 Number of groups 27 Obs per group: min =9 avg =10.9 max =11 F(4,264)=91.65 Prob >F= 0.0000		
Real GDP growth rate.	**Coef.**	**Std. Err.**	**t**	**P> |t|**	**[95% Conf. Interval]**	
Gross fixed capital formationi	0.6066615	0.0552892	10.97	0	0.4977976	0.7155255
Tertiary educational attainment	-0.1552425	0.0410749	-3.78	0	-0.2361187	-0.0743663
Labor productivity per hour worked	0.0058452	0.0015107	3.87	0	0.0028707	0.0088197
Financial Crisis Dummy	-0.0562251	0.0039328	-14.3	0	-0.0639688	-0.0484814
_cons	-0.2061999	0.0378701	-5.44	0	-0.2807657	-0.1316341
sigma u	0.08911076					
sigma e	0.02529476					
Rho	0.92543315	(fraction of variance due to u_i)				
F test that a ll u i=0:	F(26, 264) = 4.14 Prob > F = 0.0000					

Based on the data contained in Table 5, it follows that all the predictors have a statistically significant p value. It follows that, with the ceteris paribus clause, a 1% increase in the participation rate of the highly educated in the population between 30 and 34 has the effect of reducing the real GDP rate by 0.155 percentage points. The coefficient of determination is 58.14%. We attribute the negative impact to the presence of the economic crisis.

Recognizing this fact and the theoretical postulates that the effects of higher education on economic growth become more pronounced after a few years, we construct our time-delayed multiplier regression of one and two years (Table 6).

Table 6. Multiple regression using the fixed effect model with time lag for one year for share of the population aged 30-34 who have successfully completed university (tertiary educational attainment).

Fixed-effects (within) regression Group variable : Country R-sq: within = 0.5971 between = 0.2809 overall = 0.0059 corr(u_i, Xb) =-0.9347				Number of obs 268 Number of groups 27 Obs per group: min =8 avg =9.9 max =10 F (4,237)=87.81 Prob >F=0.0000		
Real GDP growth rate	**Coef.**	**Std. Err.**	**T**	**P> |t|**	**[95% Conf. Interval]**	
Gross fixed capital formation	0.6527613	0.0593155	11	0	0.5359084	0.7696142
Tertiary educational attainment LAG1	-0.1465833	0.0451384	-3.25	0.001	-0.2355071	-0.0576595
Labor productivity per hour	0.0062278	0.0017638	3.53	0	0.0027531	0.0097024

worked						
Financial Crisis Dummy	-0.0568216	0.0040386	-14.1	0	-0.0647777	-0.0488655
_cons	-0.2307366	0.0460767	-5.01	0	-0.3215088	-0.1399644
sigma u	0.0946098					
sigma e	0.0259203					
Rho	0.9301809	(fraction of variance due to u_i)				
F test that all u i=0:	F(26, 237) = 3.85 Prob > F = 0.0000					

From Table 6, we conclude that with the ceteris paribus clause, an increase in the participation rate of the highly educated in the 30- to 34-year-old population by 1% and a one-year delay in this effect results in a decrease in the real GDP rate of 0.146 percentage points. The coefficient of determination is 59.71%.

Table 7. Multiple regression using the fixed effect model with time lag for two years for share of the population aged 30-34 who have successfully completed university (tertiary educational attainment).

Fixed-effects (within) regression	Number of obs 268
Group variable : Country	Number of groups 27
	Obs per group:
R-sq: within = 0.6174	min =7
between = 0.2096	avg =8.9
overall = 0.0144	max =9
corr(u_i, Xb) =-0.9340	F(4,210)=84.73
	Prob >F =0.0000

Real GDP growth rate	**Coef.**	**Std. Err.**	**T**	**P> |t|**	**[95% Conf. Interval]**	
Gross fixed capital formation	0.6998178	0.0641767	10.9	0	0.5733047	0.826331
Tertiary educational attainment LAG2	-0.1221088	0.049119	-2.49	0.014	-0.2189384	-0.0252793
Labor productivity per hour worked	0.0062999	0.001992	3.16	0.002	0.0023731	0.0102268
Financial Crisis Dummy	-0.0568274	0.0041494	-13.7	0	-0.0650072	-0.0486476
_cons	-0.2518971	0.055817	-4.51	0	-0.3619305	-0.1418636
sigma u	0.09502024					
sigma e	0.0262978					
Rho	0.92885346	(fraction of variance due to u_i)				
F test that all u i=0:	F(26, 210) = 3.53 Prob > F = 0.0000					

