Econometric Study of the Impact of Public and Private Investment on Economic Growth in Algeria during the Period (1970-2017)

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Authors' contributions

This work was carried out in collaboration between both authors. Author HA designed the study, wrote the protocol and wrote the first draft of the manuscript. Reviewed theoretical and empirical literature, developed the model of the study, did the econometric analysis and interpretation. Author TF supervised the research process and edited the final manuscript. Both authors read and approved the final manuscript.

Original Research Article

ABSTRACT

This article examines the impact of public and private investment on economic growth in Algeria covering the period from 1970 to 2017. By applying the Auto-Regressive Distributed Lag model (ARDL)-(bounds testing approach).
The key findings of the study concluded that there is a long-run relationship between public and private investment and economic growth in Algeria.
The result of the Augmented Dickey Fuller unit root test (ADF) showed that the variables are stationary at the level and at the first difference. In addition, the results of the cointegration test indicated that the variables are cointegrated and therefore have the ability to move together over the long term.
The parsimonious error correction mechanism showed that private investment is significantly related to economic growth. The result indicated that a 1 percent increase in the present value of private

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investment, on average, stimulates economic growth by 0.09 percent. Similarly, the value of public investment is positively related to economic growth. On average, a 1 percent increase in public investment stimulates growth in Algeria by 0.05 percent.

the results of short-run dynamics reveal that, the error correction term (ECM) is negative and significant (-0.54), which means that 54% of the disequilibrium will be adjusted annually.

Keywords: Economic growth; public investment; private investment; ARDL model; Algeria.

JEL Classification Codes: E22, O11, O47.

1. INTRODUCTION

Investment is considered one of the most important determinants of economic growth. Given the legal nature of the investment, we have understood that it is divided into public and private investments.

To highlight the Algerian economy, we learned that the Algerian government decided to increase its economy by adopting development plans that extended from 1967 to 1989. First there was the tripartite plan (1967-1969), then the first quadruple plan (1970-1973), followed by the second quadruple plan (1974-1977) [1] ,Then there was the first five-year plan for the period (1980-1984) and the second for the period (1985-1989)[2]. These plans were all focused on reviving industrial activity through massive investments. In this respect, Algeria relied on oil collection as the main source of financing.

However, with the 1986 oil crisis, it reflected the fact that the accumulation system was fragile in the public industrial sector and could not create added value.

Because of the failure of these plans, Algeria began implementing several economic reforms during the transitional period (1991-1998) to reduce dependency on hydrocarbon revenues in financing investments. With the beginning of the year 2000, Algeria embarked on development programs over a period of (15) years, they were three government programs, each one lasted five years. Thus, those programs were used between 2000 and 2015 years.

Given the massive investments throughout this period, we wonder about the effects of these investments on economic growth. To this end, we assume that public and private investments have a positive effect on economic growth in Algeria. In order to determine the extent of the contribution of public and private investment to the growth, we will use modern econometric techniques. We will also observe the relationship between investment (public and private) and economic growth using the ARDL methodology.

Numerous empirical and theoretical studies have tried explaining the differences in economic growth rates between countries, Where, Investment is generally the main focus in the analysis of economic growth. Also, Empirical studies linking economic growth to capital formation have suggested that fixed investment has a major influence on economic growth.

2. LITERATURE REVIEW

Arrow & Kurz [3] suggested dividing the stock of material capital used in the public sector into two parts, productive and non-productive. Rather, they prefer to distinguish between the effects of the accumulated investments of public capital according to their impact on either production or consumption. The first effect is the contribution of public capital to the productivity of the private sector leading to its incorporation as productive expenditures. As for the second effect of this capital, which is considered unproductive, it appears directly in changing the utility function. The Unproductive investment aims to increase the productive capacity of society but indirectly, such as investment in the fields of health, education, and training, where Pradel[4] sees that unproductive investment is that investment that does not lead to an increase in the productive capacity of society in something, such as Building and military equipment and weapons.

Gaffard[5]argued that if the public investment (in infrastructure) is excessive or ineffective, expenditures that are identical to private expenditures in luxury goods are expenditures that do not contribute to future production.

According to Khan & Kumar[6] the impact of public and private investment on economic growth differs significantly, as private investment is more productive than public sector investment.

