

REVIEW OF ECONOMIC AND BUSINESS STUDIES

International Editorial Board

Professor **Jean-Pierre BERDOT**, Université de Poitiers, France

Professor **Enrique BONSÓN**, Universidad de Huelva, Spain

Professor **Henri BOUQUIN**, Université de Paris-Dauphine, France

Professor **Régis BOURBONNAIS**, Université de Paris-Dauphine, France

Professor **Oana BRÂNZEI**, York University, Toronto, Canada

Professor **Mihai CALCIU**, Université de Lille, France

Professor **Cristian CHELARIU**, York University, Canada

Lecturer **Roxana CHIRIAC**, University of Konstanz, Germany

Professor **Bernard COLASSE**, Université de Paris-Dauphine, France

Professor **Christian CORMIER**, Université de Poitiers, France

Professor **Gerry RAMEY**, Eastern Oregon University, United States of America

Professor **Jaroslav KITA**, University of Economics Bratislava, Slovakia

Professor **Raymond LEBAN**, Conservatoire National des Arts et Métiers, France

Professor **Luiz MONTANHEIRO**, Sheffield Hallam University, United Kingdom

Professor **Louis G. POL**, University of Nebraska at Omaha, United States of America

Professor **Danica PURG**, President of CEEMAN, Bled School of Management, Slovenia

Professor **Ravinder RENA**, Polytechnic of Namibia, Namibia

Professor **Jacques RICHARD**, Université de Paris-Dauphine, France

Professor **Antonio García SÁNCHEZ**, Universidad Politécnica de Cartagena, Spain

Professor **Alan SANGSTER**, Aberdeen Business School, The Robert Gordon University, Scotland, United Kingdom

Professor **Victoria SEITZ**, California State University, United States of America

Professor **Gabriel TURINICI**, Université de Paris-Dauphine, France

Professor **Peter WALTON**, ESSEC Business School Paris, France

National Editorial Board

Professor **Daniel DĂIANU**, Member of the Romanian Academy, President of the Romanian Society of Economics

Professor **Emilian DOBRESCU**, Member of the Romanian Academy

Professor **Aurel IANCU**, Member of the Romanian Academy

Professor **Constantin IONETE**, Member of the Romanian Academy

Professor **Mugur ISĂRESCU**, Member of the Romanian Academy, Governor of the National Bank of Romania

Professor **Vasile IȘAN**, Rector of Alexandru Ioan Cuza University of Iași

Members

Professor **Dinu AIRINEI**, Alexandru Ioan Cuza University of Iași

Professor **Ioan ANDONE**, Alexandru Ioan Cuza University of Iași

Professor **Gabriela ANGHELACHE**, Academy of Economic Studies, Bucharest

Professor **Laura ASANDULUI**, Alexandru Ioan Cuza University of Iași

Professor **Maria BÂRSAN**, Babeș-Bolyai University, Cluj-Napoca

Professor **Tiberiu BRĂILEAN**, Alexandru Ioan Cuza University of Iași

Professor **Sorin BURNETE**, Lucian Blaga University, Sibiu

Professor **Emil CAZAN**, West University of Timișoara

Professor **Silviu CERNA**, West University of Timișoara

Professor **Gheorghe CIOBANU**, Babeș-Bolyai University, Cluj-Napoca

Professor **Laura CISMAȘ**, West University of Timișoara

Professor **Vasile COCRIȘ**, Alexandru Ioan Cuza University of Iași

Professor **Viorel CORNESCU**, University of Bucharest

Professor **Dumitru COTLEȚ**, West University of Timișoara

Professor **Marin DINU**, Academy of Economic Studies, Bucharest

Professor **Nicoleta FARCANE**, West University of Timișoara

Professor **Niculae FELEAGĂ**, Academy of Economic Studies, Bucharest

Professor **Gheorghe FILIP**, Alexandru Ioan Cuza University of Iași

Professor **Paul FUDULU**, University of Bucharest

Professor **Iuliana GEORGESCU**, Alexandru Ioan Cuza University of Iași

Professor **Elena HLACIUC**, Ștefan cel Mare University, Suceava

Professor **Emil HOROMNEA**, Alexandru Ioan Cuza University of Iași

Professor **Alexandra HOROBETȚ**, Academy of Economic Studies, Bucharest

Professor **Ion IGNAT**, Alexandru Ioan Cuza University of Iași

Professor **Ion IONAȘCU**, Academy of Economic Studies, Bucharest

Professor **Elisabeta JABA**, Alexandru Ioan Cuza University of Iași

Professor **Alexandru JIVAN**, West University of Timișoara

Professor **Mihai KORKA**, Academy of Economic Studies, Bucharest

Professor **Dumitru MATIȘ**, Babeș-Bolyai University, Cluj Napoca

Professor **Emil MAXIM**, Alexandru Ioan Cuza University of Iași
Professor **Dumitru MIRON**, Academy of Economic Studies, Bucharest
Professor **Constantin MITRUȚ**, Academy of Economic Studies, Bucharest
Professor **Tatiana MOȘTEANU**, Academy of Economic Studies, Bucharest
Professor **Panaite NICA**, Alexandru Ioan Cuza University of Iași
Professor **Ștefan NIȚCHI**, Babeș-Bolyai University, Cluj Napoca
Professor **Dumitru OPREA**, Alexandru Ioan Cuza University of Iași
Professor **Gabriela PASCARIU**, Alexandru Ioan Cuza University of Iași
Professor **Magdalena-Iordache PLATIS**, University of Bucharest
Professor **Victor PLOAE**, Ovidius University, Constanța
Professor **Nicolae Tiberiu Alexandru POP**, Academy of Economic Studies, Bucharest
Professor **Atanasiu POP**, Babeș-Bolyai University, Cluj Napoca
Professor **Ioan POPA**, Academy of Economic Studies, Bucharest
Professor **Constantin POPESCU**, Academy of Economic Studies, Bucharest
Professor **Dan POPESCU**, Lucian Blaga University, Sibiu
Professor **Gheorghe POPESCU**, Babeș-Bolyai University, Cluj Napoca
Professor **Spiridon PRALEA**, Alexandru Ioan Cuza University of Iași
Professor **Gabriela PRELIPCEANU**, Ștefan cel Mare University, Suceava
Professor **Ștefan PRUTIANU**, Alexandru Ioan Cuza University of Iași
Professor **Ioan ROTARIU**, West University of Timișoara
Professor **Ion Gh. ROȘCA**, Academy of Economic Studies, Bucharest
Professor **Constantin SASU**, Alexandru Ioan Cuza University of Iași
Professor **Ion STANCU**, Academy of Economic Studies, Bucharest
Professor **Ovidiu STOICA**, Alexandru Ioan Cuza University of Iași
Professor **Neculai TABĂRĂ**, Alexandru Ioan Cuza University of Iași
Professor **Ileana TACHE**, Transilvania University, Brașov
Professor **Ioan TALPOȘ**, West University of Timișoara
Professor **Alexandru TAȘNADI**, Academy of Economic Studies, Bucharest
Professor **Gheorghe VOINEA**, Alexandru Ioan Cuza University of Iași
Professor **Vergil VOINEAGU**, Academy of Economic Studies, Bucharest
Professor **Dumitru ZAIȚ**, Alexandru Ioan Cuza University of Iași

Managing Editors

Co-Editor-in-chief: Professor **Ion POHOAȚĂ**

Co-Editor in chief: Dr. Hab. **Alin ANDRIEȘ**

Senior Editor: Dr. **Gabriel CUCUTEANU**

Editors

Professor **Marin FOTACHE**

Professor **Iulia GEORGESCU**

Associate Professor **Costel ISTRATE**

Professor **Dănuț JEMNA**

Associate Professor **Irina MANOLESCU**

Professor **Adrian MUNTEANU**

Associate Professor **Gabriel MURSA**

Professor **Mihaela ONOFREI**

Professor **Carmen PINTILESCU**

Professor **Adriana PRODAN**

Professor **Adriana ZAIȚ**

Editorial Secretary

Lecturer **Sorin ANTON**

Lecturer **Andreea IACOBUȚĂ**

Lecturer **Andrei MAXIM**

Lecturer **Silviu TIȚĂ**

Lecturer **Silviu URSU**

General editing secretary:

Ph.D. **Ovidiu STOFOR**

Lucia DIACONU

Ph.D. **Mircea ASANDULUI**

Ph.D. **Mugurel PATRICHI**

Ph.D. **Anca BERTĂ**

Ph.D candidate **Adriana ROBU**

Copyright © 2015 by Doctoral School of Economics/
Alexandru Ioan Cuza University
Published by Alexandru Ioan Cuza University Press

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior permission of Doctoral School of Economics of the Alexandru Ioan Cuza University.

