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Education As A Determinant Of The Economic Growth. The Case Of Romania.

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Abstract

Education is one of the most important factors of the economic growth in every country. In this paper we investigate the causality relationship between education, especially higher education, and economic growth in Romania for 1980-2013 time period. We used a vector error correction model to analyse the long run relationship between education and economic growth. As a measure for the economic growth we used GDP per capita and for education we used the number of students enrolled in higher education institutions and the public expenditures on education. We used data series for these variables available from World Bank, Eurostat and National Statistics Institute of Romania. In our econometric approach we checked the stationarity of the data series using ADF and Phillips-Perron tests and we tested if there is a cointegration relationship between the analysed variables using Johansen Juselius method. Our results showed that higher education have an important positive effect on economic growth.

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Keywords: higher education, economic growth, cointegration, ADF, unit roots.

1. Introduction

Education in general and higher education in particular is one of the most important factors of economic growth and the relationship between higher education and economic growth has been a central subject of research in economics. Although there is a solid theoretical framework of the economic growth and its relationship with education (Greiner et. al, 2005;Mankiw, et al, 1992;Barro and Sala-i-Martin, 1995;Romer, 1990) the empirical evidences of this relationship are scarce (Awel, 2013;Danacica, 2011).

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Education and especially higher education can influence economic growth in various ways: education is converted in increased labor productivity by accumulating knowledge and skills, by facilitating the technological progress and innovation.

In this paper we will investigate the long-run relationship between economic growth and higher education for Romania using data series that covers 1980-2013 period of time. The evolution of the higher education in Romania after the political changes in 1989 is analyzed in papers like (Andrei, 2010a, 2010b, 2010c;Dragoescu, 2013) but we found only few papers that treats the long run relationship between economic growth and higher education in Romania (Dragoescu, 2014;Danacica, 2008;Danacica, 2011).

The causality relationship between economic growth and education is analyzed in (Barro, 2002), and (Barro, 2013) who found that education significantly influence economic growth using a cross section of countries. Barro showed that there is a direct causality relationship from education measured by schooling rates to economic growth. Lucas (1988) developed an endogenous growth model that considered human capital as one of the factors of the economic growth and education as a proxy for the human capital accumulation. Mankiw et al (1992) showed that the human capital has a significant role in the economic growth. The authors used a Solow type model and introduced human capital measured through education as a new variable in the model. Agiomirgianakis et al (2002) studied the relationship between human capital measured through primary, secondary and tertiary education enrollment rates and economic growth for Greece and showed that there is a direct causality between primary and secondary education and economic growth and a reverse causality for tertiary education. Kui (2006) analyzed the economic growth and its relationship with education in China during 1978-2004 and obtained an interesting result: the economic growth is determined by the primary education and represents a direct cause for higher education. The long run relationship between economic growth and higher education in China is also investigated in Huang et al (2009) who found that there is a long run relationship between enrollment in higher education and economic growth. Katircioglu (2009) found that there is a long run equilibrium relationship between higher education and economic growth and a direct causality from higher education to economic growth in North Cyprus. The role of the higher education as a determinant of the economic growth in Taiwan is analyzed in (Lin, 2004) for 1965-2000 time period. The author shows that higher education provided a positive and significant effect on Taiwan's economic development. Ljunberg (2009) showed that the human capital was an important factor of the economic growth in Sweden using data series from 1870 to 2000.

In this paper we will investigate the long run relationship between economic growth and higher education in Romania. The paper is organized as follows: in section 2 we presented the data that we've used in our analysis, in section 3 we presented our methodological approach and in section 4 we discussed the results. A section of conclusions finish our paper. Data processing was achieved using Eviews.

2. Data

We used annual time series for the following variables: GDP per capita, public education expenditure as a share of GDP and the number of students enrolled in tertiary education (ISCED 5) for 1980-2012 in Romania. The data series were obtained from different sources. GDP (in constant LCU) was obtained from World Bank (2014), EconStats (www.econstats.com) and National Statistics Institute (2014). The public education expenditure was retrieved from multiple sources because neither of them cover the entire period that we analyzes: Eurostat database (Eurostat, 2014), Eurydice (2013) and (Neagu, 2005). The number of students enrolled in universities was obtained from National Statistics Institute (2014). All the data series are transformed using the natural logarithm.