The infrastructure works to remove market distortions, and thus the state's intervention HERRERA[7]justifies that partial economic studies recorded a decrease in production costs and transactions for the private sector resulting from the infrastructure in addition to the extension of markets and the spread of technical progress, especially in developing and emerging countries.

The Erenburg study [8] concluded that there is a positive relationship between public investment spending and private investment spending. Investing in infrastructure contributes to the efficiency and profitability of private investment through external savings.

In a study Khan & Reinhart[9] on investment and economic growth in developing countries, it was shown that the most important economic problems that these countries suffer from were low growth rates, high inflation rates, high external debt burden, a deficit in the trade balance, and low living standards. The production function has been applied in the study through which the impact of government investment and private investment on the process of economic growth has been demonstrated. As the study showed, it is not necessarily to be a reciprocal relationship between private investment and government investment, but government investment may be a complement to private investment. The study also showed that the impact of private investment on the economic growth process is greater than the impact of government investment. Also, private investment has a direct and broader effect on economic growth in the long run compared to public investment. According to these two economists, investment in the public sector cannot achieve a significant impact on the productivity of private capital formation unless solid infrastructure is established (roads, electricity, telecommunications and schools).

A study Odedokun[10] examined the primary and long-term effects of public and private investment spending on economic growth in developing countries during the period (1965-1990). The study used statistical data on 48 developing countries and through a method of experimental and comparative analysis. To the following: The public investment spending, particularly on infrastructure projects in developing countries, has provided great facilities for private investment, especially in the long run and promoted efficiency and economic growth in those countries, while public investment spending on other projects (other than infrastructure projects) did not have this influence. In the long run, public and private investment spending has had more positive effects on both efficiency and economic growth than in the short term.

Erum, Hussain and Yousaf [11] propagated the empirical study that examined the growth and FDI in SAARC countries. They used the pooled data for 24 years from 1990-2014. They utilized the least square model, Fixed effect model (FED) to measure the dependence variable gross domestic product and independence variable growth rate of labor, domestic capital, FDI and expenditure. The result concludes that foreign direct investment has been a helpful effect on economic development. The Labor has a positive and significant effect on GDP. The effect of government expenditure has a negative and insignificant on GDP. The global study presented investment and (FDI) as an important factor in the economy of the countries.

Zekane[12]in an experimental attempt on the Algerian economy, analyzed the relationship between capital infrastructure and long-term growth using the model of Barro and Aschauer, where he concluded that the relationship between basic structure and economic growth is achieved in the case of Algeria, but with weak flexibility, and this weakness is due to the effect Threshold.

Nguyen CT, Trinh LT. [13] have studied the impact of public investment on private investment and economic growth in Vietnam for the period 1990-2016 using the approach of the autoregressive distributed lag model, The findings indicate that public investment in Vietnam in the past period does affect economic growth in an inverted-U shape effect as of Barro (1990), with positive effects mostly occurring from the second year and negative effects in the long run. Similarly, public investment also has a similar influence pattern on private investment, boosting in the short term but crowding-out in the long term.

Barro [14] showed that public investment has a strong impact on the margin productivity of private capital and labor. Barro showed that the of public investment on growth.

Benabdallah[15]In a theoretical study of the case of Algeria, he tried to analyze the development in Algeria, which is characterized by the continuous interference of the state, where he assessed public investment in general and investment in infrastructure in particular. He concluded that the effect of public investments on economic growth is weak in the short and long term.

Bouyacoub[16] in a comparative study among many countries where the study showed that despite huge investments in Algeria, its impact was modest on economic growth.

3. ANALYSIS OF VARIABLES

Quantitative variables were used in this study to determine the effect of public and private investment on economic growth for the period 1970-2017, as follows: Economic growth, public investment, private investment, labor and inflation.

As Fig. 1 illustrates, private investment growth dominated over public investment growth from 1970 to the end of the 2005s. Economic growth rates were moderate during the period, though oscillating between 7% and 1.5%. However, soon after 1990, private investment steadily grew to economic dominance until 2017 reflecting the adopted market- friendly policies. Economic growth rates responded so positively to the economic arrangement, assuming a general upward growth trend up to 2017. From the analysis, it remains uncertain whether public investment or private investment is more beneficial to economic growth in Algeria.

