The Interactive Causality between Higher Education and Economic Growth in Romania

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Abstract

This study investigates the causal relation between higher education and economic growth in Romania, using annual time series data from 1980 to 2008. The econometric approach of this paper is based on the bivariate Vector Autoregression (VAR) model, Granger causality test and unit root test. The empirical results show evidence of unidirectional causality between economic growth and higher education in Romania.

1. Introduction

The interrelationship between education and economic growth has been the subject of public debates, enjoying a wide interest since the era of Plato. According to Dikens et all. (2006), Zoega (2003) and Barro (1991), the education has a high intrinsic economic value since the investments in education led to the formation of human capital, which is one of the cause of economic growth. According to Stevens and Weale (2003), life quality has substantially increased in the last millennium in most countries of the world, and particularly in European countries, the development of educational field has been contributing to it. One of the main motivations for studying education from economic point of view is its impact on reducing income inequalities (Ram, 1990), and the relationship between education and labor market (Benito and Oswald, 2000). Denison (1967) was one of the first economists who emphasized the importance of investing in education, which was thought to have impact on economic growth.

Boldin, Morote and McMullen (1996) showed that higher education had a significant impact on the economic growth for Argentina and Brasil, while no causal connection between these two variables was found for Chile. Asteriou and Agiomirgianakis (2001) investigated the relationship between human capital (analyzed by rates in primary, secondary, and higher education) and economic growth in Greece, and found out that causality runs through educational variables to economic growth, with the exception of higher education where exists reverse causality. Podrecca and Carmeci (2002) analyzed the causality between education and economic growth using Granger causality, for a set of 86 countries over the period 1960-1990. Their results show that both education investment and the educational stock had an impact to growth rates, both individually and jointly with physical capital investment. There is also a reverse causality that runs from growth to investment in education. Jaoul (2004) analyzed causality between higher education and economic growth in France and Germany in the period before the Second World War. The obtained results demonstrate that higher education has an influence on gross domestic product just for the case of France. For Germany, education does not appear as a cause of growth. Kui (2006) analyzed the causality and co-integration between education and GDP, showing that economy development is the cause of higher education and result of primary education in China, for the period of 1978-2004. Islam (2007), using the multivariate causality analyzed the relationship between education and growth in Bangladesh, in between 1976 and 2003 period. The author included in his analysis also capital and labor. The obtained results show evidence of bidirectional causality between education and growth in Bangladesh, for the mentioned period of time. Hunang, Jin, and Sun (2009) analyzed the causality between scale evolution of higher education and economic growth in China, between 1972 and 2007. The empirical results show that there is a long-term steady relationship between variables of enrollment in higher education and GDP per capita. For the analyzed period, with the growth of the economy, scale of higher education exhibits an ascending trend. Pradham (2009), using error correction modeling shows that there is uni-directional causality between education and economic growth (from economic growth to education, there is absence of reverse causality) in the Indian economy, in the period 1951-2002. Bo-nai and Xiong-Xiang (2006) show that there is an evident bi-directional causality relationship between education investments and China economic growth in 1952-2003 period. Chaudhary, Iqbal and Gillani (2009), using Johansen co-integration and Tod & Yamamoto causality approach in VAR framework analyzed the role of higher education in economic growth for Pakistan between 1972 and 2005. Their results show that there is unidirectional causality running from economic growth to higher education and no other causality running from higher education to economic growth

Katircioglu (2009) demonstrates that long-run equilibrium relationship exists between higher education growth and economic growth of North Cyprus. His results suggest unidirectional causality that runs from higher education to economic growth in Northern Cyprus.

The aim of this article is to analyze the causality between higher education and economic growth for Romania, between 1980 and 2008. Unfortunately there is no study to analyze the relationship between higher education and economic growth for Romania. Therefore, this paper seeks to fill a gap in the empirical literature.

The paper is organized as follows: introduction, a description of used variables and data sources is given in section 2; section 3 describes the methodological approach of the VAR model and presents the empirical results; conclusive remarks of the study are presented in section 4.

2. Variable description and data sources

The aim of this paper is to analyze the co-integration between higher education and economic growth in Romania, using dynamic causality analysis methods. In my analysis I used annual time series data of gross domestic product and higher education, for the period 1980 - 2008. The variable higher education (named *HE* in my analysis) is expressed by the number of enrolled students, measured as an absolute number of persons. Higher education had a major increase from 1990 on, and this increase was maintained until 2007. This situation is due to the profound changes occurred in the higher education system in Romania after the 1989 revolution, the emergence of many state universities in almost all counties, the emergence of private universities and the substantial increase of number of students enrolled in the higher education institutions. While before the revolution of 1989, the access in the universities was limited and the number of enrolled students was small, after 1990 the Romanian higher education became a mass education. According to the statistics of Romanian Ministry of Education, at the moment there are 56 state universities in Romania and 28 recognized private universities. The impact of this substantial growth of the number of students on the economic growth was not estimated until now, and neither if economic growth of Romania has influenced the higher education growth.