Address:

14thLăpuşneanu Street, 4th Floor, Room 412

Iaşi – Romania, Zip Code 700057

E-mail: rebs@feaa.uaic.ro

Web: www.rebs.ro

ISSN 1843-763X

Table of Contents

RESEARCH ARTICLE

DOES FORMAL EDUCATION AT ALL LEVELS CAUSE ECONOMIC GROWTH? EVIDENCE FROM GREECE 11

Panagiotis PEGKAS, Constantinos TSAMADIAS

EXPLORING PHD STUDENTS' CONCERNS REGARDING DOCTORAL PROGRAMS IN ECONOMICS AND BUSINESS ADMINISTRATION 35

Corina CARA, Tudor TOCILĂ, Adriana ZAIȚ

FROM FEARFUL TO TRUSTFUL – HOW PERCEIVED RISK DIMENSIONS IN E-COMMERCE DIFFERENTIATE BETWEEN CONSUMERS 47

Patricea Elena BERTEA

ANALYZING THE IMPACT OF FIRM'S EMBEDDEDNESS IN A CENTRALIZED SUPPLY NETWORK STRUCTURE ON RELATIONAL CAPITAL OUTCOMES..... 57

Lokhman Hakim OSMAN, Azhar AHMAD, Nor Asiah OMAR

IMPACT OF THE TRANSITION TO IFRS FOR THE ROMANIAN LISTED COMPANIES IN FINANCIAL DISTRESS..... 85

Costel ISTRATE, Ioan Bogdan ROBU, Mihai CARP

A METHOD FOR SYSTEMIC RISK ESTIMATION BASED ON CDS INDICES 105

Gabriel GAIDUCHEVICI

LOW INTEREST RATES AND BANK RISK-TAKING: HAS THE CRISIS CHANGED ANYTHING? EVIDENCE FROM THE EUROZONE..... 127

Alin Marius ANDRIES, Vasile COCRIȘ, Ioana PLEȘCĂU

EVIDENCE ON THE NEXUS BETWEEN ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH THROUGH EMPIRICAL INVESTIGATION OF UGANDA..... 151

Lira SEKANTSIAND, Mamofokeng MOTLOKOA

SURVEY ARTICLE

UNIVERSITY RESEARCH ECOSYSTEM: A CONCEPTUAL UNDERSTANDING 171

Satyendra C PANDEY, Pinaki Nandan PATTNAIK

BOOK REVIEW

WARNER, MALCOLM (ED.) (2013), THE SOCIOLOGY OF THE WORKPLACE. ABINGDON: ROUTLEDGE. 187

Reviewed by Andrzej KLIMCZUK

RESEARCH ARTICLE



DOES FORMAL EDUCATION AT ALL LEVELS CAUSE ECONOMIC GROWTH? EVIDENCE FROM GREECE

Panagiotis PEGKAS*, Constantinos TSAMADIAS**

Abstract: *This study empirically investigates the link between the levels of formal education and economic growth in Greece during the period 1960-2009. The paper applies the Lucas approach (1988) and employs cointegration, error-correction models and estimates the effect of each educational level on economic growth. The empirical analysis reveals that there is a long-run relation between educational levels and gross domestic product. The overall results show that secondary and higher education has had a statistically significant positive impact on growth, while primary has not contributed to economic growth. The findings also suggest that there is evidence of unidirectional long-run causality running from primary education to growth, bidirectional long-run causality between secondary and growth, long-run and short-run causality running from higher education to economic growth.*

Keywords: *formal education levels; human capital; enrolment rates; economic growth; VAR; Greece*

JEL classification: *O40; O41; O47; I21; I25*

1 INTRODUCTION

Since 1960, the interaction between education and economic growth has been investigated with micro-approaches (Psacharopoulos 1995; Bouaissa 2009) and macro-approaches (Pereira and Aubyn 2009; Odit, Dookhan, and Fauzel 2010). Existing economic literature accepts education as one of the primary components of human capital. Human capital refers to the stock of competences, knowledge and personality attributes embodied in the ability to perform labor so as to produce economic value (Bashir, Iqbal and Zaman 2011). According to macro-

* Panagiotis PEGKAS Phd, Department of Home Economics and Ecology, School of Environment, Geography and Applied Economics, Harokopio University, Athens, Greece

** Constantinos TSAMADIAS, Professor, Department of Home Economics and Ecology, School of Environment, Geography and Applied Economics, Harokopio University, Athens, Greece

economic literature the two main approaches are: the augmented Solow neo-classical approach and the “new or endogenous growth theories” (Sianesi and Van Reenen 2003). The augmented neo-classical model [Mankiw, Romer and Weil (1992), (hereafter M-R-W (1992))] simply extends the basic Solow’s (1956) model with education/human capital as an additional production factor. On the other hand, endogenous growth models distinguish between those which directly relate education/human capital with economic growth (Lucas 1988) and others introduced by Romer (1990), Grossman and Helpman (1991) and Aghion and Howitt (1992), who have emphasized the key role of R&D efforts and innovations in driving technical progress, productivity and economic growth. Various studies have focused on that topic (Arnold 2002; Strulik 2005; Bucci 2008, etc). While education has no role in traditional neo-classical theories of economic growth, these new approaches have explicitly brought the role of education to the fore. A key difference between new growth theory and the neoclassical growth theory involves the distinction between increasing and decreasing returns to scale. The basic underlying assumption of neoclassical theory is that diminishing returns to capital operates in the production process, while endogenous theory supports the assumption that the production function does not exhibit diminishing but increasing returns to scale. While there is a large amount of evidence on the link between education and economic growth, the effect of formal education levels on economic growth with macro-economic approaches has been studied in the last two decades. The fact that different levels of formal education may have different effects on growth has been addressed in a small set of recent papers.

The period 1960-2009 was particularly important for Greece. In that period, three major events took place influencing the economy and education. a. The association-for-entry agreement with the European Economic Community (EEC). Commencement of negotiations started in September 1959 and the validity of agreement connection finished in November 1962. b. The accession to the EEC. The induction agreement came into force in January, 1981. Greece, as an EEC member participated in all stages of European integration, including the single European Act and the signing of the Maastricht Treaty. c. The accession to the European Monetary Union (EMU) and the adoption of the new Eurocurrency (1 January, 2001). During this period, a number of structural and functional reforms and adjustments, in both economy and education had been implemented with varying success. Economic activities have moved from primary to secondary and especially to tertiary sector of the economy. Also, in this period an educational expansion took place in Greece, especially in secondary and mainly in higher education.

The purpose of this study is to empirically investigate the causal relationship between the levels of formal education and economic growth. Moreover, it estimates the effect of each level of formal education on economic growth in Greece over the transition period 1960-2009. The study uses the time series analysis, the endogenous approach of Lucas (1988) and the enrollment rates as a proxy of human capital. Additionally, it examines the consistency of findings of empirical analysis with the findings of the study of Pegkas (2014), who investigated the relation between the levels of formal education and economic growth in Greece for the same period by using the neoclassical approach of M-R-W (1992). The results may improve the decisions of policymakers about education and its contribution to economic growth.

The rest of the paper is organized as follows: Section 2 provides a brief review of empirical literature; Section 3 discusses the methodology, presents sources and data and reports the empirical results based on econometric analysis, Section 4 discusses the results. Finally, section 5 summarizes the main findings and conclusions of the study.

2 REVIEW OF EMPIRICAL LITERATURE

The existing empirical literature initially investigates the interaction between education in terms of quantity or quality and economic growth as well as the effect of education on economic growth. Various studies have used different variables as proxies of human capital (Tsamadias and Pegkas 2012). The main studies that have investigated the impact of the educational levels on economic growth are presented below: Liu and Armer (1993) found that both primary and junior-high achievement variables enhance economic growth in Taiwan, but senior-high and college education did not exert any significant effects on growth. Tallman and Wang (1994) showed that higher education has a greater positive impact on growth in relation to primary and secondary education for the case of Taiwan. Mingat and Tan (1996) for a sample of 113 countries found that higher education has a positive statistically significant impact only in the group of developed countries, while the primary has a positive effect in less developed and the secondary a positive effect in developing. Gemmell (1996) for OECD countries concluded that primary education most affects the less developed countries, while secondary and higher education the developed. Mc Mahon (1998) investigated the effect of the three levels of education on economic growth for a sample of Asian countries and concluded that primary and secondary level have a significantly positive effect on economic growth, while higher is negative. Abbas (2001) for the countries of Pakistan and Sri Lanka showed that the primary has a negative effect on economic

growth, while secondary and higher education have a positive and statistically significant impact on economic growth in both countries. Petrakis και Stamatakis (2002) found that the growth effects of education depend on the level of development; low-income countries benefit from primary and secondary education while high-income developed countries benefit from higher education. Self and Grabowski (2004) for the case of India showed that except higher education the primary and secondary education had a strong causal impact on economic growth. Villa (2005) investigated the effect of the three levels of education on economic growth for Italy and found that the higher and secondary education has a positive effect on economic growth, while the primary has no significant effect. Gyimah-Brempong, Paddison, and Mitiku (2006) found that all levels of education have a positive and statistically significant impact on the growth of per-capita income in African countries. Lin (2006) for the case of Taiwan found that primary, secondary and tertiary have a positive impact on economic growth. Chi (2008) showed that in China higher education has a positive and larger impact on GDP growth than primary and secondary education. Pereira and Aubyn (2009) showed that in Portugal primary and secondary education has a positive impact on GDP, while higher has a small negative effect. Loening, Bhaskara, and Singh (2010) for the case of Guatemala found that primary education is more important than secondary and tertiary education. Shaihani et al. (2011) for Malaysia concluded that in the short run only secondary education has a positive and statistically significant coefficient, while the primary and tertiary exhibit negative and statistically significant results. Unlike in the long run only higher has a positive and statistically significant effect.

