The Macroeconomic Variables and the Public Investment Spending in Algeria: Econometric Study using ARDL model (1990-2018)

المتغيرات الاقتصادية الكلية و الإنفاق الاستثمار العمومي في الجزائر: دراسة قياسية باستعمال نموذج الانحدار الذاتي للفجوات الزمنية الموزعة (1990- 2018)

Guennouni Habib, Univ of Mascara, Algeria, guenouni.hbib@univ-mascara.dz.
Ameur Abderrahim, University of Mascara, Algeria, a.ameur@ univ-mascara.dz.

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Abstract: Public investment spending is an important determinant of economic growth. Algeria has spent billions dollars. We noted that these spending have affected many economic variables and have also been affected by these variables. This study aims to show the impact of macroeconomic variables on this spending in Algeria during (1990-2018). We applied an econometric study using ARDL model. The majority of results were in agreement with economic theory in a short run as well as a long run relationship between the variables.

Keyword: macroeconomic variables; public investment spending; econometric study.
JEL classification code : E200, E220, C510.

ملخص: يعتبر الانفاق الاستثمار العمومي من أهم محددات النمو الاقتصادي، حيث أنفقت الجزائر من خلاله ملايير الدولارات. لاحظنا أن هذا الانفاق أثر على العديد من المتغيرات الاقتصادية، كما أن هذه المتغيرات أثرت بدورها عليه. تهدف هذه الدراسة لتوضيح تأثير المتغيرات الاقتصادية الكلية على الانفاق الاستثمار العمومي في الجزائر خلال الفترة 1990-2018. للوصول إلى النتائج قمنا بدراسة قياسية باستعمال نموذج ARDL. النتائج المتوصل إليها كانت في غالبيتها موافقة للنظرية الاقتصادية في المدى القصير، كما كانت علاقة في المدى الطويل بين متغيرات الدراسة.

الكلمات المفتاحية : المتغيرات الاقتصادية الكلية؛ الانفاق الاستثمار العمومي؛ دراسة قياسية.
تصنيف JEL: E200، E220، E510.

Corresponding author: GUENNOUNI Habib, e-mail: guenouni.hbib@univ-mascara.dz.

1. Introduction :

After the global crisis of 1929, which saw the collapse of ؤlassical thought, and with the apparent of Keynesian thought, the state had a major role to play in economic stability and economic development, through public investment spending, which was an important determinant of economic growth.

Through the economic importance of investment spending, there are many economic theories concerned with this aspect, these theories have given explanations and clarifications on the role that this spending can play in economy. It expands the production base through the rate of accumulation of capital and it is considered as one of the most important economic variables that have a significant impact on development.

Public investment spending is an economic variable and an important part of total national spending. It is affected by many economic variables. The factors determining it vary according to the state economy (developed, developing or underdeveloped). Several theoretical and empirical studies have shown that investment spending is influenced by most macroeconomic indicators.

Algeria, like many countries of the world, aims to achieve economic stability and economic development; it has spent billions of dollars on infrastructure, housing, transport, etc. Since independence, the state has pursued a public spending policy through the development plans, and this period (until the end of the 1990) has witnessed disparities in the volume of public investments spending.

From 2000, Algeria has implemented an expansionary fiscal policy, the largest since independence, based on very high oil prices. The country has adopted programs: the Economic Recovery Support Program (2001-2004), the Supplementary Growth Support Program

(2005-2009), Consolidation of economic growth Program (2010-2014) and the five-year development plan (2015-2019).

The observers of these programs notes that the public investments spending applied during this period have affected many economic variables, as well as they are also affected by these variables. Through this approach, we will try to answer the following question:

What is the impact of the most important macroeconomic variables on public investment spending in Algeria?

To answer this problem, we ask the following sub-questions:

- What is meant by investment and public investment spending?
- What are the most important macroeconomic variables?
- What is the nature of the relationship between these variables and public investment spending?

Study hypothesis:

We proposed the following hypothesis: Macroeconomic variables affect public investment spending according to economy theory.

Study aim:

This study aims to find out how macroeconomic variables affect the public investment spending, in order to help responsibles to correct the imbalances in this type of investment. The state has spent billions of dollars on public investment without results. Therefore, we must study its determinants to find the causes of its imbalance.