Due to the demographical changes that occurred in Romania in the analyzed period, and in order to exclude the influence of circulation of population on the education, I divided the student population with the number of people per year. To capture economic growth in Romania during the analyzed period, I used the GDP per capita variable (named *gdp* in my econometric analysis). In order to avoid possible errors caused by the fact that during the analyzed period Romania suffered a currency conversion from old ROL to the new RON, I used statistical data provided by the International Monetary Fund, World Economic Outlook Database, October 2009, representing Gross domestic product based on purchasing-power-parity (PPP) per capita GDP. Again, the variable population is included in the analysis by using GDP per capita. Regarding the dynamics of GDP per capita in the analyzed period, it was an ascending trend in the periods 1980-1988 and 1999-2008, and a descending trend in the periods 1988-1992 and 1997-1998.

3. Methods and empirical results

The econometric approach of this paper is based on the autoregressive vector VAR. The chosen methodology is justified by the nature of the analysis performed in this study.

Granger (1969) developed a test to check the causality between variables. Granger causality examine to what extent a change from past values of a variable affect the subsequent changes of the other variable. We can say that there is a Granger causality between two variables x_t and y_t if a forecast y_t taken from a set of information that includes the past variability of x_t is better than a forecast that ignores the past variability x_t**,** with the assumption that other variables stay unchanged.

The Granger causality test involves estimating the following pair of regressions:

$$y_t = \sum_{i=1}^{n} \alpha_i x_{t-i} + \sum_{j=1}^{n} \beta_j y_{t-j} + \varepsilon_{1t} \tag{1}$$

$$x_t = \sum_{i=1}^{n} \lambda_i x_{t-i} + \sum_{j=1}^{n} \delta_j y_{t-j} + \varepsilon_{2t} \tag{2}$$

with the assumption that the disturbances ε_{1t} and ε_{2t} are uncorrelated. We distinguish four cases:

- unidirectional causality from x_t to y_t is indicated if the estimated coefficients on the lagged x_t in (1) are statistically different from zero as a group ($\sum_{i=1}^{n} \alpha_i \neq 0$) and the set of estimated coefficients on the lagged y_t in (2) is not statistically different from zero ($\sum_{j=1}^{n} \delta_j = 0$).
- unidirectional causality from y_t to x_t is indicated if the estimated coefficients on the lagged y_t in (2) are statistically different from zero as a group ($\sum_{j=1}^{n} \delta_j \neq 0$) and the set of estimated coefficients on the lagged x_t in (1) is not statistically different from zero ($\sum_{i=1}^{n} \alpha_i = 0$).
- feedback (bilateral causality) is indicated when the set of x_t and y_t coefficients are statistically different from zero in both regression equations (1) and (2).
- independence – occurs when the set of x_t and y_t coefficients are not statistically significant in both regression equations (1) and (2).

In all four cases it is assumed that the two variables x_t and y_t are stationarity. In a stochastic process stationarity means that statistical characteristics of the process do not change in time. As Granger and Newbold (1974) and Cheng (1996) point out, Granger causality on non-stationarity time data may lead to spurious causal relation. The stationarity of a non-stable time series can be obtained with the help of certain mathematic procedure, such as differentiation of variables (Gujarati, 2004).

I my analysis the variables are transformed through the use of natural logarithm to ease interpretation of the coefficients. Using log function the regression coefficients are interpreted elasticities which are a percentage change in the dependent variable is a 1% change in the independent variable.

The aim of econometric analysis is to determine which of the following relations are valid for the mentioned variables:

- whether higher education affects the growth of gross domestic product per capita
- whether the growth of gross domestic product per capita affects higher education
- whether there is a bilateral causality between higher education, and gross domestic product per capita
- whether the variables are independent of each other.

First step of my analysis was to examine the stationarity of the variables. If all the variables are stationary I(0), then there is no problem to estimate the coefficients using the variables with initial specification. However, most of the main macroeconomic variables are non-stationary, integrated of order higher than zero.

If the series are non-stationary but co-integrated, then the estimation as an autocorrected model is admissible. If the variables are non-stationary and are not co-integrated then the specification of variables as differences is necessary.

Most commonly used tests for the integration order of variables are Dickey-Fuller (DF) test, Augmented Dickey-Fuller test (ADF, 1979), Philips-Peron test (PP, 1988) and Kwiatkowski test (KPSS, 1992).

