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Educational Stock and Economic Growth. The Case of Greece Over the Period 1981-2009

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Abstract

This paper examines the impact of education on economic growth in Greece over the period 1981-2009 by applying the model with two sectors introduced by Lucas (1988). The findings of the empirical analysis reveal that there is no long-run relation between educational stock and output. In the short run educational stock has had a statistically insignificant negative effect on economic growth. The econometric model explained 64% up to 72% of the variation of the economic growth rate through the variation of the independent variables. By checking the assumption of scale returns of the model, the results showed that the human capital stock grows but at a decreasing rate, so the endogenous character of the economic growth is not verified.

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1. Introduction

The relationship of education and economy has been studied in economics since Adam Smith (1776) made his inquiry into the wealth of nations. Human capital theory (Schultz, 1961), (Abramovitz, 1962), (Becker, 1964), (Denison, 1967), (Mincer, 1974), etc., stresses the importance of human capital as a production factor that explains economic growth and the education as the main institutional mechanism of production, accumulation and diffusion of human capital.

The impact of human capital on economic growth is well-established in the economic literature. In neoclassical economics, the early works of Solow (1956, 1957) showed that economic growth could not only be explained by capital and

labour increase. His aim was to determine the contributions of the factors of production (capital and labour) and the increase in technical progress to the growth rate as a whole. Mankiw, Romer and Weil (1992) extended Solow's (1956) model by incorporating an explicit process of human capital accumulation. They showed that an augmented Solow growth model, when solved for the steady-state per capita income level, ends up to an equation that includes physical and human capital as the basic determinants of growth.

During the last three decades new growth theories or endogenous growth theories, accept education as one of the primary components of human capital and the effect of education on the economies has been pointed out (Lucas, 1988), (Romer, 1990), etc. Lucas (1988) considered human capital as one of the factor of production and education as a means of human capital accumulation. According to Lucas (1988), education was the vehicle for human capital accumulation and was treated as a factor of production besides labour and physical capital. He endogenizes growth by assuming that effectiveness and productivity of investments in human capital depend on the human capital stock, created in the past, and time invested in new human capital. This implies that progress in the educational attainments of the labour force has a positive impact on productivity that leads to better economic performance at aggregate level. Romer (1986, 1990) has extended the concept that human capital affects growth by facilitating improvements in productivity beyond the adoption of existing technologies to the creation of new ones, starting from the observation that R&D activities require highly skilled labor as the single most important input.

The Europe 2020 strategy put knowledge at the heart of the Union's efforts for achieving smart, sustainable and inclusive growth. "Education and in particular Higher Education and its links with research and innovation, plays a crucial role in individual and societal advancement and in providing the highly skilled human capital and the articulate citizens that Europe needs to create jobs, economic growth and prosperity" (European Commission, 2011).

The purpose of this study is to estimate education's effect on the growth of the Greek economy over the period 1981-2009. The application of Lucas (1988) model was used, by approaching the average years of schooling as a stock proxy of human capital.

This paper presents the review of empirical studies in Section 2. In Section 3 a brief reference to Greek economy and education is displayed. Section 4 describes the methodology of the model. Section 5 explains sources and data and Section 6 introduces the empirical analysis and discusses the results. Finally, Section 7 summarizes the main findings and conclusions of the study.

2. Literature Review

There have been many studies on the impact of education on economic growth using different proxies of human capital. The proxy of human capital is a key issue in the empirical growth models. The most common proxies are school enrolment rates that express human capital flow and the average number of schooling years that express human capital stock. Empirical studies have shown that the coefficient of the human capital variable is positive and significantly different from zero, while other studies have presented opposite findings. These studies are based on the neoclassical theory introduced by the augmented neoclassical growth model and the endogenous theory introduced by endogenous growth models.

