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PUBLIC INVESTMENT IN HUMAN CAPITAL AND ECONOMIC GROWTH IN ALGERIA: AN EMPIRICAL STUDY USING ARDL APPROACH

Mohamed Ramli, ORCID: 0000-0002-5001-6583,
Faiçal Boutayeba, ORCID: 0000-0002-9014-4694,
Azzeddine Nezai*, ORCID: 0000-0003-0091-2993

University of Saida Dr Moulay Tahar, Elnasr BP138, Saida, Algeria.
*Corresponding author: Azzeddine Nezai, *nezai.azzeddine@gmail.com*

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Abstract. This paper examines the link between public investment in human capital and economic growth in Algeria over the period 1990 - 2017. To do so, public expenditures on education and health have been used to investigate their impact on economic growth. The study employs the autoregressive distributed lag (ARDL) approach. The main finding of this paper is that there is no cointegrating relationship between these two variables in the long run. This evidence suggests rethinking the way the public funds are devoted to the education and health sectors. This becomes today a chief priority for policy makers in order to strengthen the impact of public investment in human capital on economic growth in the future.

Keywords: *Education, Health, Economic growth, ARDL, Human Capital in Algeria.*

Rezumat. Lucrarea examinează legătura dintre investițiile publice în capitalul uman și creșterea economică în Algeria în perioada 1990 - 2017. Pentru a face acest lucru, cheltuielile publice pentru educație și sănătate au fost folosite pentru a investiga impactul acestora asupra creșterii economice. Studiul folosește abordarea lagului distribuit autoregresiv (ARDL). Principala constatare a acestei lucrări este că nu există o relație de cointegrare între aceste două variabile pe termen lung. Aceste dovezi sugerează regândirea modului în care fondurile publice sunt alocate sectoarelor educație și sănătate. Aceasta devine astăzi o prioritate principală pentru factorii de decizie politică pentru a consolida impactul investițiilor publice în capitalul uman asupra creșterii economice în viitor.

Cuvinte cheie: *Educație, Sănătate, Creștere economică, ARDL, Capital uman în Algeria.*

Introduction

In early 1960s, the theory of human capital emerged as a new revolution in economic thought thanks to the seminal contributions of some famous American economists like Schultz [1, 2], Becker [3], and Mushkin [4]. The starting point of this theory is that spending on education and health is a form of investment in human capital. In light of this, pubic as well as private expenditures on education and health yield various economic and noneconomic benefits. At the aggregate level, the evidence suggests that education and health status is closely related to national income. Theoretical literature provides a number of arguments that explain the causal relationship between human capital and economic growth. Lucas [5] states that public investment in education and health contributes to improving the quality of the workforce and therefore to increasing productivity. Romer [6] considers the accumulation of human capital as a prerequisite for the promotion of innovation, a vital engine of technological progress. In addition, Benhabib and Spiegel [7] indicate a certain level of human capital necessary to facilitate the diffusion and transfer of technology between countries.

On the other hand, economic growth constitutes the main source of public funding of education and health sectors. Hence, the link between human capital and economic growth is bidirectional. In accordance with this evidence, policy-makers worldwide advocate increased expenditures on both education and health, especially in developing countries where human development is far away from that in developed countries.

In Algeria, tremendous funds have been devoted to education and health sectors since independence. Public expenditures have been evolving over time to overcome social needs as a result of accelerated demographic growth, and to fulfill the economic requirements of the national economy. With respect to education, the overall public spending rose from 2.3 to 9.2 billion dollars between 2000 and 2018. Likewise, public health expenditures per capita increased from 278$ (PPP) in 2000 to 975$ in 2017. Meanwhile, GDP per capita increased from 1765$ in 2000 to 4278$ in 2018.

In light of this, the main objective of this research paper is to assess empirically the link between public investment on human capital and economic growth in Algeria over the period 1990-2017.