In case of Greece, a few studies have investigated the impact of education on economic growth. Magoula and Prodromidis (1999) showed that in Greece 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. Asteriou and Agiomirgianakis (2001) showed that the growth of enrolment rates in primary, secondary and higher education positively affected the GDP in Greece for the period 1960-1994. Tsamadias and Prontzas (2012) used the M-R-W (1992) model and found that economic growth had been positively affected by enrolment rates in secondary education for the period 1960-2000. Tsamadias and Pegkas (2014) used the M-R-W (1992) model and found that economic growth had been positively affected by enrolment rates in higher education for the period 1960-2009. Pegkas (2014) used the M-R-W (1992) model and found that the enrolment rates in secondary and higher education have a positive and statistically significant impact on the growth while the primary had a negative one for the period 1960-2009.

3 EMPIRICAL ANALYSIS

This section presents the methodology, the data and sources and the econometric analysis (stationarity properties of the data, cointegration tests, vector error correction models and causality, the generalized impulse response functions and the generalized variance decomposition analysis).

3.1 Methodology and Model

The empirical analysis of this paper uses the methodology of new growth (endogenous) theory. Lucas model (1988) assumes that there are two production sectors, both perfectly competitive: One goods sector (equation 1) and one education (human capital) sector (equation 2). Both productions functions have constant return to scale. The production function in the goods sector is given below¹:

$$Y_t = A(K_t)^{\alpha} (uh_t)^{1-\alpha} \quad (1)$$

Assuming no externalities and a zero depreciation rate of human capital, the creation of human capital is determined by the following linear function:

$$\Delta h_t = B(1 - u_t) \quad (2)$$

Equations (1) and (2) are the final expressions for the production functions in the two sectors. Y_t 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 k_t and uh_t 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). Human capital (h_t) consists only of educated individuals, for the entire economy and Δ represents the growth rate. A fraction u_t of human capital ($0 < u < 1$) of non-leisure time devoted to goods production is used at time t , while its complement to one ($1 - u_t$) is the proportion of time devoted to production of new human capital.

The proxy of human capital is a key issue in the empirical growth model, as it would improve the performance of the growth model. Many researchers tried to approach human capital using proxies, as flow or as stock. The proxy of human capital that was used in this study is the gross enrollment rates (flow) for the three educational levels (primary, secondary and higher). Also this kind of proxy (flow) has been used from other empirical studies, which have employed the model of Lucas (1988). Specifically, Asteriou and Agiomigrianakis (2001) have used the enrolment rates for the case of Greece, Gong, Greiner and Semmler (2004) have used the public expenditures for education for the case of USA and Germany and Haldar and Mallik (2010) have used the public expenditures for education and

primary enrolment rates for the case of India. An elementary formula used by most countries to calculate the gross enrollment ratio is that, the country divides the number of individuals who are actually enrolled in schools by the number of children who are of the corresponding school enrollment age. In Greece, gross primary, secondary and higher school enrollment ratio considers children between the age of 6 – 11, 12 – 17 and 18-23 respectively. The measure of this variable is achieved by using the following function (World Bank 2012):

$$GHER^t = \frac{E^t}{P^t} * 100 \quad (3)$$

where $GHER^t$ =Gross Enrolment Ratio in school year t for each educational level, E^t = Enrolment for each level of education in school year t, P^t = Population in age-group which officially corresponds to each level of education in school year t. This proxy is reported as quantitative measurement of human capital. The quality of education cannot be taken into account. Given the availability of the data, it is not possible to consider wider definition of human capital investment compassing on-the-job training, experience and learning-by doing, the number of repeaters and dropouts in each grade and ignoring its depreciation.

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, Greiner, and Semmler (2004); El-Matrawy and Semmler (2006)]:

$$1 - u_t = \frac{\text{universitydegrees}}{\text{employees}} * s \quad (4)$$

with $s=6$ as approximated time (years) at university. The university degrees include diplomas and doctoral degrees. Equation (4) states that the time spent in education $1-u_t$ is equal to the number of college graduates at time (t) divided by the labour force and multiplied by the school years.

3.2 Data and Sources

Data on Gross Domestic Product (GDP) and physical capital investment series are annual and were taken from the AMECO database. GDP measured at 2005 constant prices and investments is the gross capital formation at 2005 constant prices for the total economy. Data for constructing human capital proxy

were taken from the Hellenic Statistical Authority (HSA) database. All variables are expressed in logarithmic form.

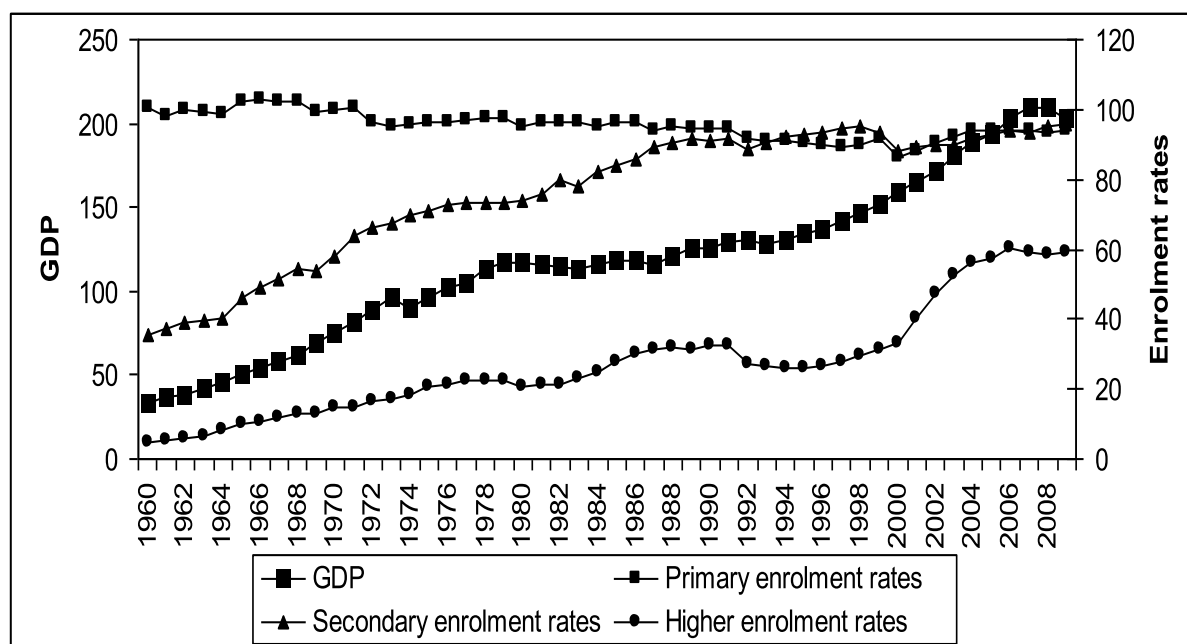


Figure 1: GDP (2005 as base year) and Primary, Secondary and Higher enrolment rates (1960-2009)

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

During the period 1960-2009 Greek GDP indicates a significant increase as well as a radical increase in the share of secondary and higher education. The primary education is represented by a very small (almost stable), negative slope over the whole period (Figure 1).

3.3 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 equals B (Monteils 2004). If B is positive and statistically significant (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 or statistically insignificant there must be decreasing scale returns (no endogenous growth). By using the OLS method the results of the estimated equation (2) for each educational level are given below on the table 1. The regressions were estimated consistently as for the existence of the Serial Correlation and the Heteroskedasticity, by using the Newey-West (1987) estimator.