Throughout the rest of the paper we will use the following notations: LGDP_PER_CAPITA is ln(GDP_PER_CAPITA), DLGDP_PER_CAPITA is the first difference of the LGDP_PER_CAPITA, LTERTIARY_EDU_STUD is ln(Number of students in higher education) and DL_TERTIARY_EDU_STUD is the first difference of LTERTIARY_EDU_STUD, LEDU_PUBLIC_SPENDING is ln(Public education expenditure) and DL_EDU_PUBLIC_SPENDING is the first difference of the LEDU_PUBLIC_SPENDING. Figures 1 to 3 show the evolution of these variables in between 1980 and 2012.

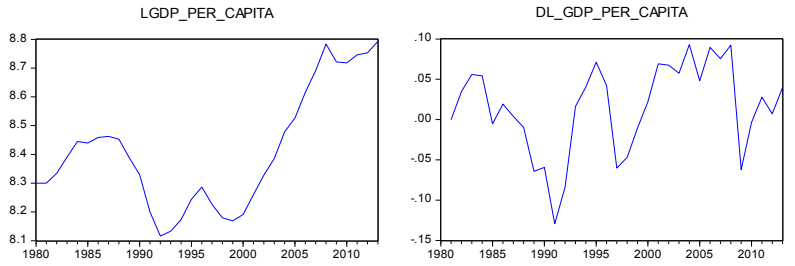

Fig.1a-b. The evolution of the GDP per capita during 1980-2012 in Romania and the same time series in first difference

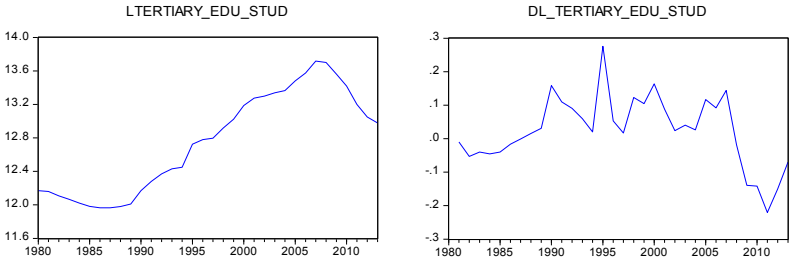

Fig.2a-b. The evolution of the number of students in higher education 1980-2012 in Romania and the same time series in first difference

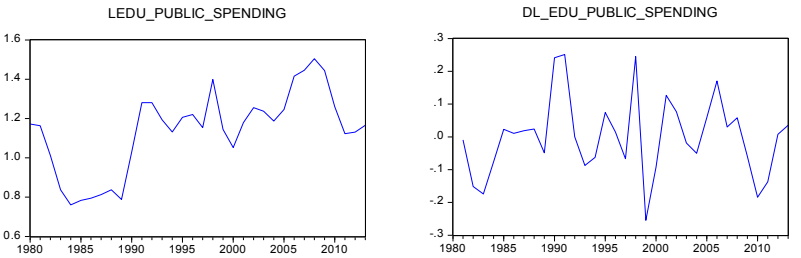

Fig.3a-b. The evolution of the public education expenditure 1980-2012 in Romania and the same time series in first difference

The GDP per capita known an increasing trend between 1980 and 1987 and after 1987 it decreased until 1992. Between 1992 and 1999 it had an oscillating evolution. Since 1999 it had constantly increased until 2008 when the economic crisis affected Romania. The GDP per capita decreased as an effect of the crisis and the level of GDP reached in 2008 was recovered only in 2013. The number of students enrolled in higher education has witnessed a slightly decrease between 1980 and 1990 under the communist regime when the access to higher education was restricted but after the political changes in December 1989, the number of students experienced a spectacular growth: if there were 192810 students in 1990 this number increased to 907353 in 2007. This evolution is due to the emergence private universities and to the increased number of public universities. After 2008, because of the economic crisis and the demographic changes in Romania, the number of students dropped constantly until 2013 when there were recorded 433234 students. The public education expenditure (as % from GDP) has recorded an oscillating evolution with an increasing trend starting from 1990. Nevertheless, the public education expenditure has always been one of the lowest in EU with a maximum value of 4.5% in 2008. The education in Romania has been constantly underfinanced.

