

Education and Economic Development: An Empirical Analysis for Greece

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Abstract

This paper inquires the interrelation between education and economic development for Greece taking into consideration the impact of employment, productivity and technology. Sensitivity analysis scrutinizes the nexus between education and development applying the Monte Carlo simulation process. The results of the empirical research indicated that education affects positively economic development in Greece for the period 2000-2019.

Keywords

Education, Economic Development, Monte Carlo Simulation, Granger Causality

1. Introduction

This study attempts to analyze the Greek educational system in the last decade. The Greek state has established the compulsory nature of the two basic education structures, primary and secondary, seeking the highest possible percentage of students enrolling in schools in order to develop the educational level of the workforce. In Greece, due to the economic growth observed in the period 1960-2004, the number of students enrolling in schools and universities increased rapidly, seeking to acquire a higher level of knowledge in order to find work.

Specifically, examining the period 2008-2019, a descending tendency can be noted to the rate of economic growth of Greece, ranging from 242 billion euro in 2008 to 183 billion euro in 2019, due to the economic crisis. The rapid increase in the number of students from 163,516 in 2000 to 236,520 in 2019 in Greek universities is due to the reforms of the educational system mainly in the way of

organization and operation. Particularly, this evolution is based on the rapid increase in the number of student admissions in Greek universities and the increase in the number of academic departments during the last five years (Greek Statistical Authority, 2020).

However, the “Greek academic map” is constantly changing as well as the structure of the educational system that requires radical changes. There has also been a steady but limited rise in the number of academic staff during the last decade from 13,722 in 2009 to 15,992 in 2019. In addition, the number of graduate students of university institutions increased from 31,353 in 2009 to 38,460 in 2019, but also of postgraduate students from 30,346 in 2009 to 78,518 in 2019, while the number of PhDs fluctuates at relatively stable levels throughout the period 2009-2019 (Greek Statistical Authority, 2020).

Moreover, the expected duration of studies in Greece varies over time from 16 - 19 years. In addition, educational expenditures range from 3.9% - 4.5% of the country’s GDP over time in the period 2000-2019, proving the importance given by the state to education, in order to cover the academic needs in the educational process. Economic and political conditions influence greatly the impact of economic development on education in Greece (Adamopoulos, 2021).

This paper examines theoretically and empirically the interrelation between education and development in Greece referring to the overall period 2000-2019, based on the contemporary literature review and the previous empirical studies.

2. Literature Review

The nexus between education and development has aroused the research interest intensely the last decade. Some neoclassical economists such as Lucas (1988) and Romer (1986) highlighted the pivotal impact of human capital in innovation explaining the operation of economic development respectively. Education affects development directly through investment, employment, productivity and innovation in technology (Psacharopoulos, 1995).

De Meulemeester and Rochat (1995) investigated the causal nexus between education and development for Japan, England, France, Sweden, Italy and Australia. They ascertained that there is a unilateral causal relationship in the four countries (Japan, England, France, and Australia), while in Sweden, no causal relationship was found between education and economic development. Also, Denison (1967) pointed out that investment affects education and development positively in general.

Education encourages the human capital growth, boosts the marginal productivity of natural capital and finally invokes the expected return on investment in education, thus contributing to a direct increase in national income relatively (Breton, 2013).

Furthermore, education promotes economic growth in two ways: Firstly, by raising the labour productivity directly and secondly through technological innovation indirectly, by leading to the knowledge acquisition and new ideas.

Economic growth and human capital development interact with each other mutually (Zivengwa et al., 2013). Petrakis and Stamatakis (2002) certified that education accelerates economic development in developing countries. Moreover, Benos and Karagiannis (2008) verified that education boosts economic development in Greece over the period 1981-2003.

Diffusion of technology improves the efficiency of resource assignment, while reduces highly the cost of production and increases the demand and the investment in all economic sectors (Grimes et al., 2012). According to Grossman and Helpman (1991) technological progress results from research and innovation.

According to Uzawa (1965) and Lucas (1988) productivity upgrades education quality and stimulates the human capital inevitably. Besides, Aghion et al. (2009) approved that educational expenditure induces development especially in industrialized countries, while Sims (2004) denoted that the rise of labour productivity is due to education evolution.