All of the following empirical studies are based on Lucas (1988) endogenous model. Bratti and Bucci (2003) used an endogenous model similar to Lucas for 92 countries and found that the stock of per capita human capital has had a positive, statistically significant, and marked effect on the level of per capita GDP. El-Mattrawy and Semmler (2006) estimated the regressions of the endogenous Lucas model and showed that education is a key component in the creation of human capital and an important factor for economic growth in the case of Egypt. The researchers found a positive and statistically impact of education on economic growth, while they showed that education and human capital formation are quite linearly related, in a positive way. The educational efforts did not end up in decreasing returns to scale case, with respect to building up of human capital. Monteils (2002, 2004) tested the Lucas' model in the case of France and the results showed that human capital returns are decreasing and thus knowledge produced by education cannot be the engine of self-maintained economic growth. So, human capital stock is a factor like the others to the production function which does not break the law of diminishing returns and does not allow an endogenous economic growth. Gong *et al*. (2004) using time series data for the U.S. and Germany over the period 1962-1996 concluded that applying the Lucas model the time series of the growth rate of human capital negatively depends on the time series of the time spent for education, and so there are decreasing returns to education (exogenous growth). Bas van Leeuwen (2006) applied the Lucas model of the new growth theories on the economic development of three countries, India, Indonesia, and Japan. He found decreasing returns for India and Japan and increasing returns for Indonesia. But by using an alternative specification the three countries present increasing returns and so evidence supports the applicability of the Lucasian growth. However, the regressions of growth for per capita GDP and growth of average years of education showed negative insignificant coefficients of the growth of human capital for India and Japan and po-

sitive insignificant coefficient for Indonesia. Foldvari and Van Leeuwen (2009) estimated the Lucas model on 21 OECD countries by using the average years of schooling as a proxy of human capital and their findings showed a negative effect of the growth of education on economic growth.

In the case of Greece, there are some empirical studies which have investigated the effects of education on economic growth by using different methods and models. Bowles (1966) estimated the contribution of education on economic growth to be 3% for the period 1951-1961, with Lianos and Milonas (1975) presenting similar results for the period 1961-1971. Caramanis and Ioannides (1980) estimated this contribution between 3%-5%, while Psacharopoulos and Kazamias (1985), who employed data from sampling family budgets, estimated the contribution to be 2%. Dimakos (1996) calculated the input of education to economic growth for the periods 1961-1971 and 1971-1981 at 2.9% and 3.1% respectively. Magoula and Prodromidis (1999) showed that the relative contribution of secondary and higher education to growth in relation to the contribution of primary education has risen: from the 1960's to the 1980's, total contribution to economic growth has increased from a low 0.16% to a high 2.25%. Asteriou and Agiomirgianakis (2001) used the Lucas model approach and showed that the growth of enrolment rates in primary, secondary and higher education, as well as of public expenditure on education, positively affected the GDP per capita over the period 1960-1994. Benos and Karagiannis (2008) found that the number of students in lower and upper secondary education levels affected growth positively over the time period 1981-2003. Tsamadias and Prontzas, (2011) examined the effect of education on economic growth during the period 1960-2000, by applying the model introduced by Mankiw, Romer and Weil (1992). The findings revealed that the coefficient of human capital flow proxied by the enrolment rates in secondary education yields positive and statistical significant. Tsamadias and Pegkas (2012) examined the effect of education on economic growth during the period 1981-2009, by applying the neoclassical model introduced by Mankiw, Romer and Weil (1992) and found that when the coefficient of human capital stock is proxied by the average years of schooling, it yields negative and statistically insignificant results.