Table 1: Returns to Scale results

Δht	$1-u$
Primary	0.00003 (0.630)
Secondary	-0.006 (-4.036)***
Higher	-0.017 (-3.818)***

Note: The t-statistics are presented in parentheses. The asterisks indicate significance at the 1% level.

The results show that the link between the time devoted to education (or the duration of training) and growth of human capital is negative. The coefficient of $1-u$ yields negative and statistical significant results at 1% level for the cases of secondary and higher education and statistical insignificant results for the primary education. The human capital 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 is a factor like the others to the production function and it does not break the law of diminishing returns. So, the application of this model would be accompanied by similar predictions as the neoclassical growth model introduced by Solow (1956) and Mankiw, Romer, and Weil (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 and the time devoted to learning may be incorrect, d) the short period of the time series data.

3.4 Estimation of the production sector

This section focuses on the effect of primary, secondary, higher education and investments in physical capital on economic growth by using a VAR methodology. We estimate three different VAR models. Each model includes the variables of economic growth, investments and one of the three educational levels. Using education data by levels may be preferable for a number of reasons. In particular, the growth impact of different forms of educational levels may vary. Also, including primary, secondary and higher education into the same equation is a procedure which may provide invalid results due to strong multicollinearity between the variables (Loening, Rao, and Singh, 2010). First, the order of integration is checked and then cointegration tests are used in order to check the existence of long run relationship between variables. Second, the causality tests based on vector error correction approach were applied and third, in order to investigate the dynamic relationships

between the variables of the models the impulse response functions and variance decomposition are plotted and calculated respectively.

Stationarity test

Initially, the stationarity of the variables GDP, physical capital investments and education is checked. The stationarity of the data set is examined using Augmented Dickey-Fuller (ADF) (1981), Phillip-Perron (PP) (1988) and Perron (1997) structural break tests. We test for the presence of unit roots and identify the order of integration for each variable in levels and first differences. The variables are specified including intercept and including intercept and trend. The optimal lag length of the ADF regressions is determined by Schwarz criterion (1978). The PP statistics are obtained by the Bartlett Kernel and the automatic bandwidth parameter approach as suggested by Newey and West (1994). For the Perron structural break test, the maximum lag length is specified by the user to be equal to 4. For the ADF, PP tests the null hypothesis is non-stationary and for the Perron test is non-stationary with a structural break. Unit root test results are given in Table 2.

Table 2: Results of unit root tests

Variables (in levels & first differences)	ADF test		PP test		Perron test	
	With intercept in equation	With intercept and trend in equation	With intercept in equation	With intercept and trend in equation	With intercept in equation	With intercept and trend in equation
q_t	-4.695***	-2.310	-3.886***	-2.879	-3.526	-3.566
Δq_t	-4.749***	-4.848***	-5.572***	-5.443***	-7.484***	-7.445***
k_t	-3.604***	-3.042	-3.605***	-3.040	-3.840	-3.265
Δk_t	-6.350***	-6.366***	-6.605***	-6.591***	-7.989***	-7.804***
$uh1_t$	-1.375	-1.318	-3.013	-2.959	-3.763	-4.130
$\Delta uh1_t$	-8.267***	-8.267***	-8.173***	-8.173***	-8.585***	-8.748***
$uh2_t$	-4.991***	-5.281***	-1.991	-1.933	-2.382	-3.354
$\Delta uh2_t$	-5.017***	-5.149***	-6.625***	-6.625***	-7.786***	-7.686***
$uh3_t$	-2.279	-2.401	-2.610	-3.796**	-4.050	-4.179
$\Delta uh3_t$	-3.515**	-3.496**	-3.736**	-3.725**	-4.818	-4.772

Note: ***, ** indicates the rejection of the null hypothesis of non stationarity (ADF) and (PP) at 1% and 5% level of significance respectively. For ADF and PP tests MacKinnon (1996) critical values have been used for rejection of hypothesis of a unit root. For structural break test critical values are those reported in Perron (1989).

The results in Table 2 showed that for all the tests the null hypothesis couldn't be rejected at 5% for every variable in their level. The null hypothesis could be rejected at 5% for all variables in their first differences. So the variables from combination of the criteria under study are stationary in their first differences on 5% significant level.

Cointegration test

Stationary tests show that all the variables which are non-stationary in levels become stationary in first differences. They are in fact integrated of order one. So there is the possibility that the variables of GDP, physical capital investments and primary, secondary, higher education are cointegrated. In order to account for influences on the GDP, two dummy variables are added to the VARs model. The first dummy variable involves the year 1974, when the international oil crisis took place and GDP had a significant fall. The second dummy variable involves the year 2001, when Greece became a member of the Euro zone. To determine the lag length of the VARs, three versions of the system were initially estimated: a four, a three and a two-lag version. Then, the Akaike information criterion (AIC) is used to select the optimal lag length. The cointegration test was conducted by using the reduced rank procedure developed by Johansen (1988) and Johansen and Juselius (1990). The Johansen multivariate cointegration approach is used to examine the long-run relationship between the variables. The estimation procedure assumes intercept and no trend in the VARs estimations. This cointegration method recommends two statistics to check the long run relationship: the Trace and maximum Eigenvalue tests. The results of the cointegration tests are presented in the tables 3, 4 and 5.

Table 3: Cointegration test: GDP, physical capital investments and primary education

Series: q k uh1					
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	Max-Eigen Statistic	5 Percent Critical Value
None*	0.887	126.38	35.192	106.90	22.299
At most 1	0.254	19.481	20.261	14.424	15.892
At most 2	0.098	5.0569	9.1645	5.0569	9.1645

Note: ^a r indicates the number of cointegrating relationships. Trace and Maximum Eigen test statistics are compared with the critical values from Johansen and Juselius (1990). *Trace and Max-Eigen tests indicate 1 cointegrating equation at the 5% level.

^b Lags interval: 0 to 0

Table 4: Cointegration test: GDP, physical capital investments and secondary education

Series: q k uh2					
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	Max-Eigen Statistic	5 Percent Critical Value
None*	0.9054	134.96	35.192	115.55	22.299
At most 1	0.2479	19.409	20.261	13.965	15.892
At most 2	0.1051	5.443	9.1645	5.443	9.1645

Note: ^a r indicates the number of cointegrating relationships. Trace and Maximum Eigen test statistics are compared with the critical values from Johansen and Juselius (1990). *Trace and Max-Eigen tests indicate 1 cointegrating equation at the 5% level.

^b Lags interval: 0 to 0

Table 5: Cointegration test: GDP, physical capital investments and higher education

Series: q k uh3					
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	Max-Eigen Statistic	5 Percent Critical Value
None*	0.6184	59.579	35.192	46.252	22.299
At most 1	0.2115	13.326	20.261	11.409	15.892
At most 2	0.0391	1.9170	9.1645	1.9170	9.1645

Note: ^a r indicates the number of cointegrating relationships. Trace and Maximum Eigen test statistics are compared with the critical values from Johansen and Juselius (1990). *Trace and Max-Eigen tests indicate 1 cointegrating equation at the 5% level.

^b Lags interval: 1 to 1

The null hypothesis in the Trace and maximum Eigenvalue tests is that there is no cointegrating vector. The null hypothesis of one co-integrating vector in the Trace test could be rejected at 5% and could not be rejected at 5% for more than one co-integrating vectors, which implies that there is only one cointegrating vector in all the cases. The finding of one co-integrating vector was further supported by the results of the maximum Eigenvalue test, in which the null hypothesis that there is no cointegrating vector could be rejected at 5% only for one co-integrating vector. Thus, the results lead to the conclusion that the GDP, physical capital investments and each of the three educational levels are cointegrated and there is a long-run relationship between them. The estimated cointegration relationships are presented in the following table 6:

Table 6: Long Run Relationships

Levels of Education	c	k	uh
Primary	2.37 (0.15)***	0.77 (0.05)***	-0.96 (0.45)***
Secondary	3.42 (0.20)***	0.50 (0.05)***	0.52 (0.07)***

Levels of Education	c	k	uh
Higher	3.05 (0.38)***	0.67 (0.09)***	0.20 (0.06)***

Note: The standards errors are presented in parentheses. The asterisks indicate significance at the 1% level.

From the above-estimated equations it can be concluded that in the long run the coefficients of secondary and higher education are positive and statistically significant at the one-percent level. The elasticity of GDP with respect to secondary and higher education is 0.52 and 0.20 respectively. This means that a one percent increase in secondary and higher education enrolment rates will foster economic growth by about 0.52 and 0.20 percent respectively. The role of secondary and higher education level on economic growth seems to be important and significantly explains economic growth. The elasticity of GDP with respect to primary education is -0.96. So the primary education has had a negative effect on economic growth. Also, it can be concluded that in the long run, physical capital investments have a significant positive effect on economic growth in all the equations.