Research model:

We will apply an econometric study from 1990 to 2018 using ARDL model. The variables of model are: domestic savings, final consumption, private investment, economy liquidity and inflation as independent variables and public investment spending as a dependent variable.

Previous studies:

Investment spending is the main pillar of achieving capital accumulation, which is the basis of any economic progress.

There are several studies in this field, including:

- Study of (Greene & & Villanueva, 1991), which included 94 developing countries during the period (1970-1990). The researchers found that the unpredictability negatively affects domestic investment while the rate of trade, the general level of prices and the rate of economic growth have a positive impact on investment.

- Study of (Aizenman & Marion, 1999), which included 46 developing countries during the period (1970-1992). Researchers found that public consumption, money supply, exchange rate, unpredictability and financial development have a negative impact on domestic investment, while the rate of economic growth has a positive one.

- Study of (Ndikumana, 2000), in which the results showed that inflation has a positive impact on investment and debt has a negative impact.

- Study of (Mlambo & Oshikoya, 2001) on macro indicators and investment in Africa during the period (1970-1980). The researchers concluded that the real growth rate has significant positive effects on investment in low-income countries and the exchange rate has a positive effect in middle-income countries but a negative impact in low-income countries. Inflation has a significant negative effect in low-income countries while in middle-income countries, it has a positive effect. They found that external debts had a significant negative effect in both cases, as did economic instability.

- Study of (Mustafa & Marwan, 2014, p. 270) showed that there are factors which have an impact on the effectiveness of public investment. These factors are real and financial ones, which affect

investment either directly or indirectly. The first is the fluctuation of economic growth, high unemployment rate, exports and domestic savings, while the other is the fluctuation of exchange rates and the increase in the volume of external debts.

Through the previous studies, we have noted that they are all concerned with the relationship between the most important macroeconomic variables and investment in general, while our study is different from the aformentioned studies in terms of dependent variable, which is public investment spending only.

2. Literature on Macroeconomic Variables and Public Investment:

2.1. The Macroeconomic Variables: Macroeconomic theory is concerned with macroeconomic variables such as GDP, government expenditure, consumption, general price level, full employment, money supply and capital stock. Economic policies can only be effective if they are based on "a thorough understanding of the nature of macroeconomic phenomena and the interrelationships between their variables. Therefore, macroeconomic theory must be studied before develop of any successful economic policy." (Iman, 2008, p. 12)

Economists of the Classical School were interested in the study of macroeconomic phenomena, such as the circulation of national income in society, the development of capitalist societies and their tendency towards stagnation and the inevitable balance between production and consumption. The law of outlets introduced by Jean-Baptiste Say is a conclusive evidence of this school's interest in total quantities (Omar, 2005, p. 8). Keynes also stressed the need to pay attention to macro-analysis so that governments can see that fiscal and monetary policy is needed to achieve economic stability.

Among the most important macroeconomic variables addressed by economic theories are:

- *Economic growth:* the continuous increase in real national income and the increase in the average per capita income (Mohamed & Ali, 2007, p. 302).

- *Consumption:* the process of extinction of the material or service when used, as consumption is one of the basic components of demand (Chouam, 2000, pp. 177-178).

- *Investment:* is a stream of spending on new fixed capital goods that create value-added and create new jobs. (Said, 2007, p. 133), and investing money to Achieving return, income, profit and money in general, the investment may be in the form of tangible or intangible (Taher, 2010, p. 13).

- *Government expenditure:* It is the amount of money spent by the public authority, or it is a cash amount spent by a public person for the purpose of public benefit, and can be defined as the use of cash by a public institution to satisfy a public need (Mohammed, 2015, p. 16).

- *Foreign Trade:* Are both visible and invisible exports and imports (Sami, 1993, p. 36).

- *Inflation:* a monetary phenomenon is an increase in the amount of money leading to higher prices whether this increase is manifested by money supply (cash balances or the expansion of credit creation), or through demand for money (cash spending) (Magdy, 2002, p. 70).

2.2. Public Investment Spending:

Among the most important investment spending in terms of property criterion, there is public investment or government investment, "... what a public institution or group of institutions makes under any legal form of public companies" (Abdelkrim, 2008, p. 38).