3.1 Public, Private Investment

It is noticeable that the volume of investments for the two sectors is constantly increasing starting from the year 1970 to its peak in 1977, as can be seen through this form a direct relationship between the size of public investments and the private-sector. It can also be concluded that public investments were a factor driving the private-sector towards investment and It explains the complementarity between the investment of the public sector and the private sector, given the quality of investments pursued by the public sector in the strategy of the industrialized industry, but with the beginning of the eighties, we note a decline in public investments, and it records a coincidence with the decline of private investments that continued despite High public investment is due to the change in the strategy adopted by the public-sector to invest and give up stepwise for productive investments of wealth as a result of the difficulty of financing these investments that are financed through hydrocarbon revenues.

However, from the beginning of the 1990s until 2002, we notice a certain stability in private investments by 30 billion dollars until the year 2000, and public investment was also known as a steady investment in 20 billion dollars during the same period, but with the beginning of economic recovery programs, the volume of Public investment reached its peak in 2007 with an investment volume in above of 50 billion$, while private sector investment achieved 80 billion$ in 2012.
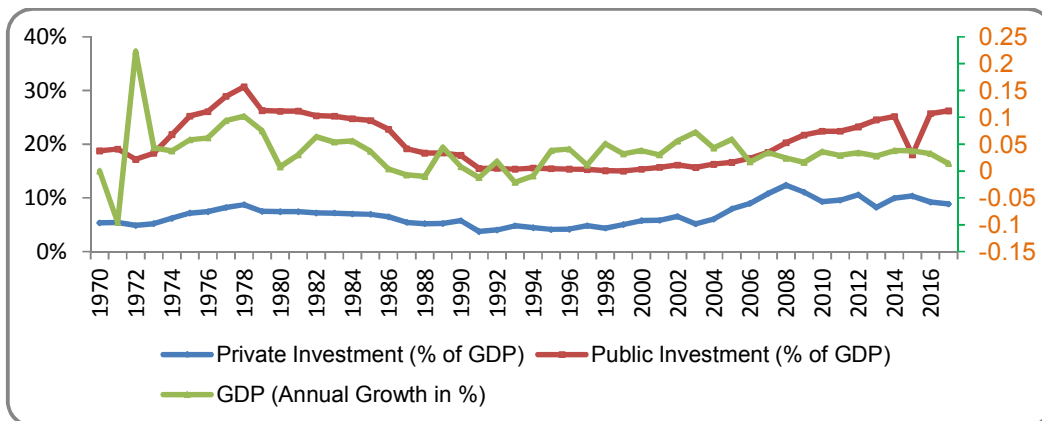

Fig. 1. Trends in Public and Private Investment and Economic Growth in Algeria (1970-2017)
Source: Own processing based on IMF (2019)

3.1.1 Public investment

The investment variable in Algeria is expressed in the raw composition of fixed capital (ABFF), where these data were obtained from the IMF database for the period 1970-2017.

From 1970 to 1989, Algeria implemented several development plans, as the public sector acquired most of the economic activity, which can be presented as follows Benabdallah[15].

The first period (1970-1985): Algeria relied on foreign borrowing to finance the investments achieved during this period, as this period witnessed strong economic growth as a result of an investment in the manufacturing industry, which was abandoned in 1985.

The second period: (1986 - 1994) it was characterized by the difficulty of financing investments. This was due on the one hand to the fall in oil prices, and on the other hand to the high debt burden, which paved the way for the rescheduling of external debt.

The third period: (1995-1994) A structural adjustment program was implemented to revive economic growth. Almost a decade ago, Algeria achieved a significant net saving thanks to oil collection revenues. Part of these savings was used in economic and social infrastructure spending. Some theories as well as the World Bank and the International Monetary Fund recommend the use of these savings in the productive sector, this was for example realized by the State of Norway. The latter has managed to achieve economic growth, unlike some oil countries that have not managed to do so.

Last period: (2000-2014) Algeria embarked on major investments in highways, railways and urban railways, Social and educational housing, dams and financing various policies to help the unemployed find a job, as a way to accompany the material achievements of these investments. As this policy had a major impact on the economic situation of the country. Over a period of twenty (20) years, this corresponds to four (04) consecutive government programs of five years. They are as follows [17]:

- The first program of economic recovery started between the period from September 2001 to December 2003 with afinancial cover of 525 billion dinars.