Error Correction Models

Having verified that the variables are cointegrated, the vector error-correction model (VECM thereafter) can be applied. The VECM can give the correction term that reflects influences of the deviation of relation between variables from long-term equilibrium upon short-term changes. The size and statistical significance of the error-correction term measures the extent to which each dependent variable has the tendency to return to its long-run equilibrium. For the VECMs including primary and secondary education the Akaike information criterion identified no lags for the VECMs with primary and secondary education and one lag for the VECM with higher education as optimal lag length. Therefore, it can be concluded that there is not a short run but only a long run relationship between the variables which included in the VECMs with primary and secondary education. The vector error-correction models pass all the standard diagnostic tests for residual serial correlation, normality and heteroscedasticity. The results² of the vector error-correction models showed that the first dummy variable has a negative and statistically significant influence on GDP. The second dummy has no influence on GDP as the coefficient is not statistically significant, except the VECM with secondary education which is significant positive.

The t statistic on the coefficient of the lagged error-correction term represents the long-run causal relationship and the F-statistic on the explanatory variables represents the short-run causal effect (Narayan and Smyth 2006). More specifically, the Wald-test applied to the joint significance of the sum of the lags of each explanatory variable and the t-test of the lagged error-correction term will imply statistically the Granger exogeneity or endogeneity of the dependent

variable. The non-significance of ECT is referred to as long-run non-causality, which is equivalent to saying that the variable is weakly exogenous with respect to long-run parameters. The absence of short-run causality is established from the non-significance of the sums of the lags of each explanatory variable. Finally, the non-significance of all the explanatory variables, including the ECT term in the VECM, indicates the econometric strong-exogeneity of the dependent variable that is the absence of Granger-causality (Hondroyannis and Papapetrou 2002).

Table 7: Causality test for primary education based on VECM

Variables	Long-Run Causality	
	ECT	
DQ	- 0.138***	[-11.03]
DK	-0.152***	[-2.96]
DUH1	0.008	[1.09]

Note: The asterisks of the lagged ECTs are distributed as t-statistics and indicate rejection of the null hypothesis that the estimated coefficient is equal to zero (weak exogeneity) and no causality. The asterisks indicate significance at the 1% level.

Table 8: Causality test for secondary education based on VECM

Variables	Long-Run Causality	
	ECT	
DQ	- 0.191***	[-11.91]
DK	-0.244***	[-3.54]
DUH2	-0.100***	[-5.92]

Note: The asterisks of the lagged ECTs are distributed as t-statistics and indicate rejection of the null hypothesis that the estimated coefficient is equal to zero (weak exogeneity) and no causality. The asterisks indicate significance at the 1% level.

Table 9: Summary of causality test for higher education based on VECM

Variables	Short-run dynamics non-causality			Weak exogeneity	Tests of Granger non-causality (joint short run dynamics and ECT)			Test for strong exogeneity
	DQ	DK	DUH3		ECT	DQ and ECT	DK and ECT	
DQ	-	1.72 (0.18)	5.39** (0.02)	- 0.10*** [-2.99]	-	24.28*** (0.00)	22.59*** (0.00)	42.48*** (0.00)

	Short-run dynamics non-causality			Weak exogeneity	Tests of Granger non-causality (joint short run dynamics and ECT)			Test for strong exogeneity
DK	2.28 (0.13)	-	4.43** (0.03)	0.12 [0.93]	1.96 (0.37)	-	4.46 (0.11)	6.18 (0.11)
DUH3	0.11 (0.73)	0.04 (0.83)	-	-0.086 [-1.22]	1.92 (0.38)	23.10*** (0.00)	-	24.80*** (0.00)

Note: The Wald test statistics reported are distributed as a chi-square distribution with degrees of freedom the number of restrictions. The p-values are presented in parentheses. In the short-run dynamics, asterisks indicate rejection of the null hypothesis that there is a short-run non-causal relationship between the two variables. The asterisks of the lagged ECTs are distributed as t-statistics and indicate rejection of the null hypothesis that the estimated coefficient is equal to zero (weak exogeneity). The t-statistics are presented in brackets. Finally, in the tests for Granger non-causality and strong exogeneity, asterisks denote rejection of the null hypothesis of Granger non-causality and strong exogeneity respectively. The asterisks indicate the following levels of significance: **5% and ***1%.

Table 7 reports the findings for the endogeneity between the variables of GDP, physical capital investments and primary education. Estimates of the parameters show that the error-correction term is negative and statistically significant for the GDP and physical capital investments equations. The t-test for the error-correction term indicates the significance of the long-run causal effect at the one percent level. Therefore, GDP and investments are not weakly exogenous variables. These results imply that in the long run, there is a unidirectional Granger causality running from primary education to GDP and bidirectional causality between physical capital investments and GDP. Table 8 reports the findings for the endogeneity of GDP, physical capital investments and secondary education. Estimates of the parameters show that the error-correction term is negative and statistically significant for the three equations. The t-test for the error-correction term indicates the significance of the long-run causal effect at the one percent level. Therefore, GDP, investments and secondary education are not weakly exogenous variables. These results imply that in the long run, there is a bidirectional Granger causality running between secondary education, physical capital investments and GDP. Table 9 reports the findings for the endogeneity of GDP, physical capital investments and higher education. Estimates of the parameters show that the error-correction term is negative and statistically significant only for the GDP equation. The t-test for the error-correction term indicates the significance of the long-run causal effect at the one percent level. Therefore, GDP is not a weak exogenous variable. In addition, the t-tests of the error-correction term for the physical capital investments and higher education enrolment rates are not statistically significant. These results imply that the physical capital investments and higher education are weakly exogenous variables. In the long run, there is a unidirectional Granger

causality running from higher education and physical capital investments to GDP. In the short-run dynamics, the Wald tests indicate that there is a unidirectional Granger causality running from higher education enrolment rates to GDP. Finally, the significance levels associated with the Wald tests of joint significance of the sum of the lags of the explanatory variable and the error-correction term provide more information on the impact of physical capital investments and higher education on economic growth and vice versa. Finally, the empirical results reveal that for the GDP and higher education variables we can reject the hypothesis of strong exogeneity supporting the proposition that there is a relationship between physical capital investments, higher education and economic growth in Greece.

Impulse Response Functions

In order to study the dynamic properties of the VAR models, impulse response functions analysis (IRF thereafter) is employed using the Cholesky decomposition. The time period of impulse response functions spreads over ten years, which is a long enough period to capture the dynamic interactions between education and physical capital investments growth rates to economic growth. The IRF derived from the unrestricted VARs are presented in figures 2, 3 and 4.