If the main objective of investment projects is to achieve profits, the public investment goes beyond this goal to other goals, which are: (Abdelkrim, 2008, pp. 44-45)

- Preservation and protection of existing investments;
- To develop the productive capacities of the country;
- Excess of production;
- Creation of jobs and reduction of unemployment;
- Providing the basic infrastructure necessary for economic activity;
- To provide the basic infrastructure necessary for the well-being of citizens.

It can also be affected by: (Mohamed, 2013, p. 7)

- GDP growth;
- The real interest rate;
- Real exchange rate;
- Type of investment (private for public, public for private);
- Credit size;
- The volume of public debt;
-The trade exchange;
- Macroeconomic stability.

3. Study Methodology (Econometric Study):

3.1. The Model: The formulation of the econometric model is one of the most important and most difficult stages of study. It is necessary to determine the variables that must be included in the model or that must be excluded from it.

Based on this, we will apply an econometric study to clarify the impact of the most important macroeconomic variables on public investment spending in Algeria during the period from 1990 to 2018 (statistics are from the word bank data base, bank of Algeria and national office of statistics). Therefore, we will apply the following model:

$$\text{Log GINV} = C + \beta_1 \text{LogFCONS} + \beta_2 \text{LogPINV} + \beta_3 \text{LogOPEN} + \beta_4 \text{LogLIQ} + \beta_4 \text{LogSAVE} + \beta_5 \text{LogINF} + \varepsilon_i$$

Where:
GINV: Ratio of public investment spending to GDP.
FCONS: Ratio of final consumption to GDP.
PINV: Ratio of private investment to GDP.
OPEN: Rate of trade openness (ratio of total X and M to GDP).
LIQ: Economy liquidity (ratio of M_2 to GDP).
SAVE: Ratio of domestic savings to GDP.
INF: Inflation rate.
C: constant, β_i: parameters to be estimated, ε_i: random error.

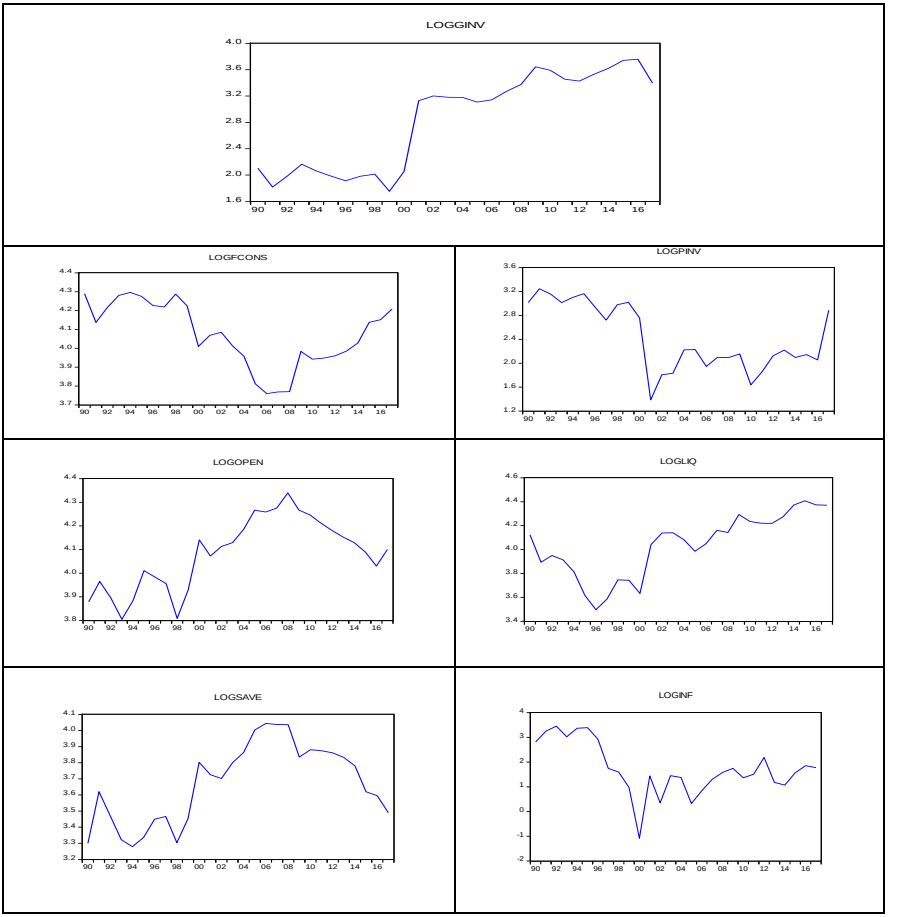
We will use the ARDL model presented by Pesaran and Al (2001). The ARDL methodology for co-integration differs from other co-integration methods by applying the bounds test, whether independent variables are I(0) or I(1). The only condition for applying this test is that there is no variable in I(2). ARDL can be applied in case that the sample size is small and this is the reverse of most traditional co-integration tests that require a large sample size to have more efficient results.