The paper is organised as follows: the second section presents an overview of the nexus between human capital and economic growth. The third section offers some empirical studies. The fourth section introduces data and methodology, while the fifth section presents and discusses the empirical findings. Finally, the conclusion is in the sixth section.

Theoretical Background

Human capital is accumulated by investing mainly in people's education and health. Economists as well as policy-makers believe that human capital accumulation impacts positively economic growth. As far as education is concerned, a large body of literature argues that investing in education boosts economic growth. According to Stevens and Weale [8], there are two reasons for expecting to find some link between education and growth. First, since 1800, living standards have raised so much because of education. Second, many econometric studies suggest that individuals' earnings depend on their level of education, evidence that is true for countries. In light of this fact, theoretical growth literature emphasizes at least three channels by which education may affect growth according to Hanushek and Wossman [9]: first, education can enhance competencies of the labour force, which raises labour productivity as in augmented neoclassical growth theories, cf. Mankiw and al. [10]. Second, education can boost the innovative capacity of the economy, and the new knowledge on new technologies strengthens growth. cf. Lucas [5] and Romer [11]. Third, education can facilitate the diffusion and transmission of knowledge which promotes growth, cf. Nelson and Phelps [12]. Despite these strong theoretical arguments, there are still mixed and conflicting empirical findings.

Thus, the causal effect of education on growth is neither mechanical nor inevitable. Many studies did not find a link between education and growth in many countries, and some of them; rather, found a negative relationship between them. In fact, there are a series of reasons behind these findings. The first one consists in focusing on education quantitative measures (such as years of schooling) rather than qualitative ones. Aghion and Howitt [13], for instance, find that a one-standard-deviation increase in science test results would enhance the growth rate by 1% per year. In contrast, a one-standard-deviation rise in school attainment would increase the growth rate by only 0.2% per year. In addition to the education measurement problem, there is a variety of econometric approaches used in the literature. Also, the data considered are different in their nature and size. Furthermore, countries are heterogeneous in their economic structure and institutions.

With regard to health, Churchill et al [14] showed that the effect of healthy growth has not received much attention in the literature compared to the effect of education growth. Although the data show clearly the positive association between health status and economic development stage, the causal effect of health on growth is subject to controversy in the literature. In his seminal paper entitled “health as an investment” published in 1962, Mushkin [4] argues that health affects positively growth in the United States. But it is until the 1990s where scholars began investigating deeply the nexus between health and growth at the cross-section level. Most of them found a positive effect of health measures on growth (see Barro [15], Barro [16], Bloom et al. [17], and Weil [18] for a review).

On contrary, other studies rejected such an effect, though some of them found a negative effect of health on growth in many countries as in Acemoglu and Johnson [19]. In terms of assessing the impact of health on growth, David E et al. [2] provided two main approaches. The first consists in microeconomic estimates of health effects to calibrate its size at the aggregate level, and the second is to estimate the aggregate link directly using macroeconomic data. For the studies that argued a positive effect of health on growth, there are various mechanisms that explain such an effect. By and large, literature highlights four mechanisms. First, health affects directly growth by increasing labour productivity. Second, health impacts indirectly growth by accumulating human capital since health can improve school attendance and cognitive skills. Third, health contributes to accumulating physical capital by rising saving (the incentives to save for retirement). Four, health leads to fertility reductions. Beyond these theoretical statements, there are many difficulties surrounding the assessment of the relationship between health and growth. David E et al. [2] stated three problems, which is the nexus between these two variables is unclear due to bidirectional causality between them, and the link between health and growth varies given the health measures considered (age, gender, and socioeconomic status). Finally, health interventions differ widely between developed and less-developed countries.

Empirical Evidence

As far as academic research is concerned, a myriad of empirical studies have examined the effect of public spending on education and health on economic growth. For instance, Eggoh et al. [20] explored the link between human capital components and economic growth for a sample of 49 African countries over the period (1996 - 2010). Using traditional cross-section and dynamic panel techniques, the authors find that government expenditures on education and health negatively influence economic growth; however, human capital stock indicators have a slight positive impact. They find also education and health expenditures are complementary.