Créel and Pilon (2006) found out that human capital and investment impulse development in Europe studying the neoclassical Solow model. Barro and Sala-i-Martin (2004) proved that expenditure in education enhance development. They revealed that the implemented policies to increase the minimum basic education threshold vary from one to another country. Economic conditions and education funding policies affect educational expenditures directly (Altundemir, 2008). State expenditures related to education are divided into three categories: 1) central, 2) regional, 3) local.

The definition of education is focused on the process of changing a person's behavior, way of thinking and cultivation of abilities. Education expresses that process, where the individual acquires specific behavioral patterns (Çalışkan et al., 2013). The increase in the efficiency of the employed is due to their quality of education level and the increase in labour productivity. People, who are more educated, may have larger possibility to get a better job (Karagor et al., 2017).

Education affects positively economic development via the natural capital growth expressed by the cost of investments and financing mainly by the public sector (Psacharopoulos, 1995). It is now imperative to change the quality of higher education in Greece, despite the low funding in comparison with the remaining of the European Union's countries (Keller, 2006). Asteriou and Agiomirgianakis (2001) appraised the causality between education and development for Greece over the period 1960-1994 and implied that economic development causes education unidirectionally.

Moreover, Agiomirgianakis et al. (2002) inferred that higher education affects development positively in the long-run, by studying a group of 93 countries during the time period 1960-1987.

The exploratory questions posed in this study are the following one:

- ❑ Education positively affects economic development through public investment (Psacharopoulos, 1995; Asteriou & Agiomirgianakis, 2001).
- ❑ Education positively affects economic development through technology (Zhou

& Luo, 2018).

- Education positively affects economic development through employment and productivity level (Hanushek & Woessmann, 2008; Pegkas & Tsamadias, 2014).

3. Research Methodology

Most empirical studies apply either cross-sectional or time series data for many countries adopting some different approaches in inquiring the causality between education and economic development.

Two-stage least squares procedure is adopted to check out empirically how education affects development. The ultimate goal of the econometric model's estimation is to verify statistically that the theoretical assumptions of the paper are valid according to economic theory. The Monte Carlo simulation process is also assesses the predictability of the model.

The general form of the model is presented as follows (Adamopoulos, 2021):

$$H_t = b_0 + b_1 G_t + b_2 L_{t-2} + b_3 T_t + b_4 T_{t-1} + e_{1t} \quad (1)$$

$$G_t = b_5 + b_6 H_{t-2} + b_7 E_{t-3} + b_8 P_t + b_9 G_{t-1} + e_{2t} \quad (2)$$

$$L_t = b_{10} + b_{11} H_{t-4} + b_{12} E_t + b_{13} L_{t-1} + e_{3t} \quad (3)$$

where

G_t = Gross domestic product;

H_t = Higher education;

L_t = Employment;

T_t = Technology;

E_t = Educational expenditure;

P_t = Productivity;

$t - i$ = time trend;

b_0, b_5, b_{10} = intercept;

$b_1, \dots, b_4, b_6, \dots, b_9, b_{11}, \dots, b_{13}$ = coefficients;

e_{1t}, e_{2t}, e_{3t} = equation residuals.

This empirical study conducted by using quantitative economic data drawn from various statistical databases such as Eurostat (Eurostat, 2020; AMECO, 2019) and International Monetary Fund (IMF, 2020).

The data variables of the estimated model are annual, referred to constant values and have been calculated with a base year of 2015 covering the period 2000-2019 for Greece. EViews (2015) software package is used for statistical estimations and calculations of econometric model.

The econometric model is consisted of three linear functions (Equations (1), (2), (3)), including three endogenous variables (H_t, G_t, L_t) and ten exogenous variables ($T_t, T_{t-1}, P_t, L_{t-1}, L_{t-2}, E_t, E_{t-3}, H_{t-2}, H_{t-4}, G_{t-1}$) respectively.

In this empirical analysis, the sample period is selected in order to assess the educational reforms in Greece over the period 2000-2019 considering the effect of economic crisis on education in 2009. The rapid decrease of rate of GDP in

2009 in Greece has caused a relative decrease of educational expenditures in higher education.