3. A brief reference on Greek economy and education during the period 1981-2009

This period has been of great importance for Greece since two major events took place, influencing the country's economic and political situation: a) The accession to the European Economic Community (E.E.C.) [the induction agreement came into force in January 1981]. Greece, as an E.E.C. member participated

in all stages of European integration, including the single European Act and the signing of the Maastricht Treaty. b) The accession to the European Monetary Union (EMU) and the adoption of the new euro-currency [January 2001]. During this period, economy was transformed from a primary to a tertiary sector. Since the 1980s in Greek economy, expansionary fiscal policy is implemented structural changes are delayed and consequently passed on to the 2009, facing a number of unsolved problems: high fiscal deficits and public debt, trade deficits and mainly low competitiveness. The need for fiscal discipline was compelling as was the need for adoption of institutional, structural and functional reforms in order to adapt to the Euro zone and in an increasingly competitive global environment.

Education in Greece constitutes a responsibility of the State and is offered for free by public educational institutions at all levels. Social demand for education increased, during the period 1981-2009, and the public educational structures of all levels have at the same time been expanded. In the case of higher education, at the beginning of the 1980s only 14 Universities operated in the country while in 2009 this number increased to 24 Universities and 16 Technological Educational Institutes. Starting from the first half of the 1990's, a new system of post-secondary vocational education and training was adopted (through the operation of public and private centers). Greek education, especially at the secondary level, has to a great extent been orientated towards general schooling. Although the education quantity expanded, the Greek educational system entered the 21st century facing a series of problems such as the low quality and low effectiveness of education at all levels, graduate unemployment, massive student exodus abroad, brain drain, misallocation of resources, regressive social transfers and reduced human capital investment.

4. Methodology and model

Lucas model assumes that there are two sectors, both perfectly competitive: One goods sector (physical capital) and one education sector (human capital). The production function in the goods sector is given by Y and the production function in the education sector is given by H where v is the amount of physical capital k and u is the amount of human capital h. Both productions functions have constant return to scale.

$$Y=A(vK)^{a}(uhL)^{1-a} \tag{1}$$

$$H=B\left[(1-v)K\right]^{\beta}\left[(1-u)h\right]^{1-\beta} \tag{2}$$

We assume that physical capital is not productive in the educational sector $\beta=0$.

If we plug in $\beta=0$ into the equation for H we get:

$$H=B(1-u)h \tag{3}$$

Since physical capital is not productive in the educational sector it implies that physical capital is only used in the goods sector $v=1$. If we plug in $v=1$ into the equation for Y we get:

$$Y_t=A(K_t)^a(uhL_t)^{1-a} \tag{4}$$

Equations (3) and (4) are the final expressions for the production functions in the two sectors. In (4), *Yt* represents the total quantity of the final good produced at time t, *A* represents the constant technological level in the goods sector of this economy, while *kt* and *uhLt* denote the aggregate quantities of factors used in the production process, again at time *t* (respectively physical and human capital). Parameter α is the elasticity of output with respect to physical capital (strictly comprised between zero and one). Labour at time t (*Lt*) consists only of educated individuals, and each of its members is endowed with a stock of human capital (per efficiency units) equal to *ht*. A fraction *ut* of human capital $(0<u<1)$ of non-leisure time devoted to goods production is used at time *t*, while its complement to one (1-*ut*) is the proportion of time devoted to production of new human capital. In other words, the human capital stock employed to produce the final good in efficiency units of labour or the effective workforce is defined as:

$$H_t=u_th_tL_t \tag{5}$$

So, the production function (4) can thus be recast as:

$$Y_t=A(K_t)^a(H_t)^{1-a} \tag{6}$$

Population is going to grow at rate n, and is not important. Hence we let $n=1$ and write the production function in per capita terms.

$$y_t=A(k_t)^a(h_t)^{1-a} \tag{7}$$

Proceeding to the framework (7) and taking the first differences in order to overcome the lack of time - series stationary, we end up to the following function:

$$\Delta \ln y_t = c_O + \alpha \Delta \ln k_t + (1-a)\Delta \ln h_t + \varepsilon_t \quad (8)$$