Maitra and Mukhopadhyay [21] investigated the impact of public investment on education and health on the economic growth of 12 countries in Asia and the Pacific over the time period (1980-2010). They used cointegration and VECM techniques.

The findings were mixed; in six countries (Bangladesh, Kiribati, Malaysia, Maldives, Philippines, and South Korea) there are cointegrating relations while in the other six countries, there are no cointegrating relations (Fiji, Nepal, Singapore, Sri Lanka, Tonga and Vanuatu).

In a meta-analysis study, Churchill et al. [14] used a sample of 306 estimates drawn from 31 primary studies and conducted an empirical synthesis of the relationship between government spending on education or health and growth. They found government education expenditures affect growth negatively. However, when they used government expenditures on both education and health as a combined measure, they found a positive growth effect. The study revealed also the factors that explain the heterogeneity in the literature. They are mainly econometric specifications, publication characteristics, and data characteristics.

Regarding the empirical evidence on the impact of public spending on education and health on economic growth in Algeria, most studies focused separately on one of the human capital components (either education or health expenditures). The studies that combine both education and health include, in addition to public spending on education or health, other measures such as years of schooling or rates of enrolment for education, and life expectancy or infant amorality for health. Mokhtari [22] investigated the main sources of economic growth in Algeria over the period (1970 - 2002).

Using Granger causality, he revealed the absence of causality between public spending on education and economic growth in both directions. In contrast, Ahmed and Bengana [23] examined the relationship between government expenditures on education and growth during [23]. They used Granger causality and cointegration techniques, and found a long-run equilibrium between the two variables in addition to the existence of causality between them in both directions.

On the other hand, Messaili and Tlilane [24] assessed the contribution of health to economic growth in Algeria over the period (1974 - 2013). Among the proxy variables used for health, they included public spending on health.

By using the ARDL approach, they found this one affects positively and significantly economic growth. Likewise, Boussalem et al. [25] investigated the causality and cointegration relationships between government spending on health and economic growth during (1974 - 2014).

The study revealed a long–run equilibrium between these two variables; however, it showed that causality runs only from economic growth into government spending on health.

Data and Methodology

The methodology of this research paper is driven by the need to investigate the effect of public investment in human capital on economic growth in Algeria. This section displays the size of the data sample, definition of variables, in addition to the specifications of the study model. This paper is also based on annual time series data ranged from 1990 to 2017. The data are obtained from the World Bank database.

The model used in this paper is based on the study of Bokhari [26] as follows:

$$Y = f(H, K, E) \tag{1}$$

After introducing logarithm in both sides, the model becomes in the following form:

$$\ln Y = \alpha_0 + \alpha_1 \ln H + \alpha_2 \ln K + \alpha_3 \ln E + \mu_i, \quad (2)$$

Where:
Y : is real GDP per capita;
H : is real is expenditures on health;
K : is physical capital measured by the Gross Fixed Capital Formation;
E : is expenditures on education;
μ_i : is random disturbance term;
α_0, α_1, α_2, α_3 : are the respective parameters.
Thus, the model used for estimation is given as follows:

$$\ln GDP = \alpha_0 + \alpha_1 \ln H + \alpha_2 \ln K + \alpha_3 \ln E + \mu_i \quad (3)$$

All variables are measured in real terms, and they are all of them expressed in logarithm.

Results and Discussion

Table 1 shows the variables to be taken into account in this paper and their measurements.