- The Economic Growth Support Program (PSCE) 2005-2009:with a financial cover of 4200 billion dinars.
- The second program of economic recovery (2010-2014) with a financial cover of 21214 billion dinars (or the equivalent of 286 billion $) This program was adopted by the Council of Ministers on 24 May 2010 [18].
- For the plan made for 2015-2019 a projected allocation of 262 billion dollars was established[19]

3.1.2 Private investment

The period 1971 to 1979 was characterized by the nationalization of the last foreign private companies and by the "underground" development of a private sector made a prudent and discreet following the launching of the Agrarian Revolution and the promulgation of Management Corporate socialist without forgetting that the "exploitative property" condemned by the National Charter (1976) specifically targets the capitalist private sector[20]. With the new development plans and reforms of the early 1980s, the sectors of activity previously considered secondary or parasitic had thus become rapidly, socially strategic and located downstream from the public sector.

The private sector in Algeria, since the end of the 1980s, has continued to grow in importance in the national economy. From 1993, all activities were opened to the private sector, without any investment ceiling. But this new freedom coincided with an unprecedented liquidity crisis. From 1995, thanks to the stabilization of the major financial balances, private entrepreneurs finally had all the tools to manage their business, so the sector could take off. Since 1998, the private sector has overtaken the public sector. It represented 55% of the added value, excluding hydrocarbons, in 2000 against only 37% in 1979. Private SMEs are divided into five major sectors. Transport and trade represent only 10% of companies with more than 10 employees. The private sector has a turnover of 12 billion dollars. Its contribution to value-added reached 55% at the end of 2003. While the public sector was dominant in almost all sectors until 1989, it now dominates only in the steel and mechanical engineering industries. More than 43,000 private investment projects have been identified since 1993, 37% of which are in the industry.

3.2 Labour

The employed labor force in Algeria witnessed a continuous increase, as it multiplied five times during this period and with an average growth rate of 3.9% annually, which moved from 2 million in 1970 to reach 6.5 million in 2000, when the employment growth rate did not exceed 1%, During this year, but with the launching of growth programs for the period 2000-2014, the rate of job growth returned to its level in the range of 4% to the end of 2014 to settle in recent years at a rate of growth of 2% with a workforce estimated at 11 million workers 2017pwt[21].

The largest employer is the government, which claims 32 percent of the workforce. Although the industry is a much larger part of the economy than agriculture. The agriculture sector employs slightly more people (14 percent of the workforce) than industry (13.4 percent of the workforce). One of the reasons for this disparity is that the energy sector is very capital-intensive. Trade accounts for 14.6 percent of the workforce, while the construction and public works sector employ 10 percent, reflecting the government's efforts to upgrade the country's infrastructure and stock of affordable housing.

3.3 Gross Domestic Product

The gross domestic product witnessed a noticeable development from one year to the next, starting from 1970 to the end of 1985, which faded with the beginning of the oil crisis in 1986, so that economic growth is known to be almost stable in its rate.

Due to the decline in the productivity of the production wheel, the growth rate declined from negative values during the period 1990-1994, but with the early 2000s to 2016, the growth rate was in the range of 3.5 percent despite high investment rates [22] [23].

With an average GDP growth of between 3.5% to 4% over the period 2000-2013 and a peak of 5.9% in 2005, Algeria has considerably improved all its economic aggregates and reduced its external public debt to an insignificant level of just over 300 million $, compared with 30 billion $ at the end of the 1990s, according to figures from the Prime Minister's Office [23].

3.4 Inflation

This record a decrease from the previous number of 7.557 % since 2018. Algeria's

Inflation: GDP Deflator data is updated yearly, averaging 12.16 % from December 1970 to 2017, with 46 observations. The data reached an all-time high of 53.78 % in 1991 and a record low of -11.162 % in 2009. Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency. Inflation, GDP deflator (annual %) in Algeria was reported at -0.65% in 2019, World. Bank [24].
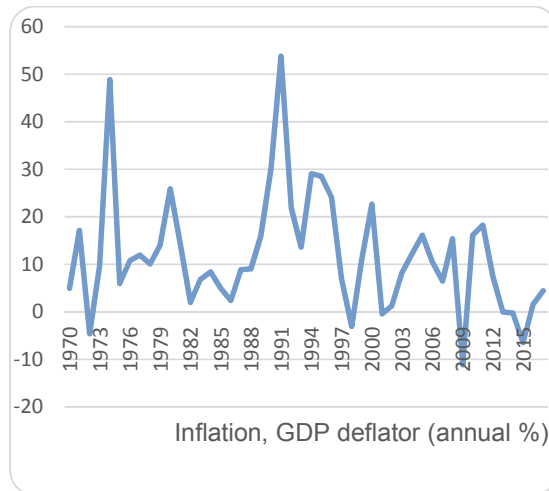

Fig. 2. Inflation, GDP deflator (annual %)
Source: Own processing based on WB (2019).

