9. THE IMPACT OF EDUCATION AND HEALTH ON ECONOMIC GROWTH: EVIDENCE FROM ROMANIA (1980-2011)

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Abstract

This paper aims at investigating the impact of education and health on economic growth by incorporating energy consumption as an important factor of production function in case of Romania during the period 1980-2011. Using ARDL bounds testing and Johansen-Juselius approaches for cointegration, the results show that the variables are cointegrated. In addition, economic growth is mainly determined by health, energy consumption and education in the long-run. Using Toda-Yamamoto causality test, the results show that there is a long-run causation linkage running from health and energy consumption to economic growth. Therefore, this paper provides an empirical evidence that supports human capital-based growth hypothesis. The findings reveal some policy implications for Romania.

Keywords: human capital, economic growth, cointegration, causality, Romania

JEL Classification: C32, I15, I25.

1. Introduction

The relationship between human capital and economic growth has been a matter of discussion among researchers for many years (Grossman, 1972; Romer, 1986; Lucas, 1988; Mankiw *et al*., 1992; Howitt, 2005). The main feature of their theoretical approaches is the identification of different channels to show how education or health influences economic growth. In addition, several studies (e.g. Barro, 1991; Barro and Sala-i-Martin, 1992; Sachs and Warner, 1997; Bhargava *et al*., 2001; Bloom *et al.*, 2004; Caselli, 2005; Aghion *et al*., 2010; Asghar *et al*., 2012; Ion, 2013) have appeared in the empirical literature.

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The European Union (EU) attaches a specific importance to human capital, particularly the 2020 Strategy. The characteristics of the human capital provide the tangible measures for the knowledge-based economy, and the successful strategy implementation depends on these characteristics (Samardzija and Butkovic, 2010).

This paper examines the relationship between human capital and economic growth in the case of Romania which has an upper-middle income and high human development level in 2013. Romania has become an important country by developing institutions compatible with a market economy in the last 20 years, and joining the European Union (EU) in 2007. Romania has also been one of the most dynamic economies of Eastern Europe during the past several years. In addition, according to the National Institute of Statistics, from 2000 to 2013, GDP growth rate averaged 0.86 % reaching an all time high of 3.60 in March of 2008.

Several empirical studies (e.g. Altar *et al.,* 2008; Ion, 2013; Burja and Burja, 2013) have investigated the link between human capital and economic growth for Romanian economy. Altar *et al.* (2008) intensify the impact of human capital on economic growth and simulate possible growth paths of the Romanian economy by using the Uzawa-Lucas model. The simulation results show that the average real GDP growth rate is around 6% owing to the human capital accumulation. Ion (2013) investigates the impact of education on individual earnings through the cross-sectional data for the year 2009 in Romania. In this study, the limited Mincerian regression model is used. Empirical results reveal that education is a key determinant of individual income. The results also show that the coefficient of the variable "years of education" is 0.081 in 2009 implying that the importance of education increased in Romania. Finally, Burja and Burja (2013) deal with identification of the relationship between the growth rate of GDP and the main elements of the educational systems containing the group of 12 countries that recently joined the EU. For this purpose, this study uses the multifactor regression method for the period 1997-2011. The empirical results indicate that only two variables (employment rate of persons with tertiary education and growth rate of real labor productivity per hour worked) are statistically significant and have positive impact on GDP growth rate for Romania. These time-series studies use only health or education variable and consider several regression models.

The main goal of the present study is to empirically investigate how education and health affected the economic growth in Romania over the period of 1980-2011. This study conducts a time series analysis for a single country which may provide better framework to analyze the relationship between human capital and economic growth. Secondly, our econometric strategy is based on time-series analysis which includes the Augmented Dickey-Fuller (1981) and Phillips-Perron (1988) unit root tests, the ARDL bounds testing and Johansen-Juselius (1990) approaches for cointegration and Toda-Yamamoto causality method. Thirdly, as Romania has a very high human capital potential, this study is expected to provide empirical evidences supporting the hypothesis of human capital-based economic growth. Finally, it presents some policy implications for Romania.

The rest of the paper is organized as follows. The following section briefly outlines the literature. The third section presents the modeling framework and data description. The fourth section introduces the econometric methodology. The fifth section reports the empirical results. The last section concludes with discussion and implications.