Therefore, this research inquires the evolution of education in the last two decades until 2019 and especially evaluates the results of reforms in educational system of Greece in order to make policy implications.

Next, we analyze the data variables are used in the estimated econometric model rigorously. Economic development is measured by the rate of per capita gross domestic product (AMECO, 2019).

Higher education is expressed by the tertiary educational attainment by sex. This index is referred to the share of the aged 30 - 34 years, who have successfully completed tertiary studies in universities or in higher technical institutions (Eurostat, 2020).

General government expenditure in education is regarded as a percentage of GDP. It includes expenditure funded by transfers from international sources to government. General government usually is referred to local, regional and central government (Eurostat, 2020).

Labour is represented by the employment rate by sex, age and educational attainment level as a percentage of GDP. This index calculates the percentage of the labour force aged 30 - 34 years (Eurostat, 2020).

Information and communication technology service exports are referred to computer and communications services namely telecommunications and postal or courier services and also concern information services namely computer data and news-related service transactions (IMF, 2020). Finally, productivity is measured by the capital share of total factor productivity index (AMECO, 2019).

4. Empirical Results

The estimations of the econometric model for Greece, applying the two-stage least squares process, are presented as follows:

$$\widehat{H}_t = -1.00 + 0.63\widehat{G}_t + 0.35\widehat{L}_{t-2} + 0.17\widehat{T}_t + 0.29\widehat{T}_{t-1} + \widehat{e}_{1t} \quad (4)$$

$$\widehat{G}_t = -0.10 + 0.15\widehat{H}_{t-2} + 0.25\widehat{E}_{t-3} + 0.84\widehat{P}_t + 0.7\widehat{G}_{t-1} + \widehat{e}_{2t} \quad (5)$$

$$\widehat{L}_t = -0.41 + 0.08\widehat{H}_{t-4} + 0.54\widehat{E}_t + 0.78\widehat{L}_{t-1} + \widehat{e}_{3t} \quad (6)$$

Equation (4) presents the estimated results of function of higher education, while Equation (5) and Equation (6) denote the estimated results of functions of economic development and employment relatively. All estimated coefficients of exogenous variables are statistically significant and have obtained the expected positive sign, as we can observe from the above empirical results.

The two-stage estimation results for Greece showed that:

- When GDP, employment and technology increase by one unit then higher education increases by 0.63, 0.35 and 0.17 respectively.
- When higher education, educational expenditure and productivity increase by one unit then GDP increases by 0.15, 0.25 and 0.84 respectively.

- When higher education and educational expenditure increase by one unit, then employment increases by 0.08 and 0.54 respectively.
- Economic development, employment and technology positively and directly affect higher education.
- Higher education, educational expenditure and productivity positively and directly affect economic development.
- Higher education and educational expenditure positively and directly affect employment.
- Educational expenditure and productivity indirectly affect higher education through economic development.
- Educational expenditure indirectly affects higher education through employment.

The coefficients of determination are quite high, ranging from 0.95 - 0.96, so there is a very good fit of the model, but there may be possibly problems of multicollinearity in the equations of the model, while no problem is observed in the signs and statistical significance of the coefficients of the independents in each equation. The estimations from the simulation model of Greece are depicted in **Figure 1**.

The simulation of the Greece model is relatively good as can be seen by studying the graphical representations of the simulated values of dependent variables, namely higher education (H_f), gross domestic product (G_f), and employment (L_f) in relation to their actual values (H , G , L) as distinguished in **Figure 1**.

To confirm the predictive ability of the estimated model we calculate Theil's indices of inequalities and more specifically, the general index, the bias index, the variance index and the covariance index based on statistical formulas. From the results presented in **Tables 1(a)-(d)**, we conclude that the general index, bias and variance indices of Theil (U) are close to zero, so they are smaller relatively.

Finally, Granger causality finds out the possible existence of causal nexus between education and economic development for Greece, taking into consideration the influence of determinants such as employment, technology and productivity index. The estimations of Granger causality appear in **Table 2** and causal relations of examined variables are illustrated in **Figure 2(a)** and **Figure 2(b)**.