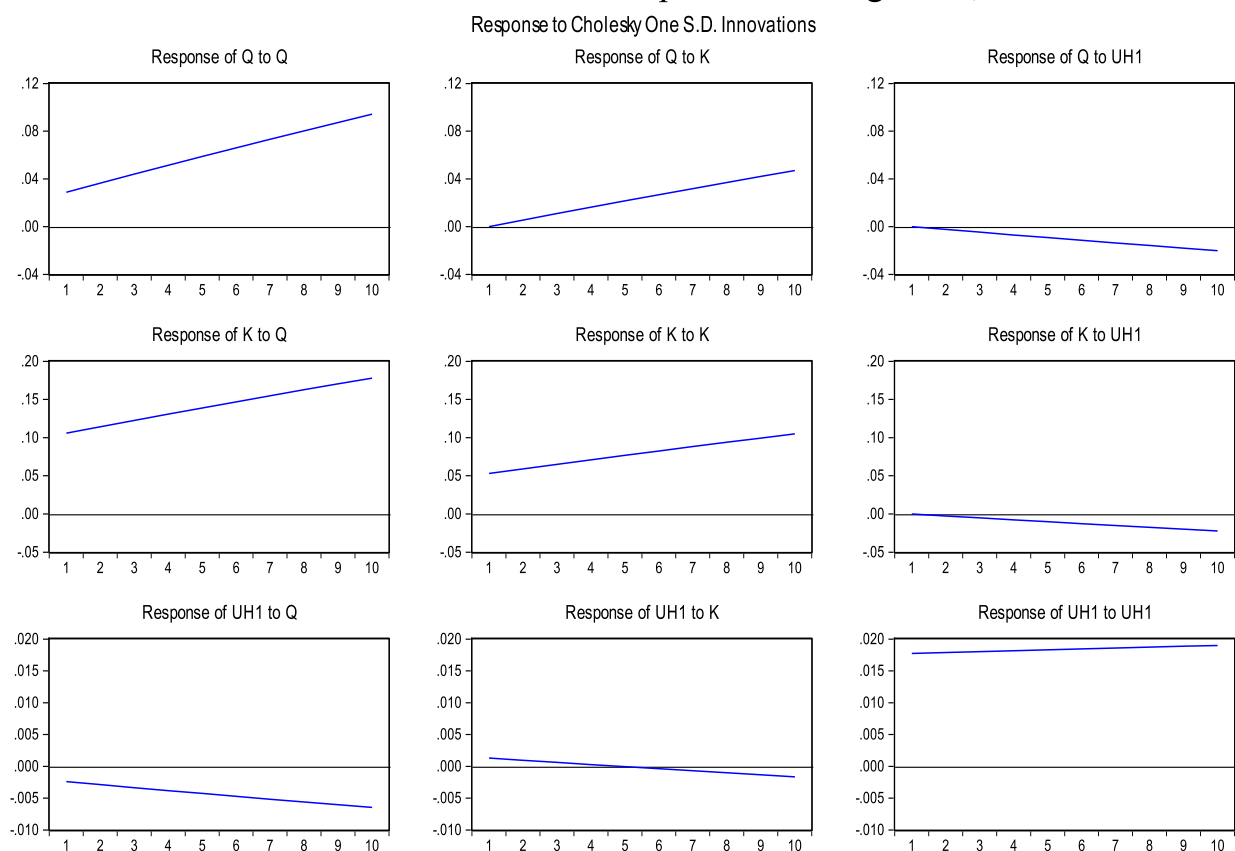


Figure 2: IRF with primary education

The variables of the first VAR order as following: GDP, physical capital investments and primary education (Q, K and UH1).

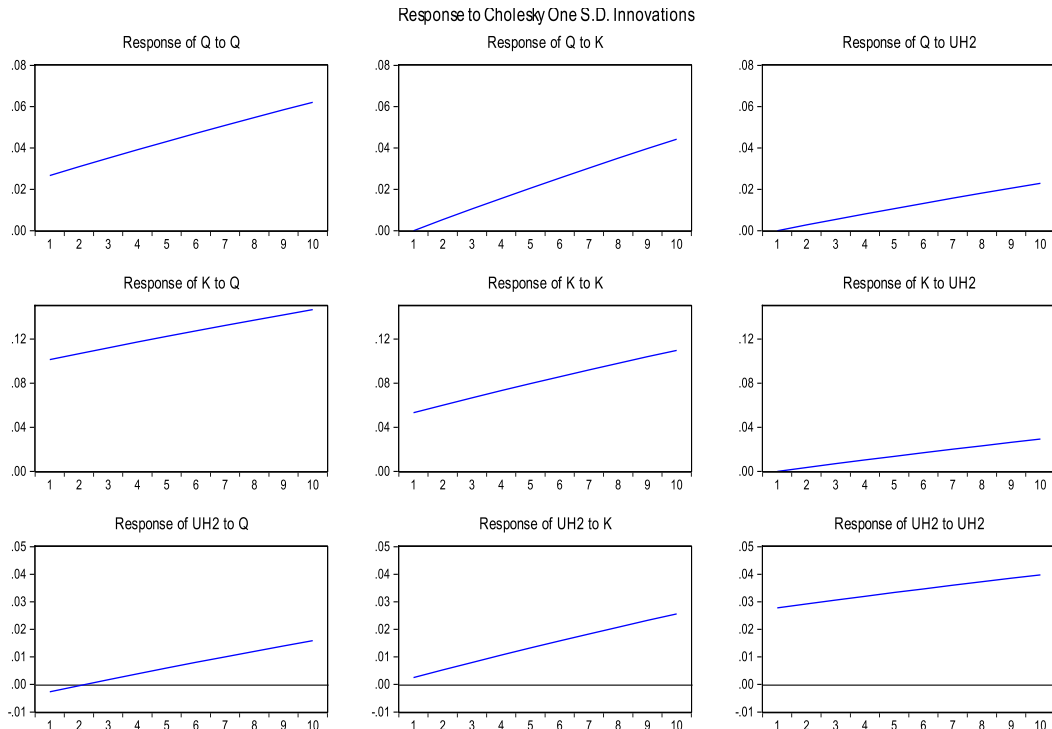


Figure 3: IRF with secondary education

The variables of the second VAR order as following: GDP, physical capital investments and secondary education (Q, K and UH2).

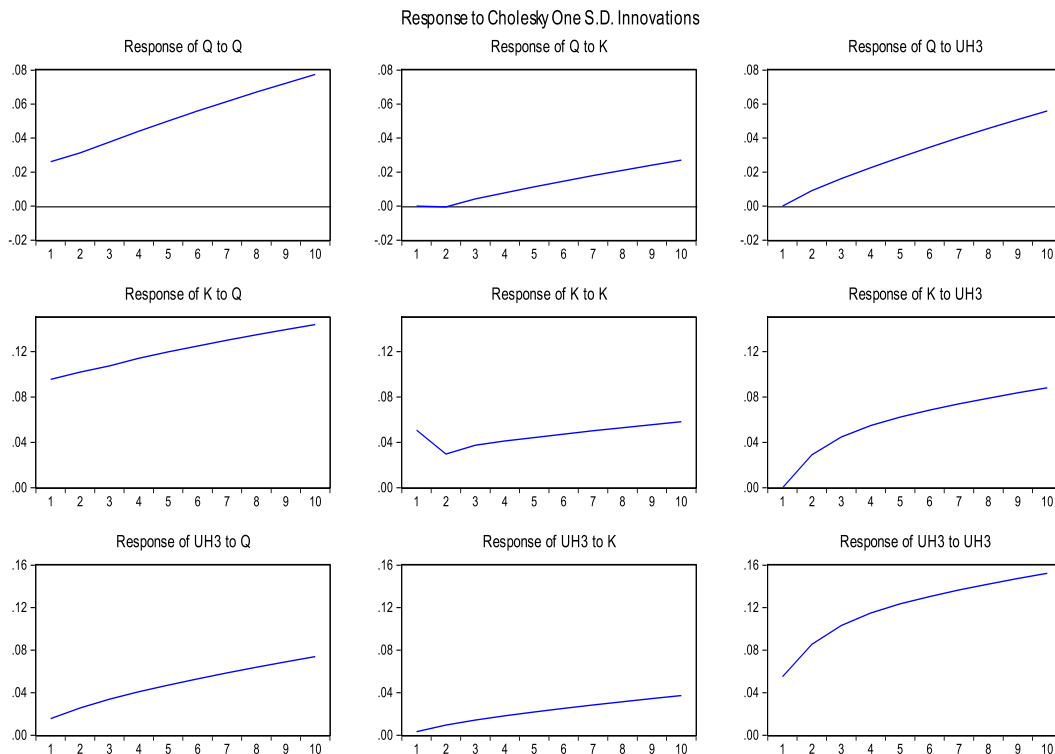


Figure 4: IRF with higher education

The variables of the third VAR order as following: GDP, physical capital investments and higher education (Q, K and UH3).

From the first row of figure 2, it becomes apparent that one standard deviation shock of primary education has a negative impact on economic growth. Similar, a one standard deviation shock to economic growth variable has negative impact on primary education. Figure 3 reports that a one standard deviation shock to secondary education has a positive impact on economic growth. In other words, a one percent increase in secondary education's innovation causes a 0.02 percent increase in economic growth. Similar, a one standard deviation shock to economic growth variable has a positive impact on secondary education after the second year. Figure 4 shows that the response of economic growth from one standard deviation shock in higher education is positive and significantly bigger than secondary education. A one percent increase in the innovation of higher education causes a 0.06 percent increase in economic growth. Similar, higher education response to economic growth innovation is positive. A one standard deviation shock to physical capital investments has a positive impact on economic growth, but the strongest positive impact arises from economic growth to investments in all the figures.

Variance Decomposition Analysis

The variance decomposition (VDC thereafter) is estimated for each variable in the VAR models for a period of ten years. The VDC estimation results are presented in tables 10, 11 and 12.