2. Literature Review

Solow (1956) and Swan (1956) are the leading theorists that make important contributions to the modern growth theory. Later on, the dynamical version of this model is presented by Koopmans (1965). These researches use a neoclassical production function but do not consider human capital as a production factor.

Schultz (1961) classifies human capital into several categories such as health status, on-the-job training, formal education and adult study programs. Therefore, education and health are the important components of human capital. Goode (1959) and Schultz (1961) argue that education is the most important factor which leads to an increase in the stock of human capital. According to Nelson and Phelps (1966), education is an essential input in the innovation process, and an increase in education level raises innovation and the long-run growth rate of the economy. Romer (1986) indicates that education is an important mechanism for accumulating technological knowledge. Lucas (1988) and Mankiw *et al*. (1992) model human capital as an input in the production function. In these models, continuous improvements in education will generate a significant effect on the growth rate of output in the long run. In the field of health, Grossman (1972) first develops a model in which health is seen as a capital good. Following Grossman (1972), the new growth theories which incorporate health into traditional growth models appear. These include Ehrlich and Lui (1991), Barro (1996), Kalemli-Ozcan *et al*. (2000), Howitt (2005), and Van Zon and Muysken (2007). In these models, the stock of health capital can be maintained through health investments and it is possible to identify different channels to show how health influences economic growth.

The empirical literature investigating the relationship between education, health and economic growth can be divided into three strands. The first strand of existing literature examines the relationship between education and economic growth. The early growth regression analyses by Barro (1991), and Barro and Sala-i-Martin (1992) have revealed that education has a positive effect on economic growth. Barro and Sala-i-Martin (2004) indicate that education expenditure to GDP is positively related to economic growth. Caselli (2005) finds that education has a strong indirect effect on economic growth in addition to the direct human capital effect. Using an alternative estimate of the stock of human capital, Leeuwen and Foldvari (2008) show that the level of human capital is cointegrated with the level of aggregate income in India, Indonesia and Japan. Employing the pooled mean group estimator and a dataset for OECD countries, Simoes (2011) finds a significant long-run relationship between higher education and growth. Using the limited Mincerian model of secondary data for the year 2009, Ion (2013) suggests that education is a key determinant of individual income and the importance of education has increased in Romania.

The second strand of existing literature examines the relationship between health and economic growth. Sachs and Warner (1997) find that health increases economic growth at a decreasing rate. Bhargava *et al*. (2001) investigate the effect of health on the growth rates of GDP per capita for 92 countries over the period 1965-1990. The panel estimation results show that health has a positive relationship with economic growth in low-income countries. Using panel data, Jamison *et al*. (2005) examine the effect of life expectancy on GDP per capita for 53 countries from 1965 to 1990. The findings are similar to the results of Bhargava *et al*. (2001). Gyimah-Brempong and Wilson (2004) find that health expenditure and child mortality rate have a positive and significant effect on per capita income growth. Their results also show that investment in health in LDCs increase the economic growth in the short and long run. Acemoglu and Johnson (2007) examine the relationship between life expectancy and growth from 1940 to 1980 through the Lucas approach. They find an insignificant relationship between the variables. Aghion *et al*. (2010) conduct a cross-country regression analysis for the period 1960-2000. The empirical results show that a higher initial level and a higher rate of improvement in life expectancy have a significantly positive impact on per capita GDP growth. Using Johansen multivariate cointegration analysis, Swift (2011) examines the relationship between health and GDP in 13 OECD countries for periods ranging from 1820-2001 to 1921-2001. The study suggests a long run relationship between life expectancy and both total GDP and GDP per capita for all the countries. The results also reveal a significant relationship between the variables in most of the countries.

The third strand of existing literature tests for the relationship among education, health and economic growth. Barro (1996) examines this relationship in a panel estimation of 100 countries over the period 1960-1990. The results reveal that health and education have a significant positive effect on economic growth. Jamison *et al*. (2003) finds that better health accounts for about 11% of growth. The study also shows that investment in physical capital, education and health plays an important role in economic growth. Bloom *et al*. (2004), using the 2SLS technique, find that life expectancy and schooling have a positive and significant impact on GDP. The study also shows that one year increase in a population's life expectancy results into an increase of 4% in output. Using Johansen cointegration and ECM methods, Aka and Dumond (2008) find a cointegration relationship between education, health and economic growth in the USA over the period 1929-1997. They also find a causality running from education to economic growth. Umaru (2011) indicates that expenditure on education and health has a positive impact on economic growth in Nigerian economy for the period 1977-2007. Asghar *et al*. (2012) examine Pakistan's economy during 1974-2009. The results of Johansen cointegration test confirm a long-run relationship among the variables. The results of VECM indicate a short-run relationship between the variables.