4. METHODOLOGY AND EMPIRICAL ANALYSIS

The neoclassical growth model framework of Solow [24]has been places and variables adopted in this study. The model has been extensively used by, among others,Khan, & Reinhart [9] to determine the impact of public and private investment on long-term economic growth in developing countries. The framework of the growth model takes as its starting point an aggregate production function of Cobb-Douglas function which related to output to factors inputs and variable referred to as total factor productivity.

4.1 Model Specification and Data Issues

The model aims to clarify the effect of public and private investment on economic growth in Algeria, and for this purpose the following equation will be estimated to measure the impact of public and private investment on economic growth in Algeria for the period 1970-2017:

$$GDP = \alpha + \beta\_1 PIi_t + \beta_2 GI_t + \beta_3 L_t + \beta\_4 Inf_t + \varepsilon_t \quad (1)$$

t=1,2,3 ……….T

Where:

t: Time period.
T: Number of Views.
GDP: Gross domestic product.
GI: public investment.
PI: private investment.
L: labor
Inf: inflation GDP DEFLATOR (ANNUAL %)
ε_t : the error term;
α : Fixed limit
β_s :Coefficients of elasticity of the GDP growth rate.

4.2 Unit Root Test

Since stability of time series is considered as a condition for joint integration, in order to detect the stability of time series and to know the statistical properties of the studied time series in terms of degree of integration, we test the two following hypotheses:

H0: The string has a unit root, that is, it is unstable when ttab<tcal.

H1: the string does not contain the unit root, i.e. (stable chain) ttab>tcal.

This is done using the Augmented Dicky-Fuller unit root test as shown in the following table:

The outcome of the ADF test in Table 2 shows that the variables Log GDP, INF are stationary in levels ,I(o) but the variables log(GI),LOG(PI) and LOG(L) , become stationary after the first differencing, otherwise included of order one, I(1), which is essential, except not sufficient underlying principle for estimating cointegration and correction error models. The ARDL model is the most appropriate model with a sample size of 45 views spanning from 1970 to 2017.

Table 1. Summary of variables used in the study

Variable	Notation	Data source	Unit
Gross domestic product	GDP	International Monetary Fund (version: August 2019)	In billions of constant 2011 international dollars.
Private investment (gross fixed capital formation),	PI	International Monetary Fund (version: August 2019)	in billions of constant 2011 international dollars.
General government investment (gross fixed capital formation),	GI	International Monetary Fund (version: August 2019)	in billions of constant 2011 international dollars.
Labor	L	Penn World Table, version 9.1 (21/03/2019)	Million people
Inflation, GDP Deflator	Inf	World Development Indicators (21/03/2019)	(ANNUAL %)

Source: Author's compilation

Table 2. Stationarity Test of Variables using ADF

At level						
		LOG(GDP)	LOG(GI)	LOG(PI)	LOG(L)	INF
With Constant	t-Statistic	-3.2450	-0.9276	-0.4410	-1.4037	-4.9111
	Prob.	*0.0236****	*0.7707* n0	*0.8933* n0	*0.57*n0	*0.0002*****
With Constant & Trend	t-Statistic	-4.9680	-1.5683	-0.9514	-1.75	-5.1609
	Prob.	*0.0013*****	*0.7905* n0	*0.9409* n0	*0.70*n0	*0.0006*****
Without Constant & Trend	t-Statistic	5.1876	1.8392	2.4906	5.27	-3.1965
	Prob.	*1.0000* n0	*0.9829* n0	*0.9964* n0	*1.000* n0	*0.0020*****
At first difference						
		d(LOG(GDP))	d(LOG(IG))	d(LOG(IP))	d(LOG(L))	d(INF)
With Constant	t-Statistic	-8.1872	-6.4337	-4.8295	-8.1908	-8.5807
	Prob.	*0.0000*****	*0.0000*****	*0.0003*****	*0.000*****	*0.0000*****
With Constant & Trend	t-Statistic	-8.8905	-6.3733	-4.7683	-8.3376	-8.5734
	Prob.	*0.0000*****	*0.0000*****	*0.0019*****	*0.000*****	*0.0000*****
Without Constant & Trend	t-Statistic	-4.5259	-5.9177	-4.3361	-0.9211	-8.6862
	Prob.	*0.0000*****	*0.0000*****	*0.0001*****	*0.3118*	*0.0000*****
Order of integration		I= (0)	I = (1)	I = (1)	I = (1)	I= (0)

Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant
*MacKinnon (1996) one-sided p-values; Source: Estimated by Author

4.3 The Co-integration According to ARDL Model

The joint integration of the model variables is tested by estimating the UECM model and the limits test proposed by [25] appropriate to detect the presence of the joint integration of the model variables according to the following formula:

$$\log(GDP) = \beta_0 + \sum_{i=1}^{p} \beta_i \, logGDP_{t-i} + \sum_{i=0}^{q} \beta_i \, logPI_{t-i} + \sum_{i=0}^{m} \beta_i \, logGI_{t-i} + \sum_{i=0}^{n} \beta_i \, logL_{t-i} + \sum_{i=0}^{n} \beta_i \, logInf_{t-i} + \lambda_1 GDP_{t-1} + \lambda_2 PI_{t-1} + \lambda_3 GI_{t-1} + \lambda_4 L_{t-1} + \lambda_5 Inf_{t-1} + \varepsilon_t \qquad (2)$$

To test for the existence of a common complementarity between variables in the model, we formulate the following assumptions:

The null hypothesis is there is no cointegration $H_0 = \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$

The alternative hypothesis is there is cointegration $H_1 \neq \lambda_1 \neq \lambda_2 \neq \lambda_3 \neq \lambda_4 \neq \lambda_5 \neq 0$

4.3.1 Determine the number of optimal lags

All criteria confirmed that the optimum Lag is 2. After making several attempts we decided to choose this Lag period because it fits with the quality of the model that we are studying.

4.3.2 Estimate the long-run model using the ARDL Model

From Table 4, All long-term coefficients are significant, meaning all model capabilities are significant. The reference to the coefficients is positive, which is consistent with economic theories, and it affects economic growth where: Increasing the labor by 1percent. While keeping the other variables constant leads to an increase in the GDP by 0.66percent. Increasing the private investment by 1percent, while keeping the other variables constant, increases the GDP by 0.09percent. Increasing the public investment by 1percent, while keepingthe other variables constant, increases the GDP by 0.05percent. If we increase one unit in inflation, it will bring a 0.002 percent change in GDP. The fixed limit is significant and positive and is estimated at 4.10. Looking at the regression result in Table 4, it indicates that the private investment coefficient is larger than the public investment coefficient. Therefore, it can be claimed that private investment is more effective in the long run than public investment in Algeria.

4.3.3 The Error Correction Term (ECT)

The error correction term (ECT) represents the speed of adjustment towards the long-run equilibrium, having one period of shock in the model.

Table 3. Lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	92.69960	NA	0.001088	-3.986345	-3.783597	-3.911156
1	114.0921	36.95063	0.000431	-4.913276	-4.669977	-4.823049
2	117.2773	5.356916*	0.000391*	-5.012603*	-4.728755*	-4.907338*
3	117.2964	0.031233	0.000409	-4.968016	-4.643618	-4.847713
4	117.3420	0.072665	0.000428	-4.924638	-4.559690	-4.789297

indicates lag order selected by the criterion

Table 4. Results for Long-run ARDL

ARDL Cointegrating And Long Run Form
Dependent Variable: LOG(GDP)
Selected Model: ARDL (1, 0, 0, 2, 2)

Long run coefficients				
Variable	Coefficient	Std. error	t-Statistic	Prob.
LOG(GI)	0.056470	0.022257	2.537192	0.0156
LOG(PI)	0.096224	0.024141	3.985964	0.0003
LOG(L)	0.666933	0.023258	28.674956	0.0000
INF	-0.002996	0.000902	-3.321158	0.0021
C	4.102185	0.077023	53.259241	0.0000

Source: Estimated by Author using Data from IMF (2019)
*Note: *, ** and *** denotes statistical significance levels at 1%, 5%, 10% respectively*

According to Table 5, in the short run, public and private investment has a positive effect with a small coefficient of 0.03 percent and 0.05percent respectively, and labor also has a positive effect with a coefficient of 0.30percent. On the other hand, inflation has a small negative impact on economic growth.