Human capital (proxied by education) is the essential factor for the production of new human capital. The motivation of this is that the human capital of one generation is an important factor in affecting the formation of human capital of the later generations. The first sector employs a share of u ($0<u<1$) of the available human capital and the rest is devoted to the production of additional human capital in the second sector with constant returns to scale. Assuming no externalities and a zero depreciation rate of human capital, the creation of human capital is determined by a linear technology in human capital only and is defined as:

$$\dot{h}_t = B(1-u_t)h_t \quad (9)$$

Transforming the equation (9), the growth rate of human capital given by the linear form:

$$\frac{\dot{h}_t}{h_t} = B(1-u_t) \quad (10)$$

So, the final estimating form is a linear regression as follow:

$$\Delta \ln h_t = B(1-u) \quad (11)$$

where $\Delta \ln h_t$ is the logarithm of growth rate of human capital, 1-*u* is the time devoted to learning, *B* is the transformation rate of learning into human capital.

5. Sources and Data

Data on Gross Domestic Product (GDP) and investment are annual and were retrieved from the AMECO database. GDP ($\ln q_t$) has been measured at 2005 constant prices. Physical Capital Investments ($\ln k_t$) is the gross capital formation at 2005 constant prices for the total economy. Data for constructing human ca-

pital and the variable of the time spent in education (1-u) were taken from the Hellenic Statistical Authority (HSA) database. The proxy of human capital that was used in this study is the average years of schooling or the educational stock ($\ln h_t$) of the population in employment. This proxy is reported as the quantitative measurement of human capital. The quality of education wasn't taken into account.

This variable has been estimated based on Lin's model (2003). The generic form of our measure of average years of schooling or educational stock (E) is in the following form:

$$\bar{E}=\frac{\sum_i S_i \cdot A_i}{S} \tag{13}$$

where, S_i is the share of employments with the ith level of education; A_i is the average number of years of schooling received in the ith level of education; i designates the classifications of illiterates or no education (A=0 years), for primary incomplete (A=3 years), primary complete (A=6 years), secondary incomplete (A=9 years), secondary complete (A=12 years), technological education complete (A=15 years), higher education incomplete (A=15 years), higher education complete (A=16 years) and master or phd complete (A=19 years). The rungs of education were categorized according to the educational system in Greece. In this analysis, all levels of schooling are weighted equally. The stock of human capital is, therefore, built up from past "investments" in education.

The model needs an approximation for the time spent to build up human capital accumulation, (1-u). In constructing the series for (1-u) is necessary to make a compromise. It is known that the time devoted to human capital accumulation includes many years of schooling, training on the job, etc. but only the earned university degrees are used here as a fraction of the employment. Therefore, we define (1-u) as follows [see, Gong *et al*. (2004), El-Mattrawy and Semmler, (2006)]:

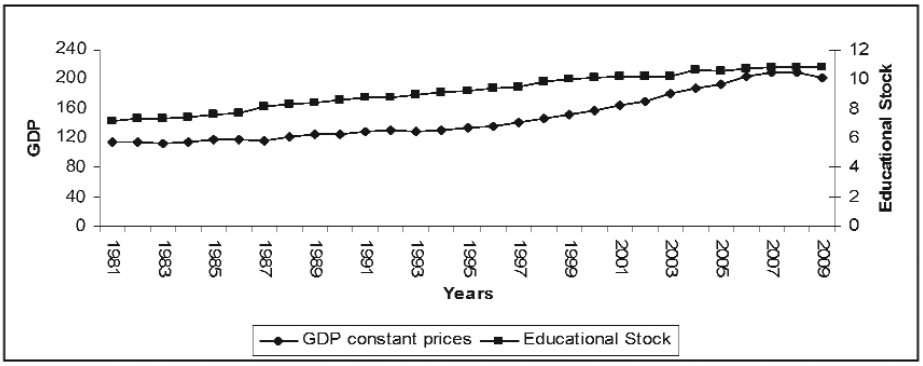
$$1\text{-}u=\frac{\text{university degrees}}{\text{employees}}*s \tag{14}$$

with s=6 as approximated time (years) at university. The university degrees include diplomas and doctoral degrees. Equation (14) states that the time spent in education 1-ut is equal to the number of college graduates at time (t) divided by the labor force and multiplied by the school years.