From Table 7 it follows that with the ceteris paribus clause, the increase of participation of the highly educated in the population from 30 to 34 by 1% and the delay of this effect of two years have an impact on the decrease of the real GDP rate by 0.122 percentage points. The coefficient of determination in this case is the highest and it is 61.74%. Also in this case, the correlation between entity error and predictors is different than zero, in our case it is -0.93. From a negative correlation value it can be concluded that the predictors are well included in the model, as the description of the predicted variable is better when the error is getting smaller. If we add to this the fact that the F test has a good value, we have confirmed that all coefficients are different from zero. From the standpoint of all these facts, we can construct a model.

$$(\mathrm{RealGDPgrowthrate})_{it} = 0.6998(\mathrm{Grossfixedcapital})_{it} - 0.1221(\mathrm{Tertiaryeducational})_{it-2} + 0.0062(\mathrm{Laborproductivity})_{it} - 0{,}0568\,(\mathrm{Dummy})_{it} - 0.2518 + c_i + u_{it} \qquad (2)$$

Figure 3 presents a graphical interpretation of the impact of the two most significant variables in the model on the growth rate of real gross domestic product with a time lag of the Tertiary educational attainment variable of 2 years. A very dominant positive influence of the variable Gross fixed capital (it) is clearly observed, as well as a negative influence, but the effect of the variable Tertiary educational attainment (it-2) is significantly less influential.

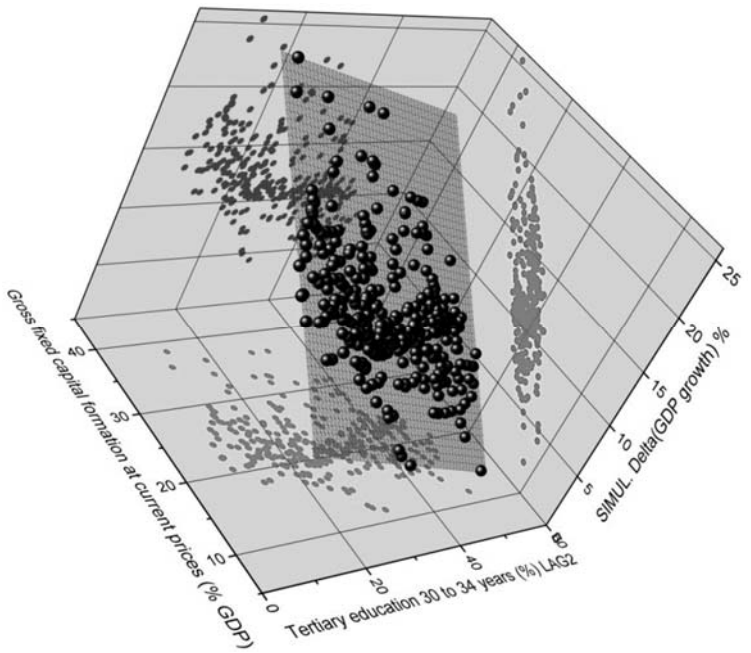

Figure 3. 3D presentation of the impact model Gross fixed capital and Tertiary educational attainment on the Real GDP growth rate.

Figure 4 illustrates that by extending the time shift from 0 to one or two years, the negative impact of the Tertiary educational attainment variable on the real GDP growth rate is reduced.

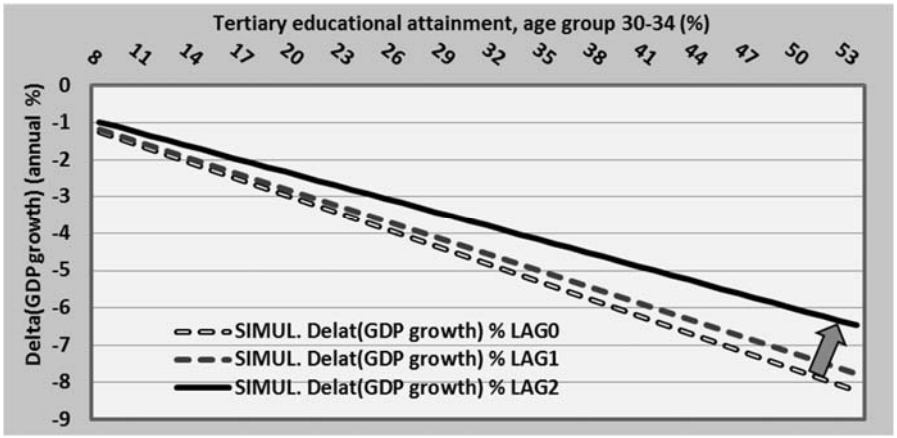

Figure 4. Presentation of the change in the impact of Tertiary educational attainment on the Real GDP growth rate as a function of time shift

Hausman test for endogenity of the model

In order to decide between fixed or random effects we run a Hausman test where the null hypothesis is that the preferred model represents random effects vs. the alternative model which represents the fixed effects (Green, 2008). It basically tests whether the unique errors uit are correlated with the regressors and the null hypothesis is that they are not.

