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An Econometric Study of the Impact of Public Expenditure on Economic Growth in Algeria Using FMOLS and ECM Models During the Period (1980-2021)

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Abstract

This study aims to highlight the impact of public expenditure on economic growth in Algeria during the period (1980-2021). For this purpose, public expenditures were divided into two variables: equipment and investment expenditures, as well as operating expenditures. The model was formulated using the Fully Modified Ordinary Least Squares (FMOLS) method for the long term, and the Error Correction Model (ECM) for the short term. The study concluded that there is a significant long-term relationship between equipment and investment expenditures and economic growth, while there was no relationship between the variables in the short term. Additionally, the study highlighted an inverse significant relationship between operating expenditures and economic growth in the short term, while there was no relationship between them in the long term.

Keywords: Public expenditure, economic growth, Johansen test, FMOLS model, ECM model.

Introduction

Public expenditure plays a strategic role in various developing and advanced economies, representing the extent of government involvement in economic activities by funding various economic activities. Public spending, both investment and consumption, contributes to improving economic performance by stimulating aggregate demand, which in turn raises the level of aggregate supply.

In Algeria, public expenditures are the main source of funding for economic development and investment projects, aimed at raising economic growth levels, which is a strategic goal of developmental programs and plans.

Based on the above, the main question can be posed: What is the impact of public expenditure on economic growth in Algeria during the period (1980-2021)?

To answer the above question, the following hypotheses were formulated:

- There is a significant long-term relationship between public expenditure and economic growth in Algeria;
- There is a significant short-term relationship between public expenditure and economic growth in Algeria.

This study aims to clarify the concepts of public expenditure and economic growth, as well as their development in Algeria during the period (1980-2021), and highlight the impact of public expenditure, both consumption and investment, on economic growth.

The importance of this study stems from the significance of economic growth in all countries, as it is one of the main goals of economic policy, as well as the large amounts of public expenditure aimed at raising the living standards of the population and achieving economic development and growth.

2. Methodological and Scientific Approaches to Public Expenditure and Economic Growth

This section will address the concept of public expenditure, its pillars, and its divisions in Algeria, and the concept of economic growth.

2.1. Methodological and Scientific Approaches to Public Expenditure

The economic policies of countries vary depending on the available material and human resources, thus public expenditure occupies a significant space in economic life. Here, we will try to provide the main definitions and categories of public expenditure.

2.1.1. Definition of Public Expenditure

- Definition of expenditure in language: Derived from the word "نفقة" which means the end or cessation of something. For example, "نفقت الدابة" means the animal died, and "نفق البيع" means the sale was successful. It is called expenditure because it goes to its purpose. "أنفق الرجل" means the man spent his money. A person who spends a lot is called "منفاق" (Amir, 2010, p. 25).

- Definition of expenditure in terminology: It is a monetary amount paid by a public person to satisfy public needs, or all the money spent by the state to satisfy the public needs of citizens, taking various forms, such as salaries for employees, payments to contractors, or grants. Public expenditure is also defined as "an amount of money that comes out of the state treasury through its administrations, institutions, and various ministries to satisfy public needs" (Haj, 2009, p. 122). It is an amount of money paid by a public person to satisfy public needs. It is also "an amount of money issued by the state or any public legal person to achieve a public benefit" (Khatib and Shamiya, 2007, p. 53). Public expenditure is when "a public authority uses an amount of money to meet a public need" (Shaoush, 2017, p. 62).

From the multiple definitions of public expenditure, it is clear that they all agree on the fact that these are the funds that come out of the state's financial resources to meet the various needs of individuals.

2.1.2. Pillars of Public Expenditure

The pillars and elements of expenditure are as follows (Abbas, 2012, p. 26):

- Use of a monetary amount: Using a monetary amount that can be estimated as the price of products, goods, and services to satisfy various individual needs;

- Expenditure issued by a public legal person: Expenditure can only have legal status if it is issued by a state-affiliated entity;

- Achieving a public interest or benefit: Its purpose is to satisfy the needs and interests of all citizens residing in its territory without exception.

2.2. Methodological and Scientific Approaches to Economic Growth

This section will address the concept of economic growth, its elements, how it is measured, and its main determinants.