It is clear that the error correction term (ECT(-1)) of the model is negative and statistically significant at the 1% level of significance. This shows the existence of a long-term adjustment mechanism. The results confirm that economic growth in Algeria has an automatic mechanism that reacts in a balanced way to deviations from equilibrium. The estimated value of (-0.54) for the

ECM coefficients suggests a rapid adjustment strategy of about 54percent.

4.4 ARDL Bounds Test

The Bound Test is the most important test to demonstrate a common complementarity relationship between the interpreted variables and the dependent variable.

- HO: There is no long-term relationship going from the set of variables explained towards the dependent variable.
- H1: There is a long-term relationship that tends from the set of variables explained towards the dependent variable.

Table 5. Short run dynamic of ARDL error correction term (ECT (-1))

Cointegrating form				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLOG(GI)	0.030475	0.012186	2.500699	0.0171
DLOG(PI)	0.051928	0.016128	3.219792	0.0027
DLOG(L)	0.305615	0.088028	3.471788	0.0014
DLOG(L(-1))	0.118419	0.077240	1.533118	0.1340
D(INF)	-0.000554	0.000268	-2.069557	0.0457
CointEq(-1)	-0.539658	0.070027	-7.706475	0.0000
Cointeq = LOG(GDP) - (0.0565*LOG(GI) + 0.0962*LOG(PI) + 0.6669*LOG(L) -0.0030*INF + 4.1022)				

Source: Estimated by Author using eviews10
*Note: *, ** and *** denotes statistical significance levels at 1%, 5%, 10% respectively*

Table 6. ARDL co-integration bound testing approach result

RDL Model	Optimum lag length		F-statistic
Variables LOG(GI) LOG(PI) LOG(L) and INF	(1, 0, 0, 2, 2)		13.80220
Significance level	Critical bound F-values		
	Lower	Upper	
1 per cent	2.45	3.52	
2.5 per cent	2.86	4.01	
5 per cent	3.25	4.49	
10 per cent	3.74	5.06	

Source: authors' computation by using eviews 10

The results of the "bounds test" procedure show that the Fisher statistic (F = 13.80) is greater than the upper limit of the critical value range corresponds to the level 1 %. So, we reject the hypothesis of no long-term relationship, we conclude that there is a long-term co-integration relationship for the estimated model.

4.5 Diagnostic and Stability Tests

4.5.1 Diagnostics tests

In order to check for the estimated ARDL models, the significance of the variables and

other diagnostic tests such as serial correlation, functional form, normality, heteroscedasticity, and structural stability of the model are considered as shown in Table (7) both models generally pass all diagnostic tests in the first stage.

The diagnostic test in Table (7) shows that there is no evidence of autocorrelation, and the models pass the normality and the test proved that the error is normally distributed. The adjusted R bar shows that around 99% of the variation in GDP is explained by the regressors in both models.

Table 7 - Diagnostics tests

Tests				Inference
Heteroskedasticity Test: Breusch-Pagan-Godfrey				
F-statistic	0.7196	Prob. F(8,37)	0.687	
Obs*R-squared	7.0137	Prob. Chi-Square	0.635	
Scaled explained	4.0934	Prob. Chi-Square	0.905	
Heteroskedasticity Test: Glejser				
F-statistic	0.768	Prob. F(8,37)	0.645	No heteroskedasticity
Obs*R-squared	7.413	Prob. Chi-Square	0.594	
Scaled explained	5.321	Prob. Chi-Square	0.805	
Heteroskedasticity Test: ARCH				
F-statistic	0.602	Prob. F(1,43)	0.441	
Obs*R-squared	0.621	Prob. Chi-Square	0.430	
Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.489	Prob. F	0.239	No autocorrélation
Obs*R-squared	3.705	Prob. Chi-Square	0.156	
Tests of Quality				
R-squared	0.998	F-statistic	2094.46	Model is standard
Adjusted R-squared	0.997	Prob(F-statistic)	0.0000	
Test of Normality				
Jarque-Bera	0.029	Probability	0.985	The residuals have a standard distribution