As it can be seen from the figures 1-3, all series have an increasing trend over the analyzed period and don't seem to be stationary in level but the same series in first difference seem to mender around 0. In order to avoid the spurious regression problem we will check if the data series have unit roots.

3. Methodology

We started our investigation testing the stationarity of the data series. We tested all the data series for unit roots using the ADF and Phillips-Perron tests to determine the order of integration of each series. According to (Enders, 2004) the ADF unit root test estimate the following equation:

$$\Delta y_t = a_0 + \gamma y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \epsilon_t \quad (1)$$

If the coefficient $\gamma = 0$ the equation is entirely in first differences and has a unit root. The ADF and Phillips-Perron can be applied even if the error term is not a white noise.

In the second step we performed the Granger causality test between the variables that is a measure of the ability of predicting the future values of a time series using past values of another time series.

After we established the properties of the data series we can proceed to estimate the possible long-run relationship between them. We employed a VAR model that has become a standard approach in time series modeling, mainly because it makes no assumptions of what variables are exogenous, considering that all variables are endogenous. In order to specify the VAR model we have to decide how many lags to include in the model. We used information criteria (SBIC, AIC, HQ and FPE) as well as missspecification tests.

Having the order of integration of the data series, the next step in our work was to test for cointegration between variables using Johansen-Juselius approach (Johansen and Juselius, 1990). Since our data series are all I(1) we proceeded with a VEC model. If the general form of a VAR(p) model is given by:

$$Y_t = B + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \quad (2)$$

and all variables from the vector $Y_t = (Y_{1t}, Y_{2t}, \ldots Y_{kt})'$ are I(1) the VAR representation can be put in an equivalent form called VEC (Vector Error Correction):

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{p-1} \Delta Y_{t+1-p} + \varepsilon_t \quad (3)$$

where Π is the matrix that contains information regarding the long-run effect and Γ_i are matrices that measures the short term impact. Analyzing equation (4) we can conclude that $rank(\Pi) = r < k$ because $\Delta Y_{t-1}, \ldots, \Delta Y_{t+1-p}$ are stationary and ΠY_{t-1} should be stationary too, i.e. the determinant of matrix Π should be zero. A matrix $\Pi(k, k)$ with $rank(\Pi) = r < k$ can be decomposed as a product of two matrices $\Pi = \alpha\beta'$ where the matrix β contains r cointegration vectors while the matrix α contains the adjustment coefficients. We can write now the VEC model as:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \cdots + \Gamma_{p-1} \Delta Y_{t+1-p} + \varepsilon_t \quad (4)$$

where $\alpha\beta' Y_{t-1} = \mu_{t-1}$ is the stationary residual vector.

4. Results

We applied the ADF test for all variables in levels, considering three models: with intercept (M1), with intercept and trend (M2) and without intercept or trend (M3). The results are reported in table 1. It can be easily observed that all variables have a unit root at 5% signification level regardless of the model used for testing. We can conclude that all variables are non-stationary. The same results have been obtained using the Phillips-Perron test

Table 1. The ADF and Phillips-Perron tests for the variables in level.

Variable	M1			M2			M3		
ADF test	Test statistics	5% critical value	Prob.	Test statistics	5% critical value	Prob.	Test statistics	5% critical value	Prob.
LGDP_PER_CAPITA	-0.970	-2.957	0.751	-1.614	-3.557	0.764	0.800	-1.951	0.880
LTERTIARY_EDU_STUD	-1.340	-2.957	0.598	0.230	-3.552	0.997	0.446	-1.951	0.804
LEDU_PUBLIC_SPENDING	-1.658	-2.954	0.442	-2.423	-3.552	0.361	-0.298	-1.951	0.570
Phillips-Perron test	Test statistics	5% critical value	Prob.	Test statistics	5% critical value	Prob.	Test statistics	5% critical value	Prob.
LGDP_PER_CAPITA	-0.433	-2.954	0.891	-1.059	-3.552	0.920	1.032	-1.951	0.917
LTERTIARY_EDU_STUD	-1.038	-2.954	0.727	-1.128	-3.552	0.908	0.769	-1.951	0.875
LEDU_PUBLIC_SPENDING	-1.658	-2.954	0.442	-2.606	-3.552	0.280	-0.304	-1.951	0.568

Since the coefficients for the constant and trend (in models M1 and M2) are not significant we tested only model M3 for the data series in first difference. The results of the ADF and Phillips-Perron tests for the series in first difference are shown in table 2.