2.2.1. Concept of Economic Growth

Economic growth is defined as "the process of expanding production over a certain period compared to a previous period in the short and medium term" (Bousserelle, 2000, p. 30). It can also be defined as expanding a state's capacity to produce the goods and services desired by society (Rajan, 2005, p. 141). Growth is also expressed as "a continuous increase in gross domestic product (GDP) or gross national product (GNP), resulting in an increase in the average per capita income of real national income" (Bouazza and Barah). Economic growth involves a continuous rise in production and income levels, typically measured by the increase in GDP. According to Kaldor, the economic growth rate must be higher than the population growth rate (Krouch, 2016, p. 615). This means that economic growth should result in an increase in real per capita income, excluding the effect of changes in the value of money, i.e., excluding the impact of inflation.

There are two types of economic growth:

- Extensive economic growth: Where income growth equals population growth, resulting in stagnant per capita income;

- Intensive economic growth: Where national income growth exceeds population growth, leading to an increase in per capita income. Transitioning from extensive to intensive growth marks a point of departure, indicating an improvement in societal conditions.

2.2.2. Elements of Economic Growth

Several elements contribute to achieving economic growth when combined in rational proportions. These elements are primarily labor, capital, and technological advancement.

- **Labor:** Labor is one of the most critical factors affecting economic growth. The most crucial element in forming labor is the population, their quality, and population pyramid. Population growth means an increase in labor supply, considering the effect of population growth on per capita national income. It is a source of increased economic activity and growth. Therefore, it is essential to train human resources and develop fundamental technical skills as these skills collectively increase productivity, leading to a higher economic growth rate (Abdelhamid, 2002, p. 273).

- **Capital:** Capital consists of goods used to produce other goods and services, considered a vital element for economic growth. Capital explains the level and degree of technical equipment under specific conditions of the explained phenomenon. It helps achieve technical progress on one hand and expands production through various investments on the other.

- **Technological advancement:** It refers to technological changes in production methods or the nature of produced goods, allowing greater output with the same inputs or maintaining the same output with fewer inputs. It addresses production bottlenecks, produces new goods of better quality, and thus represents a qualitative fact. Technological advancement necessitates a considerable and appropriate valuation in production coefficients as it improves economic performance.

2.2.3. Measuring Economic Growth

Economic growth involves an increase in real output and average per capita income. Thus, measuring this growth is done by measuring the growth of output and per capita income (Beshiker, 2017, pp. 22-23).

- **National output:** It measures the total production activity, and calculating its growth rate is what is termed the growth rate. The national output can be measured by calculating the output achieved within the country and evaluating it in the national currency, then comparing it with the results of the previous period to determine the growth rate. The drawback of these rates is that they are monetary and do not account for the effect of inflation. Additionally, since each country has its national currency, comparing growth achieved in different countries using this measure can be challenging. Therefore, an international currency is often used to evaluate national output in various countries, making it easier to compare growth rates achieved.

- **Per capita income:** The importance of measuring per capita income growth lies in understanding the relationship between production growth and population development. This measure provides a tangible assessment of growth, indicating the growth achieved at the individual level by increasing what each person can spend. Growth can also be measured by comparing the purchasing power of one dollar in a specific country with the purchasing power of the same amount (one dollar) in other countries, then ranking the most developed countries according to the highest purchasing power.

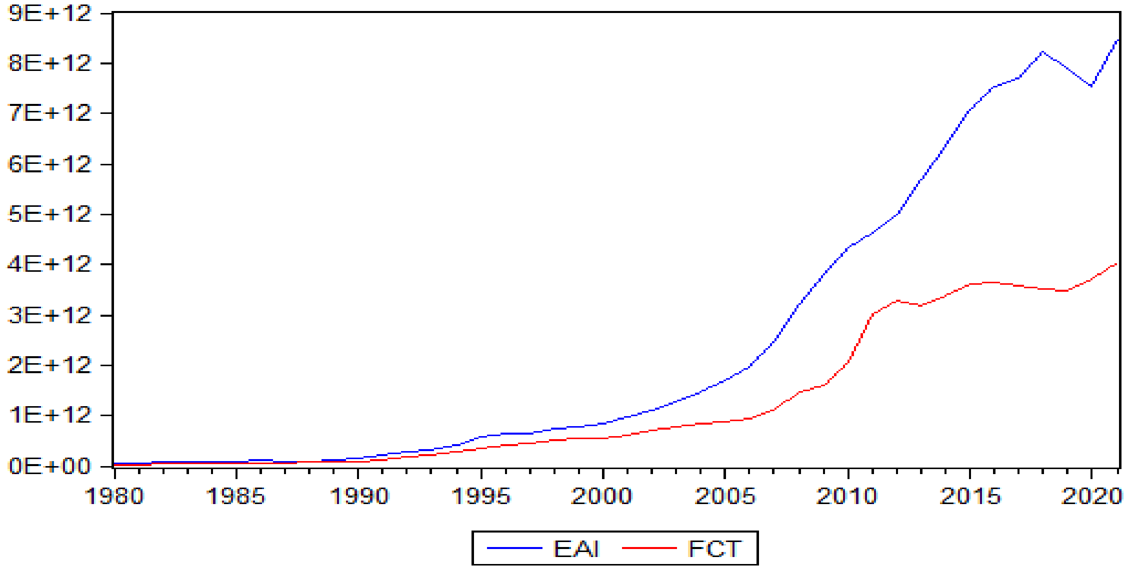
3. Development of Public Expenditure and Economic Growth in Algeria