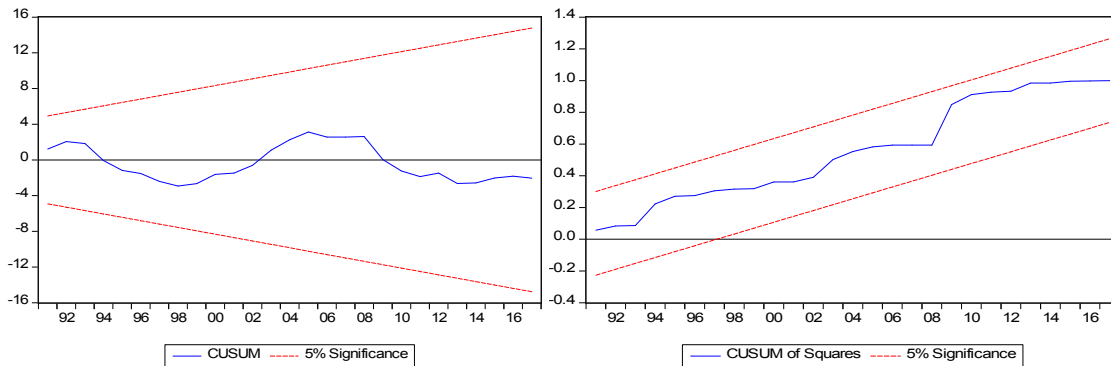*Source: authors' computation by using eviews 10*

Fig. 3. Plot of CUSUM and CUSUMSQ (Stability Test)
Source: authors' computation by using eviews 10

4.5.2 Structural stability test results for the estimated ARDL model

Finally, to ensure the robustness of the specified models along with both short-run and long-run coefficients, the study used a cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) tests proposed by[26]. To achieve this, the structural stability of the estimated parameters in the UECM format of the ARDL model is achieved if the graph of the statistics of both CUSUM and CUSUMSQ falls within the critical limits at a significant level 5 %. these coefficients are unstable if the graph of the statistics of the mentioned two tests moves out of bounds at this level.

The stability tests based on the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ), reported in Fig. 3, observe that at the 5% level of significance all the specified models are stable and have test lines that fall within the boundary. It implies model robustness along with the stability of both long run and short run coefficient acceptability over the sample period of 1970–2017.

5. RESULTS AND DISCUSSION

the proposed ARDL model is ideal for estimating the long-term relationship between the

investment of the public and private sector and economic growth in Algeria, given that there is no sequential correlation of errors, the capabilities are stable over time, and errors can be corrected in the long term by 54%.

The results of the co-integration test also showed that there is a long-term relationship between these variables, meaning that they affect economic growth during the study period.

The estimation of the error correction model showed that it is significant and negative, which confirms the existence of a long-term equilibrium relationship between the study variables.

It was also found that there is a relationship between economic growth and both public and private investment in the short term.

6. CONCLUSION

Investment is considered one of the most fundamental components of economic growth. This study aims to discover the effect of the public and private investment on economic growth in Algeria, for the period 1970 to 2017. It was discovered through the analysis of the study using the ARDL method that: The results of ADF test showed that the logarithm of the variables: private investment, public investment and labor are not static in their level and are integrated from degree $I = (1)$. But the logarithm of (GDP) and Inflation are integrated from degree $I = (0)$.

The empirical results reported in the model indicate that; the public and private investment is positively related to economic growth in the long run and short-run. The results of other variables indicate that; inflation negatively affects economic growth while Labor is positively related to economic growth in the long and short-run.

Despite the significance of the coefficient of investment for the public and the private sector, their contribution to economic growth is weak. Where it is estimated at 0.09 for the private sector and 0.05 for the public sector. These results are similar to those of bouyacoub, zakan and benabdellah, for the case of Algeria. Therefore, we can conclude the majority of public investments in Algeria are unproductive (gaffard, pradel). In addition, the efficiency of Algerian investments is low compared to that of other oil-exporting countries in the region, and it is clearly below the world average. The authorities should improve the efficiency of investments by improving the selection, execution and ex-post evaluation of investment projects. Better governance of the public enterprises would also improve the efficiency of investments while reducing the need for accidental bailouts from budgetary resources. The authorities acknowledged that the increase in public investment spending had exceeded Algeria's absorptive capacity and that this spending needed to be rationalized [27]. Reducing social public projects and increasing economic public projects.

The results of the short-term dynamics reveal that; the error correction term is negative and significant -0.54. Which means that 54% of the imbalance will be adjusted annually and approximately after 22 months. At this point the short-term dynamics will reach the equilibrium level.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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