3. Modeling Framework and Data

Following the empirical literature on the links between education, health and economic growth, it is possible to form the standard linear functional specification of long-run relationship between the variables in Romania. Modified after Aka and Dumond (2008) and Asghar *et al*. (2012), in log-linear form our economic growth function is modeled as follows:

$$\ln GDP_t = \alpha_0 + \alpha_1 \ln ED_t + \alpha_2 \ln HE_t + \alpha_3 \ln EC_t + \varepsilon_t \tag{1}$$

where: GDP_t is per capita real income (constant 2005 US$) , *ED* is school enrollment (tertiary), *HE* is life expectancy at birth, *EC* is per capita energy use and ε_t is the regression error term. Here, education is proxied by school enrollment while health is proxied by life expectancy at birth. Economic growth is proxied by per capita real *GDP*. As shown in empirical model, in addition to the variables of health and education, the variable of energy consumption is also included into the nexus to diminish the problem of omitted variable bias in the econometric estimation.[3] The annual time series data for Romania is obtained from the World Bank Indicators (WDI) prepared by World Bank for the period with 1980-2011. The coefficients, α_i, i=1, 2, 3, indicate the long-run elasticity estimates of school enrollment, life expectancy and energy consumption, respectively.

Generally, it can be said that the higher level of life expectancy should result in greater economic activity and stimulate economic growth. Therefore, it is expected that $\alpha_2>0$ in equation (1). The signs of α_1 and α_3 are expected to be positive because education and energy consumption should encourage countries' economic growth (Leeuwen and Foldvari, 2008; Bildirici and Kayıkcı, 2012).

4. Econometric Methodology

4.1. ARDL Bounds Testing Approach

We employ a relatively new cointegration method presented by Pesaran *et al.* (2001) to investigate the existence of long-run relationship between the variables in the case of Romania. This approach has significant advantages over classical cointegration methods.[4]

In this procedure, the unrestricted error correction model (UECM) integrates the short-run dynamics with the long-run equilibrium. The UECM is expressed as follows:

$$\Delta \ln GDP = \alpha_0 + \sum_{i=1}^{m} \beta_{1i} \Delta \ln GDP_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta \ln ED_{t-i} + \sum_{i=0}^{p} \beta_{3i} \Delta \ln HE_{t-i} + \sum_{i=0}^{r} \beta_{4} \Delta \ln EC_{t-i}$$
$$+ \lambda_1 \ln GDP_{t-1} + \lambda_2 \ln ED_{t-1} + \lambda_3 \ln HE_{t-1} + \lambda_4 \ln EC_{t-1} + \varepsilon_t \quad (2)$$

where: α_0, Δ, ε_t represent the constant term, first difference operator, and white noise error term, respectively. Optimal lag length can be selected on the bases of minimum value of Akaike information criteria (AIC) or Schwarz-Bayesian criteria (SBC).

In the first step of the ARDL bounds testing procedure Eq. (2) is estimated by ordinary least square (OLS) method. Here, the joint *F*-statistic is calculated to test the null

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[3] *All economic processes require energy. Therefore, energy plays a crucial role in economic growth (Stern, 1997; Allen, 2009). Besides, energy consumption is accepted as an important element of economic growth regressions (Ozturk and Acaravci, 2010; Acaravci, 2010). Larson and Rosen (2002) analyze the direct and indirect effects of energy consumption on the health of children and adults. Xu* et al. *(2000) investigates the links between energy consumption, environment and public health in the Shandong Province. The results show a significant relationship between the variables. Finally, Tao (2011) examines the relationship between energy consumption quality and the level of education and technology of Jiangsu province based on grey relation theory.*