The results of the causal relations are presented as follows:

- One-way causality from higher education to economic development.
- One-way causality from higher education to employment.
- One-way causality from education expenditure to economic development.
- One-way causality from education expenditure to employment.
- One-way causality from technology to productivity.
- Bilateral causality between economic development and productivity.
- Bilateral causality between productivity and employment.
- Bilateral causality between technology and higher education.

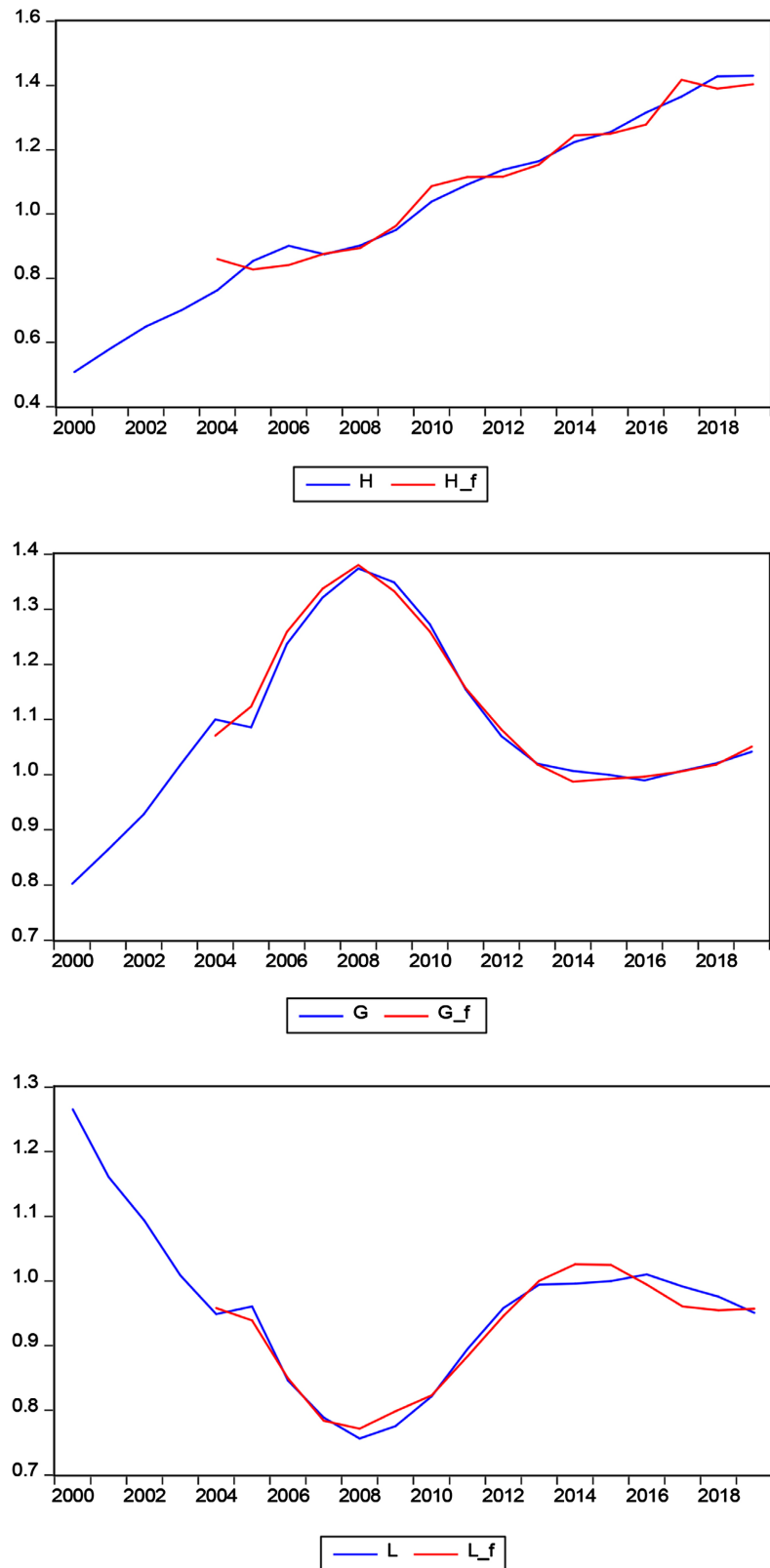
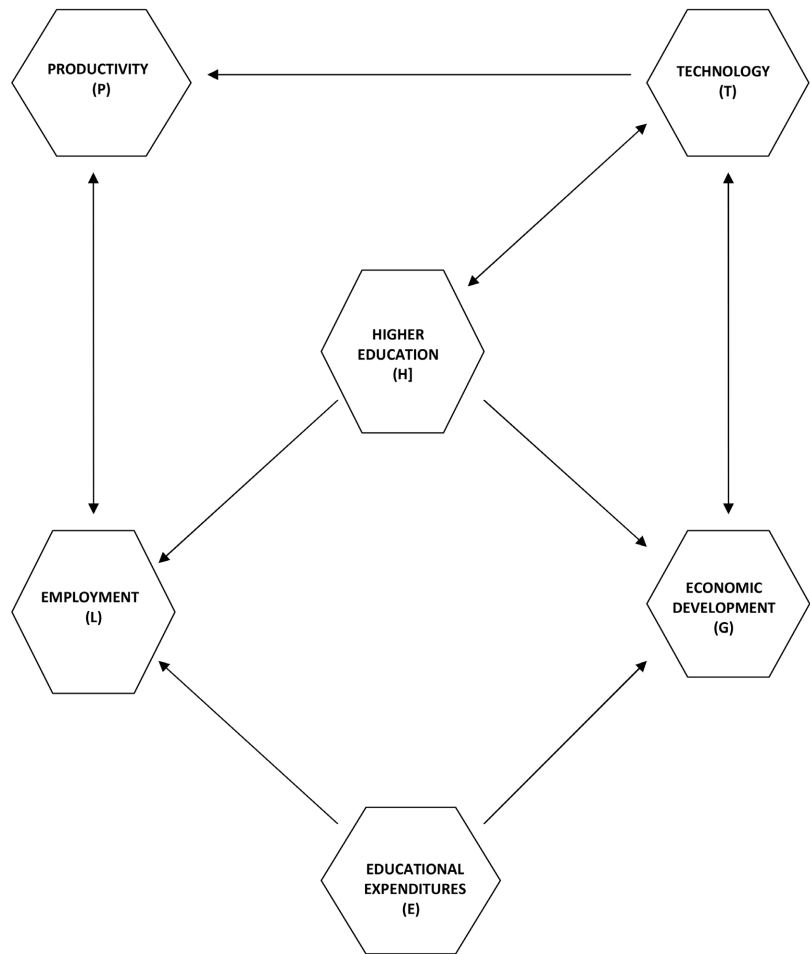
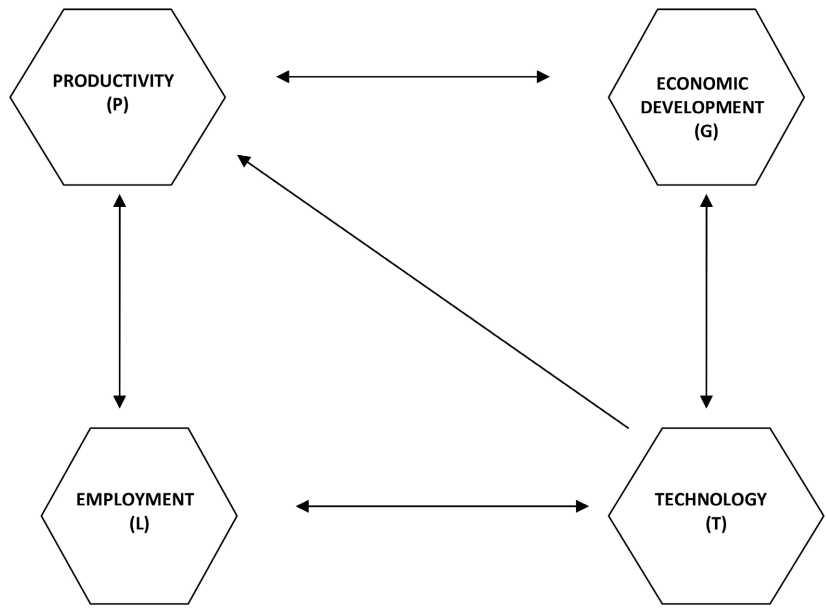


Figure 1. Sensitivity analysis. Blue line represents the real values of dependent variables, while red line expresses the simulated values of variables in vertical axis; years are presented in horizontal axis.