The ARDL methodology is based on the following:

- Unit root test for time series (stationary test);
- Determination of the Lag length;
- Co-integration testing using the Bounds Test;
- Estimating the long-run model;
- Estimation of the error correction model (ECM);
- Tests of model quality.

3.2. Results:

Fig.1: Graphical Representation



Source: Prepared by researchers based on Eviews 10 outputs

Through the graphical representation of the variables, we show that there is a trend; so these variables are perhaps not stationary in level.

Stationary of the Variables:

Since the number of observations is less than 30, we will apply the PP stationary test on all model variables to make sure that they are all stationary at the level I (0) or at the first difference I (1), because the "bounds test" procedure will not be valid if there is a variable in I(2) or more. The PP test depends on the lag length and it is defined as a zero, based on the partial auto-correlation function. The following table summarises the PP test:

Table 1: PP test of stationary

	Series	5% Level	t-statistic	Prob	result
LogGINV	level	-1.95	0.73	0.86	Not Stationary
	First	-1.95	-3.89	0.00	Stationary
LogFCONS	level	-1.95	-0.23	0.59	Not stationary
	First	-1.95	-5.01	0.00	Stationary
LogPINV	level	-1.95	-0.38	0.53	Not stationary
	First	-1.95	-5.26	0.00	Stationary
logOPEN	level	-1.95	0.59	0.83	Not stationary
	First	-1.95	-5.02	0.00	Stationary
LogLIQ	level	-1.95	0.32	0.77	Not stationary
	First	-1.95	-4.94	0.00	Stationary
LogSAVE	level	-1.95	0.19	0.73	Not stationary
	First	-1.95	-5.41	0.00	Stationary
logINF	level	-1.95	-1.22	0.19	Not stationary
	First	-1.95	-7.75	0.00	Stationary

Source: Eviews 10 outputs

From the results of the stationary, we notice that all the time series are stationary after the first difference (the series are cointegrates of the same class I(1)), we can estimate the model using ARDL models (auto-regressive Distributed Lag models).

The ARDL model is based on the optimal lag length, determined by the information criterions (HQ, SC, AIC) of three VAR models (p =

0,1,2,3). We conclude that the optimal lag length is 1 according to the AIC, SC, and HQ test because they have the lowest value.

Estimating the Model using ARDL:

The results were as follows:

Table 2: Results of the Bound test

Test statistic	value	Signification	I(0)	I(1)
F-statistic	2.982009	10%	1.99	2.94
k	6	5%	2.27	3.28
		1%	2.88	3.99

Source: Eviews 10 outputs

We observe from the bound test that the value of F 2.98 is greater than I (1) 2.94 (at 10%). Therefore, we reject the null hypothesis and accept the alternative hypothesis. There is a long-term relationship between the independent variables and the dependent variable.

Table 3: Long-run estimation results

variables	coefficient	Std.Error	T- statistic	Prob
logFCONS	128.7467	1084.57	0.118708	0.9088
logPINV	-2.009327	12.0054	-0.167367	0.8718
logOPEN	-57.08694	485.371	-0.117615	0.9097
logLIQ	-16.25652	149.085	-0.109042	0.9162
logSAVE	137.7711	1164.19	0.118340	0.9091
logINF	1.070860	8.83934	0.121147	0.9070
C	-724.7189	6104.29	-0.118723	0.9088