Table 1

The Results of Unit-Root Estimation

Variables	Augmented Dickey-Fuller test statistic			Philips Perron test statistic		
	Intercept & trend	Intercept	None	Intercept & trend	Intercept	None
$\ln GDP$	-3.434654 (0.0677) ***	- -	- -	-3.244546 (0.0972) ***	- -	- -
D($\ln GDP$)	-3.535422 (0.0563)	-3.721133 (0.0098)*. **.***	- -	-3.498629 (0.0605)	-3.696229 (0.0104)*. **.***	- -
$\ln H$	-3.423889 (0.0691) ***	- -	- -	-3.423889 (0.0691) ***	- -	- -
D ($\ln H$)	-9.013764 (0.0000)	- -	-8.032099 (0.0000)*. **.***	-9.013764 (0.0000)	- -	- 7.481609 (0.0000)*. **.***
$\ln K$	-2.797564 (0.2104)	- -	- -	-5.796629 (0.0003)*.**. ***	- -	- -
D($\ln K$)	-5.952730 (0.0003)	- -	-2.792516 (0.0072)*. **.***	- -	- -	- -
$\ln E$	-2.274073 (0.4329)	- -	0.950339 (0.9044)	-2.333838 (0.4031)	- -	- -

Continuation Table 1

D($\ln E$)	-5.199853 (0.0015)	- -	-5.058759 (0.0000)*. ** ***.	-5.199853 (0.0015)	- -	-5.029942 (0.0000)*. ** ***.

Note: *, **, *** represent significance at 1%, 5% and 10% respectively.

Source: Authors' Computation.

By employing *ADF* and *PP* unit root tests, all variables are non-stationary at level I(0), but they are stationary after taking the first difference I(1) except the ($\ln K$) variable which is stationary at level when using *PP* unit root test. Moreover, some variables have a difference stationary (DS) specification while others have a trend-stationary specification.

Based on the stationary results obtained, the autoregressive distributed lag (ARDL) approach can be used to estimate the link between human capital and economic growth in Algeria. This approach popularized by Pesaran and Shin [27], Pesaran, et al [28] is used to investigate the relation between the variables under study.

Table 2 displays the estimation of the model (3) by using ARDL approach. In this model, the dependent variable is real GDP per capita while the dynamic regressors are: the real GDP per capita with one lag, expenditures on health, physical capital measured by the Gross Fixed Capital Formation without lag, and expenditures on education with four lags.

Table 2

ARDL Model Estimation Results

Variables	Coefficient	Std. Error	t-Statistic	Prob
$\ln GDP$ (-1)	0.743852	0.222433	3.344162	0.0048
$\ln H$	0.043224	0.030504	1.417025	0.1783
$\ln K$	0.131286	0.238343	0.550829	0.5904
$\ln E$	-0.007490	0.035798	-0.209234	0.8373
$\ln E$ (-1)	-0.051474	0.035179	-1.463192	0.1655
$\ln E$ (-2)	0.000977	0.039714	0.024603	0.9807
$\ln E$ (-3)	-0.009479	0.032178	-0.294594	0.7726
$\ln E$ (-4)	-0.063843	0.024616	-2.593562	0.0212
C	5.290718	4.992031	1.059833	0.3072
@TREND	0.005274	0.009680	0.544850	0.5944

R-squared	0.998559	Mean dependent var	25.64137
Adjusted R-squared	0.997632	S.D. dependent var	0.253843
S.E. of regression	0.012352	Akaike info criterion	-5.655592
Sum squared resid	0.002136	Schwarz criterion	-5.164736
Log likelihood	77.86710	Hannan-Quinn criter	-5.525367
F-statistic	1077.664	Durbin-Watson stat	2.087458
Prob(F-statistic)	0.000000		

Source: Authors' Computation.

The results in Table 2 came after having determined the appropriate lag structure that allowed this estimated model to be free of econometric problems, which were determined according to Akaike Criterion Information: ARDL (1.0.0.4) as Figure 1 shows:

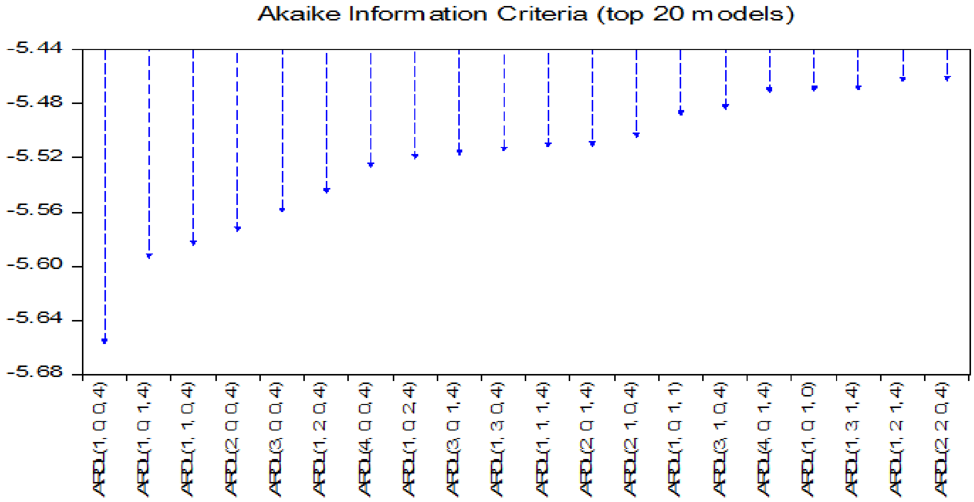
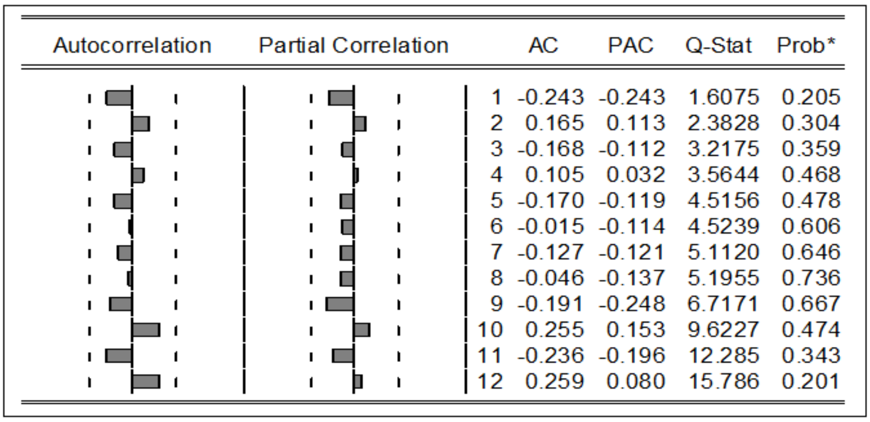


Figure 1. Lag Length Selection.
Source: Authors' Computation.

Figure 2 shows that there is no autocorrelation of residuals in the model. Besides, Figure 3 denotes that the residuals are normally distributed since the probability is higher than 5%.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.243	-0.243	1.6075	0.205
		2	0.165	0.113	2.3828	0.304
		3	-0.168	-0.112	3.2175	0.359
		4	0.105	0.032	3.5644	0.468
		5	-0.170	-0.119	4.5156	0.478
		6	-0.015	-0.114	4.5239	0.606
		7	-0.127	-0.121	5.1120	0.646
		8	-0.046	-0.137	5.1955	0.736
		9	-0.191	-0.248	6.7171	0.667
		10	0.255	0.153	9.6227	0.474
		11	-0.236	-0.196	12.285	0.343
		12	0.259	0.080	15.786	0.201

Figure 2. Correlogram of Residuals.
Source: Authors' Computation.