Table 2. The ADF and Phillips-Perron tests for the variables in the first difference.

Variable	ADF test (M3)			Phillips-Perron test (M3)		
	Test statistics	5% critical value	Prob.	Test statistics	5% critical value	Prob.
LGDP_PER_CAPITA	-2.619	-1.951	0.010	-2.718	-1.951	0.008
LTERTIARY_EDU_STUD	-2.427	-1.951	0.016	-2.375	-1.951	0.019
LEDU_PUBLIC_SPENDING	-4.690	-1.951	0.000	-4.605	-1.951	0.000

The results show that all the data series are stationary in first difference and we can conclude that our variables are I(1). A possible causal relationship between the analyzed variables could be foreseen using Granger causality test. The results of the Granger tests using 4 lags are presented in table 3. These results show that the number of students enrolled in tertiary education is helpful in predicting the economic growth, a direct causality from the number of students to the GDP per capita being emphasized by the Granger test. No other causality is indicated by this test. The same results are obtained running the Granger test with 3 lags. The results of the Granger causality test should be taken with precaution since the variables are non-stationary. Only if we could show that these variables are cointegrated, the Granger causality is valid.

Table 3. Granger causality test between variables

Null Hypothesis:	Obs	F-Statistic	Prob.
LTERTIARY_EDU_STUD does not Granger Cause LGDP_PER_CAPITA	30	4.170	0.012
LGDP_PER_CAPITA does not Granger Cause LTERTIARY_EDU_STUD		1.412	0.264
LEDU_PUBLIC_SPENDING does not Granger Cause LGDP_PER_CAPITA	30	1.036	0.411
LGDP_PER_CAPITA does not Granger Cause LEDU_PUBLIC_SPENDING		0.639	0.639

LEDU_PUBLIC_SPENDING does not Granger Cause LTERTIARY_EDU_STUD	30	0.198	0.936
LTERTIARY_EDU_STUD does not Granger Cause LEDU_PUBLIC_SPENDING		1.951	0.139

Since we've established that our series are I(1) we will proceed to estimate the VAR model. The first step is to decide how many lags to include in the model. We used the sequential modified LR test statistics, final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), Hannan-Quinn information criterion (HQ) and all these criteria indicate 2 lags. In the second step we tested the existence of a cointegration relationship between variables using the Johansen-Juselius method. Both the trace and max eigenvalue tests are presented in table 4.

Table 4. Johansen test for cointegration for LGDP_PER_CAPITA, LTERTIARY_EDU_STUD, LEDU_PUBLIC_SPENDING (5% level)

	Model M1	Model M2	Model M3	Model M4	Model M5
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	1	1	1	1
Max-Eig	0	0	0	0	0

The results of the Johansen test show that there is no cointegration between the three analyzed variables. We proceeded by testing if there is a cointegration relationship only between the GDP per capita and the number of students in higher education. The LR, SC and HQ criteria indicates 2 lags. Using 2 lags the Johansen cointegration test gives the results presented in table 5.

Table 5. Johansen test for cointegration for LGDP_PER_CAPITA and LTERTIARY_EDU_STUD (5% level)

	Model M1	Model M2	Model M3	Model M4	Model M5
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	1	2	1	2
Max-Eig	0	1	2	0	0

Akaike information criterion indicates that the most appropriate model is M2 with 1 cointegrating equation between variables. The existence of a cointegrating equation indicates that there is a long-run relationship between the variables and we can estimate a VEC model that will capture the long-run and short run relationship between our two variables. The cointegration between variables is very important to validate the Granger causality tests presented earlier because if the variables are non-stationary and not cointegrated the Granger causality tests are not valid. We estimated the VEC model and we obtained the cointegration vector β presented in table 6 and the adjustment parameters α presented in table 7.