Table 10: Variance Decomposition for Primary Education

Periods	Variance Decomposition of Q				Variance Decomposition of K				Variance Decomposition of UH1			
	S.E.	Q	K	UH1	S.E.	K	Q	UH1	S.E.	UH1	Q	K
1	0.02	100.00	0.00	0.00	0.11	20.05	79.94	0.00	0.01	97.69	1.79	0.51
2	0.04	98.37	1.37	0.25	0.17	20.60	79.36	0.02	0.02	97.44	2.16	0.38
3	0.06	95.85	3.49	0.64	0.22	21.12	78.80	0.06	0.03	97.14	2.55	0.29
4	0.08	93.21	5.72	1.05	0.26	21.60	78.27	0.12	0.03	96.79	2.98	0.22
5	0.10	90.73	7.81	1.44	0.31	22.04	77.75	0.20	0.04	96.38	3.44	0.17
6	0.12	88.50	9.70	1.78	0.35	22.45	77.26	0.28	0.04	95.92	3.91	0.15
7	0.15	86.54	11.36	2.09	0.39	22.83	76.79	0.37	0.04	95.43	4.41	0.14
8	0.17	84.81	12.82	2.36	0.43	23.18	76.35	0.46	0.05	94.90	4.93	0.16
9	0.20	83.29	14.10	2.60	0.48	23.51	75.92	0.55	0.05	94.33	5.46	0.20
10	0.22	81.95	15.23	2.80	0.52	23.82	75.53	0.64	0.06	93.73	6.01	0.25

The variables of the first VAR order as following: GDP, physical capital investments and primary education (Q, K and UH1).

Table 11: Variance Decomposition for Secondary Education

Periods	Variance Decomposition of Q				Variance Decomposition of K				Variance Decomposition of UH2			
	S.E.	Q	K	UH2	S.E.	K	Q	UH2	S.E.	UH2	Q	K
1	0.02	100.00	0.00	0.00	0.11	21.64	78.35	0.00	0.02	98.30	0.92	0.77
2	0.04	97.91	1.64	0.44	0.16	22.89	77.05	0.04	0.04	97.53	0.44	2.01
3	0.05	94.30	4.49	1.20	0.21	24.08	75.77	0.13	0.05	95.98	0.38	3.62
4	0.07	90.16	7.75	2.07	0.25	25.21	74.52	0.25	0.06	93.85	0.65	5.48
5	0.08	86.04	11.00	2.95	0.29	26.26	73.32	0.40	0.07	91.34	1.17	7.48
6	0.10	82.18	14.04	3.76	0.33	27.26	72.15	0.57	0.08	88.60	1.86	9.52
7	0.11	78.67	16.81	4.50	0.36	28.19	71.04	0.76	0.09	85.75	2.67	11.56
8	0.13	75.53	19.28	5.17	0.40	29.06	69.98	0.95	0.10	82.89	3.56	13.54
9	0.15	72.74	21.49	5.76	0.44	29.87	68.96	1.15	0.11	80.07	4.48	15.44
10	0.17	70.26	23.44	6.28	0.48	30.64	68.00	1.35	0.12	77.33	5.41	17.24

The variables of the second VAR order as following: GDP, physical capital investments and secondary education (Q, K and UH2).

Table 12: Variance Decomposition for Higher Education

Periods	Variance Decomposition of Q				Variance Decomposition of K				Variance Decomposition of UH3			
	S.E.	Q	K	UH3	S.E.	K	Q	UH3	S.E.	UH3	Q	K
1	0.02	100.00	0.00	0.00	0.10	22.03	77.96	0.00	0.05	92.35	7.31	0.33
2	0.04	95.25	0.01	4.73	0.15	14.54	81.94	3.50	0.10	91.19	7.89	0.90
3	0.05	89.48	0.53	9.97	0.19	12.56	80.11	7.32	0.15	89.94	8.74	1.31
4	0.07	84.30	1.34	14.35	0.23	11.61	78.05	10.33	0.19	88.71	9.62	1.65
5	0.09	79.94	2.20	17.84	0.27	11.10	76.20	12.68	0.23	87.52	10.49	1.97
6	0.11	76.35	3.02	20.62	0.31	10.83	74.63	14.52	0.27	86.36	11.35	2.27
7	0.14	73.38	3.77	22.83	0.35	10.68	73.28	16.02	0.31	85.24	12.18	2.56
8	0.16	70.92	4.44	24.63	0.38	10.61	72.12	17.25	0.35	84.17	12.98	2.83
9	0.18	68.84	5.02	26.12	0.42	10.59	71.09	18.30	0.39	83.14	13.75	3.09
10	0.21	67.08	5.54	27.36	0.46	10.59	70.18	19.21	0.42	82.16	14.48	3.34

The variables of the third VAR order as following: GDP, physical capital investments and higher education (Q, K and UH3).

As the years pass primary, secondary and higher education gradually affect more the variation of economic growth. More precisely, 2.80, 6.28 and 27.36 percent of economic growth forecast error variance in a ten years period is explained by disturbances of primary, secondary and higher education, respectively. Higher education innovation explains much more than primary and secondary the variation of economic growth. Overall, this figure is quite substantial, underlying the importance of higher education on economic growth. Also, as the years pass physical capital investments affect the variation of economic growth in all figures. From the first year a substantial part of the forecast error variance of economic growth from 5.54 to 23.44 percent, is affected by the disturbance of the physical capital investments. On the other hand, the variation of

physical capital investments is largely explained by economic growth. The overall results from VDC seem to be in agreement with those of IRF, providing evidence in favour of the importance of secondary and higher education to explain variation in economic growth.

4 DISCUSSION OF THE RESULTS

The results of the econometric analysis show that secondary and higher education have had a positive contribution to economic growth in Greece during the period 1960-2009. These results are consistent with most of the previous studies mentioned above. Specifically, the results are in line with the studies, such as Tallman and Wang (1994) for Taiwan, Lin (2006) for Taiwan, Loening Bhaskara, and Singh (2010) for Guatemala, Abbas (2001) for Pakistan, Shaihani et al. (2011) for Malaysia, Villa (2005) for Italy, Chi (2008) for China, Gyimah, Paddison, and Mitiku (2006) for African countries. In the case of Greece, the results are in line with the studies of Magoula and Prodromidis (1999), Asteriou and Agiomirgianakis (2001), Tsamadias and Prontzas (2012), Pegkas and Tsamadias (2014) and Pegkas (2014). The result that primary education has had a negative impact on economic growth is consistent with less of the previous studies mentioned above. Specifically, the results are in line with the studies, such as Abbas, (2001), Villa, (2005) and Shaihani et al, (2011), Pegkas (2014). As Romer (2001) noted, primary education might not show short run results in the economy, but has indirectly long term effects on it. As primary is the first and basic level of education it is very important for the other two levels of education, which make up the productive sector of the country. In addition, in the case of Greece, possibly due to the fact that primary enrollment rates were already high, during the period under review they had declined in some subperiods. So, for the examined period which the GDP has grown significantly, the primary education had a negative significant effect on economic growth. During the period 1960-2009 Greek economy was transformed from the primary to the tertiary production sector. Furthermore, Greece was transformed from a less developed to a developed country. That may explain the findings of the study that secondary and higher education have had the most significant positive impact on growth in Greece, while primary education had not contributed to growth. This conclusion is supported by the research of Gemmell (1996), Mingat and Tan (1996) and Petrakis and Stamatakis (2002), who concluded that primary education affects more less developed countries, while growth in more developed countries depends mainly on secondary and higher education.

Another main result of the study reveals the rejection of the increasing returns to scale. This finding is consistent with other studies that applied the Lucas model such as: Monteils (2004) in the case of France, Gong, Greiner, and Semmler (2004) in the case of U.S. and Germany, Van Leeuwen (2006) in the cases of India and Japan. So, the endogenous character of the economic growth suggested by Lucas is not verified. As a result the application of this model would be accompanied by similar predictions as the neoclassical growth model introduced by Mankiw, Romer, and Weil (1992). Probably that explains the similarity with the results of the study which has applied the neoclassical growth model for the case of Greece (Pegkas, 2014).

5 CONCLUSIONS

The study empirically investigates the causal relationship between each level of formal education and economic growth. Moreover, it estimates the effect of each level of formal education on economic growth, in Greece during the time period 1960–2009. In order to estimate the contribution of education to economic growth, the paper used the endogenous approach of Lucas (1988) and the enrollment rates as proxy for human capital. The empirical analysis reveals that GDP, the three levels of education and physical capital investments are cointegrated. The elasticity of GDP with respect to primary, secondary and higher education, is -0.96, 0.52 and 0.20 respectively. The results also suggest that there is evidence of unidirectional long-run causality running from primary education to growth, bidirectional long-run causality between secondary and growth, long-run and short-run causality running from higher education to economic growth. These results are supported by the generalized impulse response functions and the generalized variance decomposition analysis. Overall, the conclusion of the study indicates that the quantity of secondary and higher education has had a positive contribution to economic growth. In Greece, the quantity of education has increased during the last five decades (Pegkas and Tsamadias, 2014) whereas the quality of education remains low as many reports indicate (PISA 2012 Results-OECD). In Greece, many important structural reforms in various sectors of the educational system need to be implemented, in order to further improve the quality of human capital. This way the contribution of education to economic growth in Greece will be increased. Future research could focus on the investigation and evaluation of the quality of education, efficiency, effectiveness and productivity of higher education institutions and schools. Another study could investigate synergies among higher education institutions and businesses. We believe that these are crucial factors in

the direction of the country's development in the international competitive and dynamic environment.