After the initial data analysis, GDP has remained relatively stable over the first half of the examined period and started to increase significantly after the year of 1996. The educational stock is represented by a small, positive slope over the whole period (Figure 1). More specifically, over the last thirty years, Greek GDP indicates an average increase of 2% and the educational stock an average increase of 1.5%.

FIGURE 1

GDP (2005 as base year) and Average Years of Schooling / Educational Stock (1981-2009)



Source: AMECO database and Hellenic Statistical Authority (EL.STAT.).

6. Empirical Analysis and Results

6.1 Estimation of the human capital sector

If the assumption of constant returns in the second sector holds, the marginal effect of (1-u) on the growth of human capital stock equals B (Monteils, 2002). If B is positive (increasing scale returns) then increasing stock of human capital is the engine of long run growth (endogenous growth). In the opposite direction if B is negative there must be decreasing scale returns (no endogenous growth). By using the OLS method the results of the estimated equation (11) are given below (t-statistic in parenthesis):

$$\Delta ht = \underset{(-8.476)}{-0.005}\,(1-u) \qquad (12)$$

The results show that the link between the time devoted to learning/education (or the duration of training) and growth of human capital stock is negative. The

coefficient of 1-u yields negative and statistical significant results at 1% level. The human capital stock grows in such a decreasing rate, so the endogenous character of the economic growth suggested by Lucas is not verified. Consequently, all findings point to the conclusion that human capital stock is a factor like the others to the production function and it does not break the law of diminishing returns. So application of this model would be accompanied by similar predictions as the neoclassical growth model introduced by Solow (1956) and Mankiw *et al*. (1992). Potential explanations for these results may be the following:

a) Lucas model may not be compatible with the time series analysis.
b) Our approach of the variable 1-u may be biased as to the measurement used method.
c) The assumption of linear relationship between growth rate of human capital stock and the time devoted to learning may be incorrect.
d) The short period of the time series data.

6.2 Estimation of the production sector

6.2.1 Stationarity test

The stationarity of the data set is examined using the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. We test for the presence of unit roots and identify the order of integration for each variable first in level and next for first difference. The variables are specified including intercept and including intercept and trend. No automatic model selection is performed and the lag order has been taken as fixed equal to one because of small sample data. The null hypothesis is stationary. Unit root test results are given in Table 1.

The results in Table 1 show that all variables under study have unit root, or integrated of order one in their levels and stationary, or integrated of order zero in their first differences at least at 5% level. Hence all the series are non-stationary and the standard regression analysis may produce spurious results. If a time series has a unit root, a convenient way to remove non-stationary would be by taking first differences of the relevant variable. Once the series are made stationary, they can be used in regression analysis.

TABLE 1
Results of Unit Root Test

Variables (in levels & first difference)	KPSS test	
	Including intercept	Including intercept and trend
lnq_t	1.4449*	0.3428*
Δlnq_t	0.3522	0.1289
lnk_t	1.3081*	0.2345*
Δlnk_t	0.1196	0.1200
lnh_t	1.4998*	0.3207*
Δlnh_t	0.4387	0.0557

Note: *, ** indicates the rejection of the null hypothesis of stationarity (KPSS) at 1% and 5% level of significance respectively.