[4] *Firstly, this approach is applicable irrespective of whether the underlying regressors are* I*(0),* I*(1) or fractionally integrated. Secondly, this method can distinguish between the short and long-run dynamics regarding the variables. Thirdly, the ARDL approach has suitable properties for small samples. Finally, all variables are assumed to be endogenous (Pesaran* et al.*, 2001).*

hypothesis of no cointegration. The null hypothesis of no long run relationship between the variables is $H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = 0$ against the alternative hypothesis of cointegration $H_1: \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq 0$. In order to test for the existence of cointegration calculated *F*-statistic is compared with critical bounds (the lower critical bound and the upper critical bound) generated by Pesaran *et al.* (2001). If computed *F*-statistic is more than upper critical bound, it is concluded that there is a cointegration relationship between the variables. If computed *F*-statistic does not exceed the upper critical bound, it is concluded that there is no cointegration relationship between the variables. If the computed *F*-statistic falls between the lower and upper bound values, the results are ambiguous.

The diagnostic and stability tests are conducted to check the robustness of the ARDL model.[5] Once a long-run relationship has been determined, error correction model (ECM) based on ARDL model is estimated and short-run dynamics are obtained. A general ECM model of Eq. (2) is as follows:

$$\Delta \ln GDP_t = \beta_0 + \sum_{i=1}^{m} \delta_{1i} \Delta \ln GDP_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta \ln HE_{t-i} + \sum_{i=0}^{p} \delta_{3i} \Delta \ln ED_{t-i} + \sum_{i=0}^{r} \delta_{4i} \Delta \ln EC_{t-i} + \varphi ECM_{t-1} + \varepsilon_t \quad (3)$$

where the error correction term (ECM_{t-1})is the residuals obtained from estimated long-run association. It indicates the speed of the adjustment and show how quickly the variables return to the long-run equilibrium. The significant *t*-statistics on the coefficient of ECM_{t-1} implies the presence of a long-run relationship between the variables.

4.2. The Johansen-Juselius Cointegration Method

We also employ the Johansen-Juselius cointegration procedure to test a long run relationship between the variables. This methodology begins with the vector autoregression (VAR) of order *p* given by

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (4)$$

where: $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$. Johansen-Juselius present two different likelihood ratio tests: the trace test and maximum eigenvalue test. These are shown as follows:

$$J_{tr} = -T \sum_{i=r+1}^{n} \ln\left(1 - \hat{\lambda}_i\right) \; J_{\max} = -T \ln\left(1 - \hat{\lambda}_{r+1}\right) \quad (5)$$

[5]*The diagnostic tests include testing for the serial correlation, functional form, normality of error term and heteroskedasticity in the model. The stability tests cover the cumulative sum of recursive residuals (CUSUM) and the squares of sum of recursive residuals (CUSUMsq) tests presented by Brown* et al*. (1975).*

In the trace test the null hypothesis of *r* cointegrating vectors is tested against the alternative hypothesis of *n* cointegrating vectors. In the maximum eigenvalue test the null hypothesis of *r* cointegrating vectors is tested against the alternative hypothesis of *(r+1)* cointegrating vectors.

4.3. The Toda-Yamamoto Causality Test

This study uses Toda and Yamamoto (1995) methodology in order to test causal links between the variables. Toda and Yamamoto overcome the problems of the classical causality tests.[6]

Toda-Yamamoto causality test considers an augmented VAR ($k+d_{max}$) model. In this procedure, k is the optimal lag length in the original VAR system, and d_{max} is the maximal order of integration of the series. This test uses a modified Wald test (MWald) for zero restrictions on the parameters of the original VAR (k) model and has an asymptotic chi-squared distribution. Here, the dynamic causal relationship between education, health, energy consumption and economic growth would be as follows:

$$\ln GDP_t = \alpha_0 + \beta_{1i}\sum_{i=1}^{k}\ln GDP_{t-i} + \beta_{2j}\sum_{j=k+1}^{d_{\max}}\ln GDP_{t-j} + \gamma_{1i}\sum_{i=1}^{k}\ln HE_{t-i} + \gamma_{2j}\sum_{j=k+1}^{d_{\max}}\ln HE_{t-j}$$
$$+ \lambda_{1i}\sum_{i=1}^{k}\ln ED_{t-i} + \lambda_{2j}\sum_{j=k+1}^{d_{\max}}\ln ED_{t-j} + \delta_{1i}\sum_{i=1}^{k}\ln EC_{t-i} + \delta_{2j}\sum_{j=k+1}^{d_{\max}}\ln EC_{t-j} + \varepsilon_t \quad (6)$$

5. Empirical Results

In this study, we employ ADF and PP tests to determine the stationarity properties of the variables. Table 1 reports the outcome of these unit root tests on the levels and the first differences of the variables. The results show that the variables are found to be non-stationary at their levels. After first differencing, series do not show unit root problem implying that all the series are integrated at *I(1)*. Hence, this validates the use of ARDL and Johansen-Juselius approaches for cointegration.