Source: Eviews 10 outputs

Table 4: Short-run estimation results

variables	coefficient	Std.Error	T- statistic	Prob
D(logGINV(-1))	-0.75	0.16	-4.52	0.00
D(logFCONS)	0.89	0.75	1.18	0.27
D(logPINV)	-0.38	0.05	-7.38	0.00
D(logPINV(-1))	-0.27	0.07	-3.90	0.00
D(logOPEN)	1.23	0.29	4.17	0.00
D(logOPEN(-1))	3.32	0.46	7.10	0.00
D(logLIQ)	1.34	0.30	4.36	0.00
D(logSAVE)	0.04	0.53	0.08	0.93
D(logSAVE(-1))	-2.49	0.44	-5.66	0.00
D(logINF)	0.02	0.02	1.30	0.23
D(logINF(-1))	0.07	0.02	2.92	0.02
ECT(-1)	-0.03	0.005	-6.59	0.00
Statistical indicators				
R^2	0.96	**AIC**		-2.46
R^2adj	0.94	**SC**		-1.88
F pro	0.00	**HQ**		-2.29
DW	2.38			

Source: Eviews 10 outputs

Through the results obtained we note that:

-There is a non-significant positive effect of final consumption on public investment spending in the short and long run. The increase in final consumption by 1% leads to an increases in public investment spending by 0.89% and 128% respectively.

- There is a significant negative impact of private investment on public investment spending in the short run. The increase in private investment by 1% leads to a decrease in public investment spending by

0.38%, while in the long run there is non-significant negative impact whereas the increase in private investment by 1% leads to a decrease in public investment spending by 2%.

- There is a significant positive impact of the rate of trade opening on public investment spending in the short run. The increase in it by 1% leads to an increase in public investment spending by 1.23%, while in the long run there is a non-significant negative impact, the increase in the first by 1% leads to a decrease in the second by 57%.

- There is a significant positive effect of the economy liquidity on public investment spending in the short run. The increase in economy liquidity by 1% leads to an increase in public investment spending by 1.34%, while in the long run there is a non- significant negative impact, the increase in it by 1% leads to a decrease in public investments spending by 16 %.

- There is a non-significant positive impact of the saving on public investment spending in the short and long run. The increase in it by 1% leads to an increase in public investment spending by 0.04% and 137% respectively.

- There is a non-significant positive impact of inflation on public investment spending in the short and long run, whereas an increase in it by 1% leads to an increase in public investment spending by 0.02% and 1%, respectively.

- The error correction coefficient is negative and significant, i.e, the possibility of a long-term relationship between the independent variables and the dependent variable.

-Independent variables explain 94% of the dependent variable, which is a significant correlation force.

The Quality of the Model:

In order to study the quality of the model, we apply the following diagnostic tests:

Table 5: Results of diagnostic tests of the model

Breusch-Godfrey Serial Correlation LM Test			
Null hypothesis (H0): There is no auto-correlation of residuals			
0.34	Prob F (2,17)	0.52	F-statistique
0.11	Prob Chi-Square (2)	6.28	Obs*R-au carré
Heteroskedasticity Test ARCH			
Null hypothesis (H0): stability of variance			
0.31	Prob F (1,23)	1.05	F-statistique
0.29	Prob Chi-Square (1)	1.09	Obs*R-au carré
Jarque-Bera Normality test			
Null hypothesis (H0): Residuals are normality distributed			
0.89	Prob	0.21	Jarque-Bera
Ramsey Reset Test			
Null hypothesis (H0): the model is correctly specified			
0.65	Prob	0.45	t-statistique
0.65	Prob	0.20	F-statistique

Source: Eviews 10 outputs

From the table, the results of the diagnostic tests of the model confirm the following:

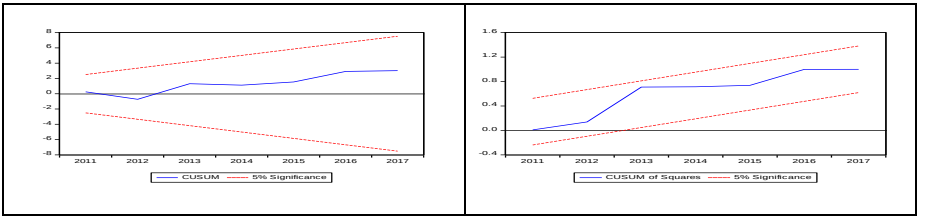
- The Serial Correlation LM test indicates that Fisher's probability 0.34 is greater than the 5%, so we accept the null hypothesis; there is no auto-correlation of residuals.