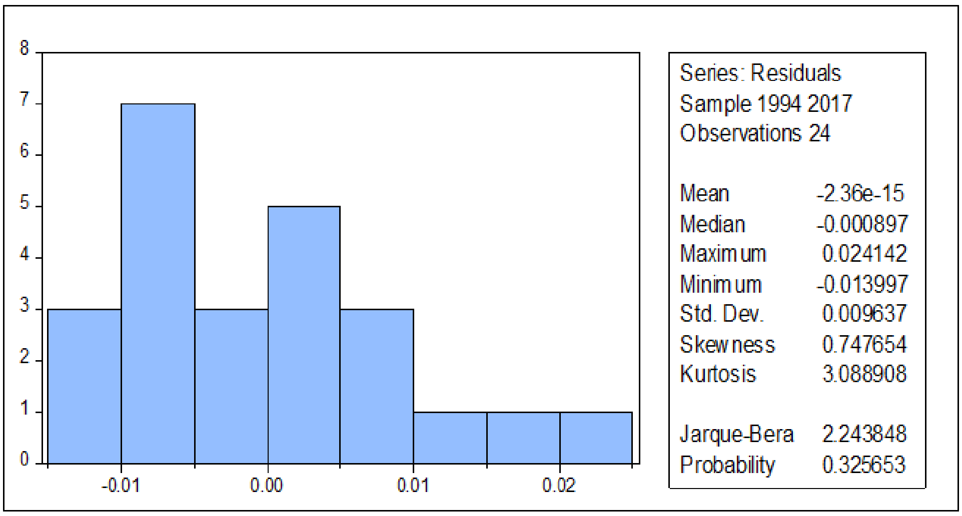


Figure 3. Normality Test for Residuals.
Source: Authors' Computation.

On the other hand, we use also another test that detects the risk of second-degree autocorrelation. This test is Breusch–Godfrey serial correlation *LM*. The results in a Table 3 show that the probability associated with Fisher's statistic (F-statistic) equals 0.8817 and the probability of Chi-Square equals 0.7795. Both of them are more than 5%, therefore, one can conclude that there is no autocorrelation of residuals.

Table 3

Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.127188	Prob. F(2,12)	0.8817
Obs*R-squared	0.498190	Prob. Chi-Square (2)	0.7795

Source: Authors' Computation.

In addition, there is no problem with error variances, which means that they are constant over time. Based on Table 4, and according to the ARCH heteroskedasticity test, the probability value of Fisher's statistic (Prob. F(1.21)) equals 0.2525. In addition, the probability value of Chi-square observations (Prob. Chi-Square (1)) equals 0.2330. These two results are higher than the critical probability value of 5%. Thus, the model is not suffering from heteroskedasticity problem.

Table 4

ARCH Heteroskedasticity Test

Heteroskedasticity Test: ARCH			
F-statistic	1.384531	Prob. F(1.21)	0.2525
Obs*R-squared	1.422599	Prob. Chi-Square (1)	0.2330

Source: Authors' Computation.

Based on Table 2, the long run form and bounds test has been used to find out the equilibrium relationship. Their results are shown in Table 5. In fact, the relationship is completely unknown at 10% because it falls within the area of suspicion (between lower and upper bounds). Its statistical value F-statistic 4.121209 obtained from the results of bounds test of the public investment in human capital and economic growth in Algeria falls between the upper I(1) and lower I(0) critical value bound.

Table 5

Results of Bounds Test Approach to Cointegration

F-Bounds Test			**Null Hypothesis: No levels relationship**	
Test Statistic	Value	Signif.	I(0)	I(1)
			Finite Sample: n=35	
F-statistic	4.121209	10%	3.8	4.888
Actual Sample Size	3	5%	4.568	5.795
		1%	6.38	7.73
t-Bounds Test			**Null Hypothesis: No levels relationship**	
Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-1.151575	10%	-3.13	-3.84
		5%	-3.41	-4.16
		1%	-3.96	-4.73

Source: Authors' Computation.

Consequently, the null hypothesis cannot be rejected, so there is no cointegrating relationship between public investment in human capital and economic growth in Algeria in the long run.

As for the rest of the significance levels 1% and 5%, respectively, there is no equilibrium relationship between these variables, because the F-statistic value 4.121209 is evidently below the I(0) critical value bound. Consequently, the alternative hypothesis is rejected and the null hypothesis is accepted, which indicates no equilibrating relationship between the variables of this study. Also, these results are also confirmed by using t-statistic.