Table 1

Unit Root Tests

Phillips-Perron test statistic					Augmented Dickey-Fuller test statistic				
Variable	Levels	lag	1st differences	t lag	Variable	Levels	lag	1st differences	k lag
lnGDP	-0.549	3	-2.692[c]	2	ln*GDP*	-1.195	1	-2.627[c]	0
ln*ED*	-0.262	2	-3.221[b]	1	ln*ED*	-1.098	2	-2.832[b]	4
ln*HE*	2.984	6	-3.134[b]	2	ln*HE*	2.256	0	-3.038[b]	0
ln*EC*	-1.205	2	-2.657[c]	5	ln*EC*	-1.549	1	-3.513[b]	1

Note: The unit root tests have an intercept. The optimal lag length is selected automatically using AIC for ADF test and the bandwidth is selected using the Newey-West method for PP test. [a], [b] and [c] represent , 1%, 5% and 10% level of significance, respectively.

[6] *This procedure minimizes the risks associated to possibly wrongly identifying the orders of integration of the series, or the presence of cointegration. It also minimizes the distortion of the tests' sizes as a result of pre-testing (Giles, 1997).*

The ARDL procedure requires appropriate lag order of the variable to carry out the *F*-test for joint significance of all lagged level variables in Eq. (2). Lutkepohl (2006) argue that the statistics of *F*-test are very sensitive to the selection of lag order. The optimum lag is selected relying on minimizing the AIC. The calculated *F*-statistic of Eq. (2) reported in Table 2 shows an evidence for cointegration between the variables because it is above the upper bounds of the critical value.

The results of diagnosis tests such as serial correlation, functional form, normality and heteroskedasticity are reported in the lower part of Table 2. This implies that there is no problem with diagnosis tests of the model.

Table 2

Cointegration Tests (Dependent Variable: lnGDP)

Bounds *F*-test		Lower-upper bound values			
F(ln*GDP*/ln*ED*, ln*HE,* ln*EC*)	*F*-statistic	at 1%		at 5%	at 10%
	4.047	4.29-5.61		3.23-4.35	2.72-3.77
Diagnostic tests statistics				Lag	AIC
Adj-R^2	0.896	*Breusch-Godfrey LM*	0.339 (0.725)	1	-4.678
F-statistic	13.298 (0.000)	*Ramsey Reset*	0.190 (0.675)	2	-4.783
Jarque-Bera normality	0.079 (0.961)	*ARCH LM*	2.175 (0.152)	3	-4.893*
Johansen-Juselius test					
F(lnGDP/lnED, lnHE, lnEC)	Hypotheses	Trace statistics	Critical value at 5 %	Max. eigen statistics	Critical value at 5 %
	H_0:r=0 H_a:r=1	64.866	47.856 (0.000)	31.848	27.584 (0.013)
	H_0:r≤1, H_a:r=2	33.018	29.797 (0.020)	20.742	21.131 (0.056)
	H_0:r≤2, H_a:r=3	12.276	15.494 (0.144)	12.133	14.264 (0.105)
	H_0:r≤3, H_a:r=4	0.142	3.841 (0.705)	0.142	3.841 (0.705)

Note: The model with constant is used for cointegration tests. For bounds *F*-test, critical value bounds are found in Tables CI(iii) and CI(v) in Pesaran *et al.* (2001). *P*-values are shown in parentheses. * denotes optimal lag length.

We determine the optimal lag as 3 based on AIC. The results are presented in Table 2. The results of the trace and maximum eigenvalue statistics reveal a cointegration relationship between education, health, energy consumption and economic growth over the period.