(a)



(b)

Figure 2. (a) Causal relations, (b) Causal relations.

Table 1. (a) Theil index (U), (b) Bias index (U^B), (c) Variance index (U^V), (d) Covariance index (U^{Cl}).

(a)		
U Theil _H	U Theil _G	U Theil _L
0.0172	0.0071	0.0094
(b)		
U^B Theil _H	U^B Theil _G	U^B Theil _L
0.0013	0.0095	0.0001
(c)		
U^V Theil _H	U^V Theil _G	U^V Theil _L
0.0386	0.0195	0.0361
(d)		
U^{Cl} Theil _H	U^{Cl} Theil _G	U^{Cl} Theil _L
0.9599	0.9709	0.9637

Table 2. Granger causality.

Initial hypothesis	F-statistic tests	Probability values
G ≠ H	0.45	0.52
H ≠ G	3.44	0.09
T ≠ H	5.77	0.03
H ≠ T	6.17	0.03
L ≠ H	0.51	0.49
H ≠ L	3.95	0.07
E ≠ G	3.39	0.09
G ≠ E	0.68	0.43
T ≠ G	10.37	0.00
G ≠ T	2.91	0.11
P ≠ G	16.90	0.00
G ≠ P	29.36	0.00
L ≠ E	0.66	0.43
E ≠ L	4.54	0.05
L ≠ T	3.33	0.09
T ≠ L	10.17	0.00
P ≠ T	0.00	0.97
T ≠ P	3.59	0.08
P ≠ L	15.47	0.00
L ≠ P	18.48	0.00

Note: ≠ symbolizes (does not Granger Cause).

- Bilateral causality between technology and employment.
- Bilateral causality between technology and economic development.

5. Discussion

The least empirical studies examine simultaneous equation models in inquiring the interrelation between education and development considering the modern literature review. In contrast, most empirical studies are focused on the estimation of single linear or exponential functions by choosing the panel data analysis and applying time series theory.

Therefore, this study attempts to cover possible theoretical and empirical gaps based on the previous research that has been conducted, while it highly focuses on discovering the direct and indirect effects on education, as well as the possible existence of causal relation between education and development taking into account some exogenous factors such as technology and employment.

For this purpose, two-stage least squares process estimates a structural system equation model, while the Monte Carlo simulation technique inquires the predictive ability of the estimation model, but also the Granger causality reveals the causal relations of the model's variables.

The subject discussed in this study is particularly current and arouses the interest of the researchers both theoretically and empirically. Most empirical studies ignore the impact of natural capital on education, while other studies emphasize either at the usage of a small sample size or at the application of inappropriate econometric methods. Dummy variables could be used in this empirical research in order to study the effects that have been caused by unforeseen events such as either an economic crisis or an accidental historical event.

The limitations of this empirical study concern the interrelation between education and development only for one country and also are concentrated on the size of the sample period and the selected variables of the estimated model.

Consequently, future research topics should be focused on:

- Extension of the sample size by including more countries.
- Estimation of econometric model by using dummy variables.
- Estimation of dynamic multipliers for the sensitivity analysis of the model.
- Conduction of future economic forecasts and formulation of policy implications in the field of education.
- Implementation of a business plan for the better organization and operation of educational system through the preparation of economic studies.
- Assessment of the effectiveness of leadership in education through the creation of a new innovative educational development model.

6. Conclusion

In this research, the empirical nexus between education and economic development was examined, taking into account the influence of direct factors such as technology and employment, but also indirect factors such as productivity level.

The conclusions of the empirical analysis resulted that economic development, employment and technology affect positively and directly higher education in Greece and education expenditure affects positively and indirectly higher education through employment.

Finally, it was proven that higher education caused economic development and employment in Greece over the period 2000-2019, while there is a bilateral causality between technology and higher education.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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