Among the sensitive technical econometric issues is that the estimated parameters for this model by the autoregressive distributed lag (ARDL) approach must be constant during the study period. In such a case, there is no structural imbalance over time, and there is only one estimated equation for this study. Based on the Figure 4, the cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) of the recursive residuals tests show that the parameters of the estimated model appear constant. The results confirm the stability of coefficients since the (CUSUM) and (CUSUMSQ) statistics do not exceed 5% critical bounds of parameter stability.

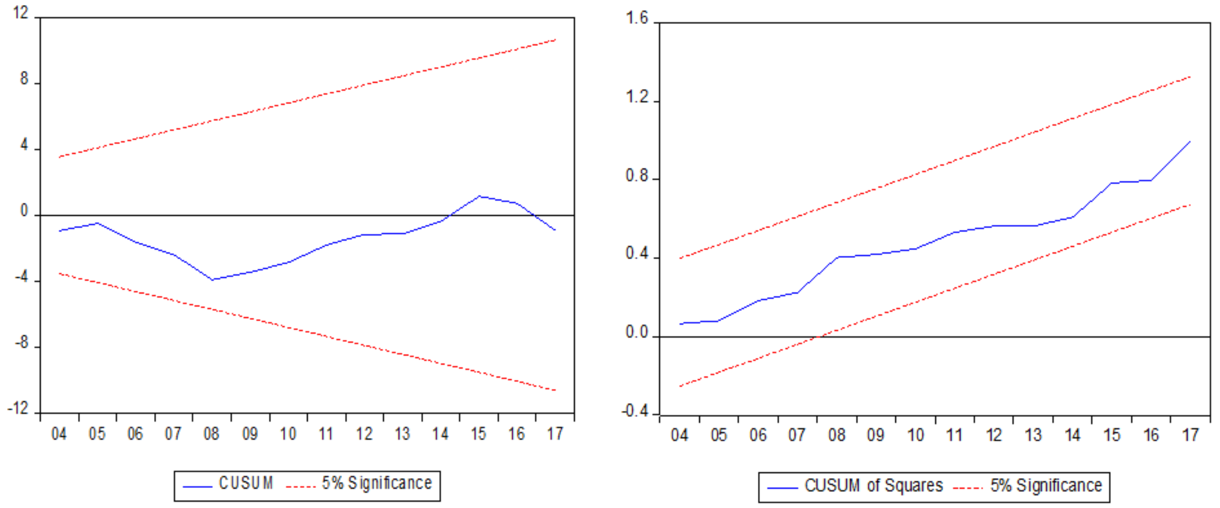


Figure 4. Plot of CUSUM and CUSUMSQ of Recursive Residuals.
Source: Authors' Computation.

The lack of any co-integrating relationship between public investment in human capital and economic growth in Algeria and its absence entirely at levels of significance by the autoregressive distributed lag (ARDL) approach reflects the failure of adopted policy, the small funds allocated to education and health sectors as a percentage from gross national income. In addition, incentives for innovation and creativity are not enough to spur growth. Consequently, the educational outcomes are not compatible with the requirements of the Algerian economy and the focus on quantity rather than the quality of graduates from education establishments will never change the current situation. All these facts lead to the absence of any impact of public investments in human capital on economic growth.

Conclusions

This paper aimed to investigate the relationship between public investment in human capital (education and health) and economic growth in Algeria. During the last decades, Algerian authorities devoted increasing funds to finance education and health sectors in order to meet social needs. In fact, it has been a big challenge for policy makers to keep up with the accelerated demographic growth.

Theoretically speaking, scholars argue that, for developing countries, investing in human capital is a sine qua none condition to spur growth and cutch up developed countries. However, a large body of empirical literature conclude contradictory findings. In Algeria, for instance, many studies found a positive association between public investment in human capital and growth while other studies did not find any association.

In this paper, and by using an ARDL approach, we concluded that public investment in human capital and growth are not cointegrated in the long run in Algeria. This evidence suggests that public policy in this regard failed to achieve the objective. Therefore, it is highly recommended to policy makers to rethink the current policies in terms public funding and try to fund efficiently strategic sectors such as education and health.

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