We also have to make the regression with The Random effect model in order to compare the significance of an estimator versus an alternative estimator. The regression is shown in Table 8.

Table 8. Regression using a random effect with time lag of two years for share of the population aged 30-34 who have successfully completed university (tertiary educational attainment)

Random-effects (within) regression					Number of obs 241	
Group variable : Country					Number of groups 27	
					Obs per group:	
R-sq: within = 0.5924					min =7	
between = 0.1618					avg =8.9	
overall = 0.4999					max =9	
corr(u_i, X) =0 (assumed)					Wald chi2 (4)=271.27	
					Prob> chi2=0.0000	
Real GDP growth rate	**Coef.**	**Std. Err.**	**Z**	**P> |z|**	**[95% Conf . Interval]**	
Gross fixed capital formationi	0.5415416	0.0531542	10.19	0	0.4373612	0.645722
Tertiary educational attainment LAG2	-0.0303151	0.0263206	-1.15	0.249	-0.0819026	212724
Labor productivity per hour worked	0.0003521	0.0001788	1.97	0.049	1.63E-06	7025
Financial Crisis Dummy	-0.0570723	0.0043802	-13.03	0	-0.0656573	484873
_cons	-0.084596	0.0154517	-5.47	0	-0.1148808	543111
sigma u	0.00768588					
sigma e	0.0262978					
Rho	0.07869572	(fraction of variance due to u_i)				

The result of Hausman test is presented in Table 9.

Table 9. The Hausman test result

Fixed vs. random test	Coefficients			
	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
Gross fixed capital formationi	0.6998178	0.5415416	0.1582762	0.0359622
Tertiary educational attainment LAG2	-0.1221088	-0.0303151	-0.0917937	0.0414717
Labor productivity per hour worked	0.0062999	0.0003521	0.0059479	0.0019839
Financial Crisis Dummy	-0.0568274	-0.0570723	0.0002449	
b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg Test: Ho: difference in coefficients not systematic chi2(**4**) = (b-B) ' [(V_b-V_B)^(-1)] (b-B)=**59.25** Prob>chi2 = **0.0000** (V_b-V_B is not positive definite)				

The realized Hausman test resulted in a probability of almost 100%, which indicates the rejection of his null hypothesis about the adequacy of a multiple regression model with a

random effect. By this, we confirm that an alternative hypothesis of the test has been proved, or that between the independent and control variables, on the one hand, and the residual uit, on the other, there is a correlation. This also speaks in favor of justifying the acceptance of the developed fixed-effect multiple regression model.

The search for the cause of the results obtained in this way should start from the selected observation period, which characterizes the years before and immediately after the economic crisis. There is also the assumption that the education systems of EU countries do not sufficiently follow real developments in the labor market, that is, they do not sufficiently educate people who are able to put into practice the knowledge gained at universities in the knowledge that is rapidly commercializing into innovation and economic growth.

We believe that future research must operate with an independent variable, the proportion of employees with tertiary education up to 64 years of age, and to include the years after 2012, which are characterized by more dynamic rates of economic growth in EU

CONCLUSION

The use of the multiple regression statistical method rejected the starting hypothesis that the increase in the share of tertiary graduates in the total number of employees aged 30-34 had a positive impact on the economic growth rate of these countries in 2001-2012. The study confirmed the alternative hypothesis that the economic growth of EU countries was negatively correlated with the participation of persons who successfully completed tertiary education in the population between the ages of 30 and 34 in the period between 2001 and 2012.

We can look for the cause of confirmation of the alternative hypothesis in the too narrow (in terms of the set age range from 30 to 34 years) population we observed as an exogenous variable or in the too short time series the study covered. A decrease in the negative impact of the exogenous variable is observed with an increase in the time lag relative to the observed economic growth as an endogenous variable.

This may be an initial starting point for some future research, where on the one hand A) the exogenous variable would vary in terms of changing (above mentioned), the age range of the observed employee population, and on the other hand b) further increase the observed lag time relative to the endogenous variable (up to the limit allowed by available data).

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