Table 3 reports the long-run estimation results along with diagnosis tests such as serial correlation, functional form, normality and heteroskedasticity. The results show that all the variables are statistically significant and have the expected signs. The significant positive coefficients of education and health with respect to economic growth provide evidence in support of human capital-based growth hypothesis in Romania. The estimation results confirm that health and education are important determinants of economic growth over the period. These results are consistent with the findings of Barro (1996) for 100 countries; Bloom *et al*. (2004) for 104 countries; Leeuwen and Foldvari

(2008) for India, Indonesia and Japan; Li and Liang (2010) for East Asia; Swift (2011) for OECD countries; Asghar *et al*. (2012) for Pakistan and Ion (2013) for Romania. Besides, our findings regarding energy consumption are consistent with the findings of Kaplan *et al.* (2011) for Turkey.

The results of diagnostic tests which ascertain the goodness of fit of the ARDL model are reported in the lower part of Table 3. The findings indicate that the error term is normally distributed and there is an absence of serial correlation. There is no evidence of heteroskedasticity and the functional form of the long-run model is correctly specified. In other words, the findings suggest that the long-run model passes all diagnosis tests successfully.

Table 3

ARDL Model: Long-run Estimates

Dependent variable: ln*GDP*	Constant	
Regressors	Coefficient	*t*-values
ln*ED*	0.506	6.672[a]
ln*HE*	2.334	1.772[c]
ln*EC*	1.254	10.345[a]
Intercept	-12.739	-2.716[b]
Diagnostic tests	Statistic	*p*-value
R^2	0.996	
Adj- R^2	0.994	
F-statistic	410.512	0.000
Jarque-Bera normality	0.900	0.637
Breusch-Godfrey LM	0.552	0.588
Ramsey RESET	0.876	0.365
ARCH LM	1.688	0.205

Note: ARDL (4,1,2,2) selected on the bases of AIC.[a], [b] and [c] denote 1%, 5% and 10% level of significance, respectively.

In this study, the stability of long-run parameters is checked by CUSUM and CUSUMsq tests. Figure 1 presents the plots of CUSUM and CUSUMsq test statistics. The results show that the recursive residuals stray inside the two standard error bounds, not rejecting the hypothesis of parameter constancy (p-value greater than 0.05). The results imply that all coefficients in the model are stable. Thus, we can use the estimation results of the model for policy implications regarding economic growth in the case of Romania.

The short-run estimation results in error-correction representation are reported in Table 4. The results imply that education and energy consumption have a positive effect on economic growth in the short run. The estimated coefficient of $ECM_{t-1}$is -0.546 and significant at the 1% level. This suggests that changes in economic growth from the short run to the long run are corrected by 54.60% each year. The result confirms the presence of the long-run relationship between the variables in Romania over the period. The results concerning education are consistent with the findings of Asghar *et al*. (2012) for Pakistan; Aka and Dumond (2008) for the USA. The results regarding health are consistent with the findings of Asghar *et al*. (2012) for Pakistan. The results about energy consumption are consistent with the findings of Kayhan *et al.* (2010) for Romania and Shahbaz *et al.* (2012) for Romania. Table 4 shows that there is no problem with diagnosis tests of the model.

Figure 1

Plots of CUSUM and CUSUMsq

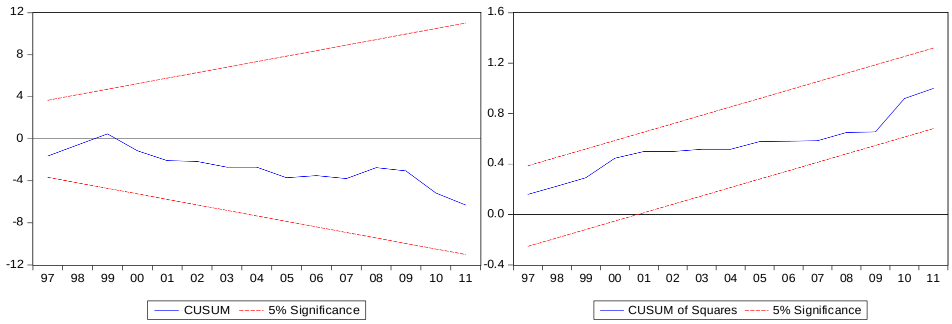

Table 4

ARDL Model: Short-run Estimates

Dependent variable: Δln*GDP*	Constant	
Regressors	Coefficient	*t*-values
Δln*ED*	0.105	3.989[a]
Δln*HE*	-0.247	-0.345
Δln*EC*	0.560	11.400[a]
Intercept	0.000	0.000
ECM(-1)	-0.546	-9.160[a]
Diagnostic tests	Statistic	*p*-value
R^2	0.964	
Adj- R^2	0.946	
F-statistic	54.219	0.000
Jarque-Bera normality	0.900	0.637
Breusch-Godfrey LM	0.475	0.629
Ramsey RESET	0.040	0.843
ARCH LM	1.688	0.205

Note: ARDL (4,1,2,2) selected on the bases of AIC. [a], [b] and [c] denote 1%, 5% and 10% level of significance, respectively.