Table 6. The cointegration parameters (t-statistics are in [ ])

Vector Error Correction Estimates -	t-statistics in [ ]
Cointegrating Eq:	CointEq1
LGDP_PER_CAPITA(-1)	1.000000
LTERTIARY_EDU_STUD(-1)	-0.2019 [-3.595]
C	-5.9053 [-8.283]

Table 7. The adjustment parameters

Error Correction:	D(LGDP_PER_CAPITA)	D(LTERTIARY_EDU_STUD)
CointEq1	-0.2094	-0.1965

Inspecting t-statistics we can note that all coefficients are highly significant. The cointegrating equation can be written as follows:

$$LGDP\_PER\_CAPITA_t = 5.9 + 0.2 \cdot LTERTIARY\_EDU\_STUD_t \quad (5)$$

The cointegrating equation shows that a 1% increase in the number of students enrolled in tertiary education leads to a 0.2% increase in GDP per capita meaning that tertiary education has a significant positive effect on economic growth. The matrix $\alpha' = (-0.2094, -0.1965)'$ contains the adjustment coefficients in response to a disequilibria in the cointegration equation. The speed of adjustment of the GDP per capita to imbalances in the long-run is highly significant (t-stat=-3.85). The negative sign of α indicates that the GDP per capita is an endogenous variable which corresponds to the theoretical framework and it also shows that the model is dynamically stable.

The error correction equations with the corresponding are:

$$\Delta LGDP\_PER\_CAPITA_t = -0.2\mu_{t-1} - 0.62\Delta LGDP\_PER\_CAPITA_{t-1} - 0.09\Delta LGDP\_PER\_CAPITA_{t-2} - 0.03\Delta LTERTIARY\_EDU\_STUD_{t-1} - 0.32\Delta LTERTIARY\_EDU\_STUD_{t-2} \quad (6)$$

$$\Delta LTERTIARY\_EDU\_STUD_t = -0.19\mu_{t-1} - 0.33\Delta LGDP\_PER\_CAPITA_{t-1} + 0.21\Delta LGDP\_PER\_CAPITA_{t-2} + 0.47\Delta LTERTIARY\_EDU\_STUD_{t-1} - 0.06\Delta LTERTIRY\_EDU\_STUD_{t-2} \quad (7)$$

Figure 4 shows the impulse response function of the GDP per capita. An impulse in the number of higher education students causes a drop in GDP per capita in the first years then follows an increase in the long-run.

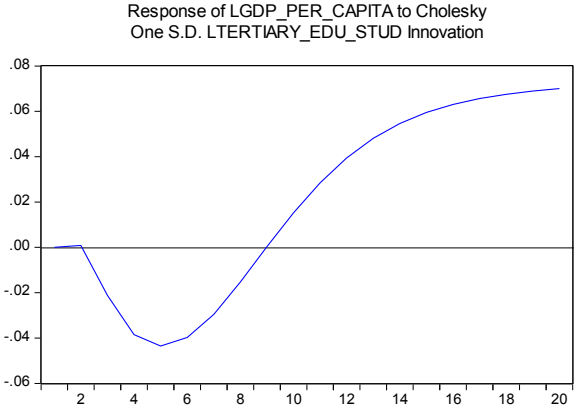

Figure 4. The impulse-response function of the GDP per capita

The cointegration between GDP per capita and the number of students in higher education validates the Granger causality presented in table 3 showing that there is a direct causal relationship from higher education to economic growth for the analyzed period in Romania.

5. Conclusions

At this moment there are few studies that treats the long-run relationship between economic growth and education in Romania (Andrei, 2010c), (Danacica, 2011), (Dragoescu, 2014). In this paper we examined the long run relationship between economic growth and education in Romania during 1980-2012. We used data series for GDP per capita, the number of students enrolled in higher education and the public education expenditure. We tested the data series for unit roots in levels and in first differences and found that they are I(1). Using the Johansen-Juselius method we tested whether there is a cointegration relationship between GDP per capita, public education expenditure and the number of students in higher education. The test showed that there is no cointegration equation between these three variables. We tested then the cointegration only between GDP per capita and the number of students and we found that there is a cointegration relationship between these two variables. This means that on the long run there is a link between economic growth and higher education. We estimated the VEC model and showed that the number of students in higher education has a significant positive effect on economic growth. Our results are in line with other studies (Barro, 2002), (Danacica, 2011), (Ljundberg, 2009).

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