6.2.2 Cointegration test

Stationary test show that all the variables which are non stationary at level, become stationary at first difference. They are in fact integrated of order (1). So there is the possibility that variables of output, physical capital investments and educational stock are cointegrated. Output, investments and educational stock variables have been tested for cointegration, following the Johansen (1988) and Johansen and Juselius, (1990) procedure. The Johansen multivariate cointegration approach is used to examine the long-run relationship between the variables. The cointegrating model specification that fits the data and the theoretical constraints is one with a linear deterministic trend in the data, including intercept and trend in the cointegrating equation. This cointegration method recommends two statistics to check the long run relationship; Trace and Maximum Eigen value test. The null hypothesis in the Trace and maximum Eigen value test is that there is no cointegrating vector. Lag selection is based on minimizing the Schwartz and Akaike criteria. The null hypotheses of one or more than one cointegrating vectors in the Trace test could not be rejected at 5%, which implies that there is not cointegrating vector. The finding of one or more than one cointegrating vectors was further supported by the results of the maximum Eigen value test in which the null hypothesis that there is no cointegrating vector could not be rejected at 5%. So, the results from the cointegration test (Table 2), lead to the conclusion that there is no long-run relation between output, physical capital investments and educational stock.

TABLE 2

Cointegration Test

Series: lnq lnk lnh					
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	Max-Eigen Statistic	5 Percent Critical Value
None	0.467718	28.62073	42.91	17.02571	25.82
At most 1	0.246145	11.59502	25.87	7.628991	19.38
At most 2	0.136611	3.966026	12.51	3.966026	12.51

Note: a) Trace and Max-Eigen value tests indicate no cointegration at the 0.05 level.
b) Lags interval: 1 to 1.

6.2.3 Regression Analysis

After the cointegration analysis, in order to assess education's effect on Greece's economic growth in the short run, two specifications of the equation (8) were estimated. It should be mentioned that all variables are stationary in their first differences (Table 1). The econometric analysis is based on the time series approach by using OLS method and all variables are in natural logarithms. The specifications examined, were estimated consistently as for the existence of the Serial Correlation and the Heteroskedasticity by using the Newey–West HAC estimator.

TABLE 3

Educational stock effect on GDP Growth

Variables	Specification 1	Specification 2
c_0	0.019* (5.490)	0.011* (3.235)
Δlnk_t	0.171* (11.628)	0.178* (12.015)
Δlnh_t	-0.149 (-1.158)	-0.059 (0.426)
Dum		0.015*(2.720)
R^2	0.67	0.75
Adjusted R^2	0.64	0.72
Observations	28	28

Notes: a) The dependent variable is $\Delta \ln qt$ (1981-2009). b) * indicate significance at 1% level. c) t-statistics in parentheses.

The results on the Table 3 indicate that the education proxy yields negative and statistically insignificant results. If a dummy variable is taken into account

(Specification 2) the coefficient remains negative and insignificant. The price of the coefficient was found to be between -0.05 to almost -0.15. The coefficient of investment yield positive and statistically significant at 1% level in the two specifications of the model. The price of the coefficient found from the 0.17 to almost 0.18. The dummy variable has a positive influence on economic growth. The coefficient is as low as 0.015, but statistically significant at 1% level. The model explained 64% up to 72% of the variation of the economic growth rate through the variation of the independent variables in two specifications.

Through this framework, it seems that the educational stock process has had an insignificant negative effect on Greece's economic growth during the period of study (1981-2009).

6.2.4. Granger causality test

In order to improve the validity of the results and verify any causality between education and economic growth, the Granger Causality test is applied. The best lag is determined by the Akaike and Schwarz Information Criterion. The null hypothesis is that there is not Granger causality.

TABLE 4

Granger Causality Test

Null hypothesis	Obs	F-statistic	Probability
Δlnh_t does not Granger Cause Δlnq_t	27	0.704	0.409
Δlnq_t does not Granger Cause Δlnh_t	27	0.366	0.550

Note: a) The *F*-statistic indicate that Δln *ht*, does not Granger Cause to Δln *qt*, and Δln *qt* does not Granger Cause to Δln*ht*, on any significant level. b) The results are based on a one-period lag time.

The results from Table 4 show that the null hypothesis could not be rejected in both cases and so lead to the conclusion that educational stock/average years of schooling growth rate is not causally related to GDP growth rate. In the same direction, GDP growth rate has no causal relation to educational stock growth rate.