The results of Toda-Yamamoto causality test are presented in Table 5. The hypothesis that health does not cause economic growth is rejected at 10% significance level. This means that health causes economic growth in Romania. This finding is consistent with the finding of Asghar *et al*. (2012) for Pakistan. The hypothesis that energy consumption does not cause economic growth is rejected at 5% significance level. This implies that energy consumption causes economic growth. This result is consistent with the finding of Shahbaz *et al*. (2012) for Romania and Kaplan *et al*. (2011) for Turkey. Finally, the hypothesis that education does not cause economic growth is not rejected. This result is not consistent with the findings of Asghar *et al*. (2012) for Pakistan; Aka and Dumond (2008) for the USA.

Table 5

Results of Toda-Yamamoto Causality Test

Hypotheses	Lag length (k+d_{max})	χ^2-statistic	*P*-value	Causality
ln*GDP*=*f*(ln*HE*)	3+1=4	7.800	0.050	Yes
ln*GDP*=*f*(ln*ED*)	3+1=4	1.148	0.765	No
ln*GDP*=*f*(ln*EC*)	3+1=4	9.447	0.023	Yes

6. Concluding Remarks

Romania is an essential case study because of moderate economic growth, great energy consumption, and strong human capital base.The economic analysts estimate a 2.7-2.9% economic growth for 2014 in Romania. However, it seems a very crucial topic to sustain economic growth of Romania. The basic motivation for this study is the lack of empirical studies that examine the impact of human capital on economic growth by incorporating both education and health as important factors of production function in case of Romania. In addition, Altar *et al.* (2008) emphasize that the average real GDP growth rate can be increased by human capital accumulation in Romania. Thus, the current study attempts to investigate the fundamental determinants behind the economic growth. Specifically, the study examines the effect of education and health on economic growth by incorporating energy consumption to the empirical model over the period 1980-2011 in Romania.

The study employs ARDL bounds testing and Johansen-Juselius approaches to cointegration to test the presence of a long-run relationship between the variables. The study also employs Toda-Yamamoto causality procedure to test for causal relationships between the variables. Empirical results indicate that the variables are stationary in first differences. This allows for applying ARDL bounds testing and Johansen-Juselius approaches to test the long run relationship between the variables.

Empirical results also indicate that the variables are cointegrated. This implies the presence of a long-run relationship between the variables. We conclude that education, health and energy consumption are positively related to economic growth in the long run. We also conclude that there is an evidence regarding causality running from health and energy consumption to economic growth.

The study provides empirical evidence that human capital can contribute to the long-run economic growth in Romania. Therefore, it suggests a number of policy implications to the Romanian policy-makers. Romania should mobilize its human capital and resources to evolve towards to the knowledge or R&D-based economy in order to achieve considerable and sustained economic growth and to improve the life standards of its citizens. In this context, it is especially recommended that the government should invest in human capital in order to achieve the national targets regarding Europe Strategy 2020. In the second programming period 2014-2020, Romania may use multi-background programming to improve coordination of the investments in human capital with infrastructure investments. In addition, the implementation of projects financed by the EU which support the participation in professional training programs in Romania should be continued.

The study also provides empirical evidence that energy consumption can contribute to the long-run economic growth in Romania and there is a causal relationship running from energy consumption to economic growth. Like human capital, energy is an important determinant of economic growth. In order to increase economic growth, policy-makers should enhance both energy supply investment and energy efficiency. In addition, they should carry out energy conservation policies to reduce unnecessary wastage of energy. Romania has very rich renewable energy sources such as solar, wind, natural gas, geothermal sources and bio-diesel fuel. However, the place of renewable energy sources in total energy source usage is only 5%. Therefore, the Romanian government should support the utilization of these sources and employs these sources efficiently.

Finally, future empirical research can analyze the relationship between the variables by disaggregating both education and health capital into various components for Romania or by comparing Romania with other developing countries.

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