Dickey Fuller (DF) test and Augmented Dickey-Fuller (ADF) test are described by the following equations:

$$\text{(DF)}\ \Delta x_t = a + bx_{t-1} + \varepsilon_t \quad (3)$$

where Δ is the difference operator and a and b are parameters to be estimated.

$$\text{(ADF)}\ \Delta x_t = a + bx_{t-1} + \sum_{i=1}^{\gamma} c\Delta x_{t-1} + \varepsilon_t \quad (4)$$

a, b, c are parameters to be estimated.

Both of these tests are based on the null hypothesis (H_0**):** x_t is not *I(0).* If the obtained DF and ADF statistics are less than their critical values from Fuller's table, then we can reject the null hypothesis H_0 and we conclude that the series are stationary or integrated.

I used the Dickey-Fuller test (DF) and augmented Dickey-Fuller test (ADF) to test the existence of unit roots and to determine the order of integration of the variables. The tests were done with and without a time trend. The results of both tests showed that the variables *he* and *gdp* are non-stationary, at the 5% significance level. However, the non-stationary problem vanished after second difference.

Next step was choosing the optimal lag length is based on synthesis results of several methods such as Akaike Information Criteria (AIC), Schwartz Bayesian Criteria (SC), Hannan-Quinn information criteria (HQ), Final prediction error (FPE) and likelihood ratio test (LR). As Enders (1995) suggested, the optima lag is selected based on the lowest values of AIC, SC, HQ criteria, and rejecting the null hypothesis in LR test that parameter values at lag *k* are equal to zero. Due to the fact that I used annual data in my analysis, I chose 4 lags to be included. In Table 1 are presented the results of the lag selection. As it can be noticed from Table 1, most of the tests (FPE, AIC and HQ) suggest that the optimal lag length is 4.

Table 1. VAR lag selection for ($\Delta^2 \ln he, \Delta^2 \ln gdp$)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-250.7172	NA	2.63e+14	38.87957	38.96649	38.86171
1	-246.6475	6.261146	2.65e+14	38.86884	39.12959	38.81525
2	-242.5535	5.038710	2.79e+14	38.85439	39.28897	38.76507
3	-240.5715	1.829545	4.51e+14	39.16485	39.77326	39.03980
4	-222.9595	10.83816*	8.18e+13*	37.07069*	37.85293*	36.90991*

*indicates the optimal lag selection

In order to test the co-integration of the analyzed variables, I used the maximum likelihood estimation method of Johansen and Juelius (1990, 1995). Both eigenvalue and trace tests, without a trend and with a trend led to the same results; there are two co-integration equations at the 5% level of significance between higher education and gross domestic product per capita. The fact that the analyzed variables are co-integrated is very important for the validity of Granger causality test results. According to Sims et all (1990), if the times series are non-stationarity and not co-integrated, then the obtained *F* statistics used to detected Granger causality are not valid.

The four hypotheses enounced at the beginning of section 3, higher education affects economic growth, economic growth affects higher education and bilateral causality or independence were tested using Granger causality method. According to Enders (1995), this method is best suited to determine whether the lags of one variable enter into the equation for the other variable.

Customizing equations (1) and (2) with the analyzed variables we have:

$$\Delta^2 gdp_t = \sum_{i=1}^{n} \alpha_i \Delta^2 he_{t-i} + \sum_{j=1}^{n} \beta_j \Delta^2 gdp_{t-j} + \varepsilon_{1t} \quad (4)$$

$$\Delta^2 he_t = \sum_{i=1}^{n} \lambda_i \Delta^2 he_{t-i} + \sum_{j=1}^{n} \delta_j \Delta^2 gdp_{t-j} + \varepsilon_{2t} \quad (5)$$

In order to determine if there is a Granger causality between education and gross domestic product per capita, I used an *F*-statistics to test $H_0 : \sum_{i=1}^{n} \alpha_i = 0$. Analogue, I applied the *F*-statistics for testing the hypothesis of Granger causality between gdp per capita and higher education, $H_0 : \sum_{j=1}^{n} \delta_j = 0$. The obtained results are presented in Table 2.

Table 2: Granger causality test

Null Hypothesis:	Obs	F-Statistic	Probability
D2HE does not Granger Cause D2GDP	13	0.92685	0.52846
D2GDP does not Granger Cause D2HE		6.15224	0.05318

Analyzing the results presented in table 2 we can conclude that the variable higher education is not Granger cause of economic growth with a 5% significant level. At a 10% significance level we can also accept the alternative hypothesis that gross domestic product is Granger cause of higher education.

4. Conclusions

The aim of this article was to analyze the causality between education and economic growth for Romania, in between 1980 and 2008. Using data gathered from various issues of the Statistical Year Book of Romania (1994, 1995, 2004, 2008), from the National Statistical Institute of Romania, Tempo-Online Database and the VAR methodology, I found out that there is empirical evidence of a long-run relationship between higher-education and gross domestic product per capita in Romania, during the analyzed period. Granger test showed a unidirectional causality running from gross domestic product per capita to higher education.

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