7. Concluding Remarks

This paper has analyzed the effect of educational stock on economic growth in Greece during the period 1981-2009. This period has been most crucial as significant economic, social and political changes of strategic nature have taken place in the country. In order to estimate education's contribution to economic growth,

the study used the methodology and model of Lucas (1988) with two sectors, without externalities. The approach of human capital has been explored using a stock proxy. This proxy was the educational stock or the average years of schooling of the population in employment. The empirical analysis reveals that there is no long-run relation between educational stock and output. In the short run the educational process has had no influence on Greece's economic growth during the examined period. The coefficient for the proxy that was used has been found to be negative and statistically insignificant. By testing for Granger causality we may confirm that the educational stock growth rate doesn't cause the economic growth rate (and *vice versa*). It thus, becomes obvious that during the period 1981-2009, Greece's economic growth has not been positively affected by educational stock. These results are similar to those found in the study of Tsamadias and Pegkas, (2012), who examined the effect of education on economic growth in Greece, during the period 1981-2009, by applying the neoclassical model introduced by Mankiw, Romer and Weil (1992) and found that the coefficient of the educational stock or the average years of schooling yields negative and statistically insignificant results. By checking the scale returns of the model the results showed that the human capital stock grows but at a decreasing rate, so the endogenous character of the economic growth, such as Lucas suggests is not verified. Consequently, everything points to the conclusion that the human capital stock defined by Lucas is a production factor that similarly to others, it does not break the law of diminishing returns and does not allow an endogenous economic growth.

References

Abramovitz, M., 1962. Economic Growth in the United Sates, American Economic Review, vol. 52, pp. 762-782.

Akaike, H. 1974. A new look at the statistical model identification, IEEE Transactions on Automatic Control, 19 6, pp. 716-723.

Ameco database - European Commission. Available at http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm accessed June 2012.

Asteriou, D. and Agiomirgianakis, G., 2001. Human capital and economic growth, Time series evidence from Greece, Journal of Policy Modeling, vol. 23, pp. 481-489.

Becker, G. S., 1964. Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. New York: Columbia University Press.

Benos, N. and Karagiannis, S., 2008. Convergence and economic performance in Greece: evidence at regional and prefecture level, Review of Urban and Regional Development Studies, vol. 20, No 1, pp. 52-69.

Bowles, S., 1971. Growth Effects of Changes in Labor Quality and Quantity, Greece 1951-1961, in: H. Chenery, ed., Studies in Development Planning, Harvard University Press, Cambridge.

Bratti, M. and Bucci, A., 2003. Human Capital and International Differences in Income Levels, working paper presented at the workshop 'Economic Growth and Income Distribution' in Ancona.

Caramanis, M. and Ioannides, J., 1980. Sources of growth and the contribution of education, sex and age structure to the growth rate of the Greek economy, Greek Economic Review, vol. 2, pp. 143-162.

Denison, E. F., 1967. Why Growth Rates Differ? Washington DC, The Brookings Institution.

Dimakos, G., 1996. Education – Productivity, Social and Economic development of Greece, PhD Thesis, Department of Economics, National and Kapodistrian University of Athens.

El-Mattrawy, K. and Semmler, W., 2006. The Role of Education and Human Capital for Economic Growth in Middle Income Countries: Egypt's Case, working paper DOI:http://www.newschool.edu/cem/eg-role-of-education-egypt-062006.pdf

European Commission, 2011. Recent developments in European higher education systems. Commission Staff Working Document SEC 2011 1063 final.

Foldvari, P. and Van Leeuwen, B., 2009. An alternative interpretation of average years of education in growth regressions, Applied Economics Letters, vol. 16, No 9, pp. 945-949.

Gong, G., Greiner, A. and Semmler, W., 2004. The Uzawa-Lucas model without scale effects: theory and empirical evidence, Structural Change and Economic Dynamics, vol. 15, No 4, pp. 401-420.