- The Heteroskedasticity test indicates that Fisher's probability 0.31 is greater than the 5%, so we accept the null hypothesis; the variance is stable.

- The Normality test indicates that Jarque-Bera's probability 0.89 is greater than the 5%, so we accept the null hypothesis; the residuals are normality distributed.

- Ramsey Reset test indicates that Fisher's probability 0.65 is greater than the 5%, so we accept the null hypothesis; the model is correctly specified.

- Structural stability test of the model (CUSUM and CUSUM^2 tests) indicates that the model is structurally stable.



4. Discussion and Economic Analysis:

Through our econometric study, we found that most of the results were statistically significant in the short run, while they were not significant in the long run. Also, there is a long - run relationship between the variables of the study and it had a difference in the impact on public investment spending according to economic theory.

Although the result of final consumption is not significant, the relationship between it and public investment spending was positive. The increase in consumption leads to an increase in public investment spending, because consumption is the first source of economic growth (first in total national demand). The improvement in the standard of living of the population leads to an increase in demand for products, production and creating jobs, which leads to an increase in taxes collected by state from enterprises or individuals (increasing state resources), which positively affects public investment spending.

For private investment, we found that it was an inverse relationship between it and public investment spending, because the role of the state in the economy is very large compared to that of the private sector. Most private investments are projects that rely on public funds for realisation of public programs. In economic theory, it is called the **eviction effect**, the eviction of private sector by public sector. However, this situation has a significant impact on State resources. The private sector must play its economic role by diversifying its activities and not focusing on entrepreneurship, whose its added value in the national economy became almost non-existent.

We found also that there is a positve relationship between the rate of trade openness and public investment spending, which agrees with economic theory. The increase in exports, which depends on petrol, has enabled the state to obtain substantial financial resources (especially during (2000-2014), which was reflected in the realisation of development programs on wich hundreds of billions of dollars were spent. Although the increase of imports during the same period, higher prices of petrol have had a significant impact on the trade balance.

The economy liquidity had a positive relationship with public investment spending, which also agrees with economic theory. There no are projects without sufficient liquidity. During this period, due to high prices of petrol, the level of exchange reserves exceeded $ 200 billion, which was reflected on the liquidity of the economy and thus, facilitates the process of completion of projects.

Due to the correlation of saving with consumption (saving is non consumed part of income) (Habib, 2016, p. 33), we found that the result was also statistically non significant, yet there is a positive correlation between it and public investment spending. According to the economic theory, it is acceptable, but in Algeria, reality is quite different, because

the banking system in Algeria is underdeveloped. In spite of the large volume of savings, their employment is limited only to fast-profit economic operations such as import, but big investments are financed from the public treasury.

For inflation, we found that the result agrees with economy theory, there is a positive relationship between it and public investment spending. This is explained by the realisation of major development projects by the state despite the high costs, because of its dependence on petrol prices.

5. Conclusion:

We studied the relationship that could be between the most important macroeconomic variables and public investment spending. Through the economic theories, the public investment spending plays an effective role in the economy through its contribution to economic growth and development by creating jobs and reducing unemployment, providing the basic infrastructure necessary for economic activity, for the well-being of citizens. We found that public investment spending affects many economic variables and it is also affected by these variables**.**

Many studies on developing countries have found that macroeconomic variables have different effects on investment. Most of these studies have found that economic growth and inflation have a positive impact on investment; while public consumption, debt, exchange rate have a negative impact on it.

For our econometric study, we found that the results were not different from economic theory. Most of the variables have a positive relationship with public investment spending, except private investment which has a negative relationship; which is called in economic theory the eviction effect.

It can be said that the state has exerted effort in realisation of

large projects during the last 20 years, relying on petrol as the first source of financing, (more than $ 1000 billion), and due to mismanagement, these projects were not in the aspirations of the state and citizens and drained the resources. This has created financial problems for the state due to the decrease in petrol prices for a period not exceeding three years (from 2014 to 2017). It is necessary to take an economic path in the realisation of major development projects without relying on the state treasury, through partnership between the public and private sectors and push banks to finance this type of projects. Develop a planning strategy (as a ministry of planning) and control the projects in order to avoid revaluation problems that have affected the public treasury.

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