Notes

¹ For more details of the model please refer to Bratti and Bucci (2003) and Pegkas (2012).

² The results of VECMs are available from the authors upon request.

REFERENCES

1. Abbas, Q. (2001). Endogenous Growth And Human Capital: A Comparative Study Of Pakistan And Sri Lanka. *The Pakistan Development Review*, 40(4), 987-1007.
2. Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, 19(6), 716–723.
3. Ameco Database. European Commission. Accessed July (2013). Available At <Http://Ec.Europa.Eu/Economy Finance /Ameco/User/Serie/Selectserie. Cfm.Sed>.
4. Arnold, L., G. (2002). On The Effectiveness Of Growth-Enhancing Policies In A Model Of Growth Without Scale Effects. *German Economic Review*, 3(3), 339-346.
5. Asteriou, D. And Agiomirgianakis, G. (2001). Human Capital And Economic Growth, Time Series Evidence From Greece. *Journal Of Policy Modeling*, 23, 481-489.
6. Bashir, M., Iqbal, M. and Khalid Zaman, K. (2011). Estimating private rate of return on higher education in Pakistan. *Review of Economic and Business Studies*, 4(1), 179-197.
7. 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.
8. Bouaissa, M. (2009). Human capital theory, returns to education and on the job learning: evidence from the Canadian data, preliminary and incomplete version. *CEA*, 43rd Annual Conference, 29-31 May, in University of Toronto, Ontario.
9. Bucci, A. (2008). Population growth in a model of economic growth with human capital accumulation and horizontal R&D. *Journal of Macroeconomics*, 30(3), 1124-1147.
10. Chi, W. (2008). The role of human capital in China's economic development: Review and new evidence. *China Economic Review*, 19(3), 421–436.
11. Dickey, D. and Fuller, W. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49(4), 1057-1072.
12. El-Matrawy, 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>.
13. Gemmell, N. (1996). Evaluating the impacts of human capital stock and accumulation on economic growth: some new evidence. *Oxford Bulletin of Economics and Statistics*, 58, 9-28.
14. Gong, G., Greiner, A. and Semmler, W. (2004). The Uzawa-Lucas model without scale effects: theory and empirical evidence. *Structural Change and Economic Dynamics*, 15(4), 401-420.
15. Granger, C.W.J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37, 424-438.

16. Granger, C.W.J. (1988). Some recent developments in the concept of causality. *Journal of Econometrics*, 39, 199-211.
17. Gyimah-Brempong, K., Paddison, O. and Mitiku, W. (2006). Higher education and economic growth in Africa. *Journal of Development Studies*, 42(3), 509-529.
18. Haldar S. K., and Mallik G., (2010), Does Human Capital Cause Economic Growth? A Case Study of India, *International Journal of Economic Sciences and Applied Research*, 3(1), 7-25.
19. Hellenic Statistical Authority. Accessed June (2013). Available at <http://www.statistics.gr/portal/page/portal/ESYE>.
20. Hondroyannis, G. and Papapetrou E. (2002). Demographic transition and economic growth: Empirical evidence from Greece. *Journal of Population Economics*, 15, 221-242.
21. Johansen, S. (1988). Statistical analysis of cointegrating vectors. *Journal of Economic Dynamic and Control*, 12, 231-254.
22. 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*, 52, 169-210.
23. Lin, T., C. (2006). Alternative measure for education variable in an empirical economic growth model: Is primary education less important?. *Economics Bulletin*, 15, 1-6.
24. Liu, C., and Armer, M. (1993). Education's effect on economic growth in Taiwan. *Comparative Education Review*, 37(3), 304-321.
25. Loening, J., Bhaskara R. and Singh, R. (2010). Effects of education on economic growth: Evidence from Guatemala. MPRA Paper 23665, University Library of Munich, Germany.
26. Lucas, E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, 22, 3-42.
27. Mackinnon, J., G. (1996). Numerical distribution functions for unit root and cointegration tests. *Journal of Applied Econometrics*, 11(6), 601-618.
28. Magoula, T. and Prodromidis, K. (1999). Education and economic growth in Greece. Discussion Paper No. 99, Athens University of Economics and Business.
29. Mankiw, G., Romer, D. and Weil, D. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics*, 107, 407-437.
30. Mc Mahon, W. (1998). Education and growth in East Asia. *Economics of Education Review*, 17(2), 159-172.
31. Mingat, A. and Tan, J. (1996). The full social returns to education: Estimates based on countries economic growth performance, *World Bank, Washington, DC*.
32. Monteils, M. (2004). The analysis of the relation between education and economic growth. *Compare: A Journal of Comparative and International Education*, 34(1), 103-115.
33. Narayan, P. K. and Smyth, R. (2006). Higher education, real income and real investment in China: Evidence from Granger causality tests. *Education Economics*, 14(1), 107-125.
34. Newey, W., K. and West, K., D. (1987). A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, 55(3), 703-708.
35. Newey, W., K. and West, K., D. (1994). Automatic lag selection in covariance matrix estimation. *Review of Economic Studies*, 61(4), 631-654.

36. Odit, M., Dookhan, K. and Fauzel, S. (2010). The impact of education on economic growth. The Case of Mauritius. *International Business and Economics Research Journal*, 9(8), 141-152.
37. OECD, PISA 2012 Results: What Students Know and Can Do – Student Performance in Mathematics, Reading and Science (Volume I, Revised edition, February 2014), PISA, OECD Publishing. Available at <http://dx.doi.org/10.1787/9789264201118-en>.
38. Pegkas, P. (2012). Educational stock and economic growth: The case of Greece over the period 1981-2009. *Journal of Economics and Business, Spoudai*, 62(1-2), 56-71.
39. Pegkas, P. and Tsamadias, C. (2014). Does higher education affect economic growth? The case of Greece. *International Economic Journal*, DOI:10.1080/10168737.2014.894551.
40. Pegkas, P. (2014). The link between educational levels and economic growth. A neoclassical approach for the case of Greece. *International Journal of Applied Economics*, 11(2), 38-54.
41. Pereira, J. and Aubyn, M. (2009). What level of education matters most for growth?: Evidence from Portugal. *Economics of Education Review*, 28(1), 67-73.
42. Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica*, 57, 1361-1401.
43. Perron, P. (1997). Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics*, 80, 355-385.
44. Petrakis, P., E. and Stamatakis, D. (2002). Growth and educational levels: a comparative analysis. *Economics of Education Review*, 21(5), 513–521.
45. Philips, P., C. and Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 57(2), 335-346.
46. Psacharopoulos, G. (1995). The profitability of investment in education: Concepts and methods, human capital development and operations policy. Working paper No.76. World Bank, Washington, D.C.
47. Romer, P. (1990). Endogenous technological change. *Journal of Political Economy*, 98, 71-102.
48. Romer, D. (2001). *Advanced macroeconomics*, 2nd edition, New York: McGraw-Hill.
49. Schwarz, G., E. (1978). Estimating the dimension of a model. *Annals of Statistics*, 6(2), 461–464.
50. Self, S. and Grabowski, R. (2004). Does education at all levels cause growth? India, a case study. *Economics of Education Review*, 23(1), 47-55.
51. Shaihani, M., Harisb, A., Ismaila N. and Saida R. (2011). Long run and short run effects on education levels: Case in Malaysia. *International Journal of Economic Research*, 2(6), 77-87.
52. Sianesi, B. and Reenen, J. (2003). The returns to education: macroeconomics. *Journal of Economic Surveys*, 17, 157-200.
53. Solow, R., M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70(1), 65-94.
54. Strulik, H. (2005). The role of human capital and population growth in R&D-based models of economic growth. *Review of International Economics*, 13(1), 129-145.
55. Tallman, E. and Wang, P. (1994). Human capital and endogenous growth: evidence from Taiwan. *Journal of Monetary Economics*, 34, 101-124.

56. 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*, 3(3), 237-251.
57. Tsamadias, C. and Prontzas, P. (2012). The effect of education on economic growth in Greece over the 1960-2000 period. *Education Economics*, 20(5), 522-537.
58. 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.
59. Villa, S. (2005). Determinants of growth in Italy. A time series analysis. Working Paper, University of Foggia, Italy.
60. World Bank. (2012). Education statistics – definitions. Accessed January 2012. Available at <http://www.worldbank.org>.