Granger, C. W. J., 1969. Investigating causal relations by econometric models and cross-spectral methods, Econometrica, vol. 37, pp. 424-438.

Granger, C. W. J. 1988. Some recent developments in the concept of causality, Journal of Econometrics, vol. 39, pp. 199-211.

Hellenic Statistical Authority. Available at http://www.statistics.gr/portal/ page/ portal /ESYE accessed December 2011.

Johansen, S., 1988. Statistical Analysis of Cointegrating Vectors, Journal of Economic Dynamic and Control, vol. 12, pp. 231-254.

Johansen, S. and Juselius, K., 1990. Maximum likelihood estimation and inference on cointegration with applications to the demand for money, Oxford Bulletin of Economics and Statistics, vol. 52, pp.169-210.

Kwiatkowski, D., Phillips, P. C. B., Schmidt, P. and Shin, Y., 1992. Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. Journal of Econometrics, vol. 54, pp.159-178.

Lianos, T. and Milonas, A., 1975. The contribution of production input to the Greek growth rate, 1961-1971, Centre for Planning and Economic Research, Athens. [In Greek].

Lin, T., 2003. Education, technical progress, and economic growth: the case of Taiwan, Economics of Education Review, vol. 22, pp. 213-220.

Lucas, E., 1988. On the mechanics of economic development, Journal of Monetary Economics, vol. 22, pp. 3-42.

Magoula, T. and Prodromidis, K., 1999. Education and economic growth in Greece, Discussion Paper No. 99, Athens University of Economics and Business.

Mankiw, G., Romer, D. and Weil, D., 1992. A contribution to the empirics of economic growth, Quarterly Journal of Economics, vol. 107, pp. 407-437.

Mincer, J., 1974. Schooling, Experience and Earnings, Columbia University Press.

Monteils, M., 2002. Education and economic growth theory test. The French case, Historical Social Research, vol. 27, No 4, pp. 93-107.

Monteils, M., 2004. The analysis of the relation between education and economic growth, Compare: A Journal of Comparative and International Education, vol. 34, No 1, pp. 103-115.

Newey, W. and West, K. D., 1987. A Simple, Positive, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. Econometrica, vol. 55, No 3, pp. 703-708.

Psacharopoulos, G. and Kazamias, A., 1985. Education and Development in Greece, Ed. NCSR. [In Greek].

Romer, P. M., 1986. Increasing Returns and Long-Run Growth, Journal of Political Economy, vol. 94, No 5, pp. 1002-1037.

Romer, P., 1990. Endogenous technological change, Journal of Political Economy, vol. 98, No 5, pp. 71-102.

Schultz, T. W., 1961. Investment In Human Capital, American Economic Review, vol. 51, pp. 1-17.

Schwarz, G. E., 1978. Estimating the dimension of a model, Annals of Statistics, vol. 6, No 2, pp. 461-464.

Smith, A., 1776. The Wealth of Nations, Modern Library 1937.

Solow, R. M., 1956. A Contribution to the Theory of Economic Growth, Quarterly Journal of Economics, vol. 70, No 1, pp. 65-94.

Solow, R. M., 1957. Technical change and the aggregate production function, Review of Economics and Statistics, vol. 39, No 3 Aug., 1957, pp. 312-320.

Tsamadias, C. and Prontzas, P., 2011. The effect of education on economic growth in Greece over the 1960-2000 period, Journal of Education Economics, vol. 20, No 5, pp. 522-537.

Tsamadias, C. and Pegkas, P., 2012. The effect of education on economic growth in Greece over the 1981-2009 period. Does the proxy of human capital affect the estimation? International Journal of Education Economics and Development, Vol. 3, No 3, pp. 237-251.

Van Leeuwen, B., 2006. The role of human capital in endogenous growth in India, Indonesia and Japan, 1890-2000, International Economic History Conference, August, Helsinki.