This section will illustrate the development of public expenditure and growth in Algeria during the period (1980-2021).

3.1. Development of Public Expenditure in Algeria

The development of public expenditure, both investment and consumption, in Algeria during the period (1980-2021) can be shown through Figure 1 below:

Figure 1: Development of Public Expenditure (Investment and Consumption) in Algeria during the Period (1980-2021)



Source: Prepared by the researchers, based on World Bank data.

From Figure 1, it can be observed that the level of public expenditure, both investment and consumption, increased over the study period. However, a closer examination of the data reveals that equipment and investment expenditures saw a significant jump, particularly at the beginning of 2000, when national authorities began implementing economic recovery policies and programs. These policies are based on Keynesian economic theory, which asserts that demand creates supply, considering public expenditure as an effective tool to stimulate aggregate demand. This stimulation of aggregate demand is expected to elicit a supply response, thereby increasing national output. Large financial allocations were made for these programs (an expansionary fiscal policy), with the goal of utilizing the financial surplus to invigorate the national economy, promote productive and service investments, and achieve economic diversification by reducing reliance on oil. This was to be accomplished by focusing on non-oil sectors such as agriculture and industry, ultimately increasing the economic growth rate.

3.2. Development of Economic Growth in Algeria

The economic growth rate experienced various levels during the study period, as shown in Figure 2 below:

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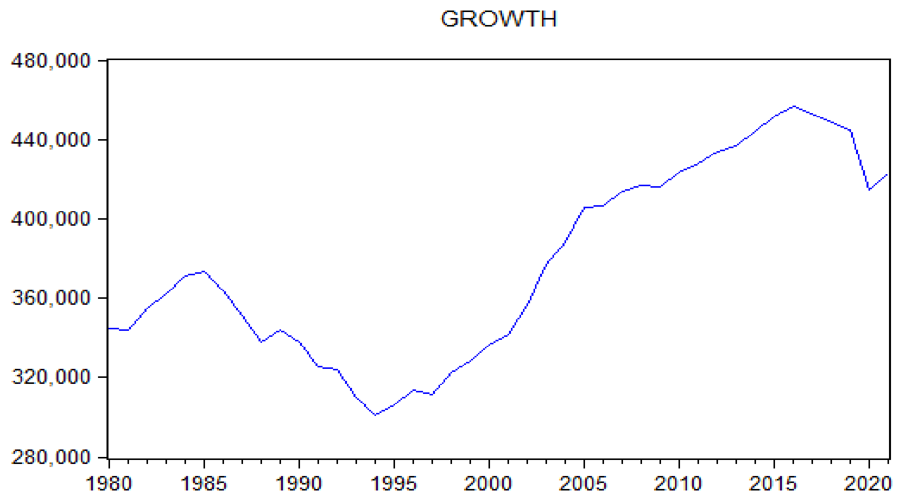
Figure 2: Development of the Economic Growth Rate in Algeria during the Period (1980-2021)



Source: Prepared by the researchers, based on World Bank data.

From the figure, it is evident that economic growth rates in Algeria fluctuated during the study period (1980-2021). This can be divided into two phases. The first phase, from 1980 to 1994, saw economic growth in the first half of the 1980s due to improved oil prices during that period. However, this improvement began to decline starting in 1986, leading to a reduction in economic growth. This decline can be attributed to several factors, including the collapse of oil prices in the global market, weak industrial sector performance, and the onset of debt, which led Algeria to negotiate with the International Monetary Fund (IMF). The IMF recommended adopting austerity fiscal policies, which resulted in decreased investments and loans to institutions.

In the second phase, starting in 1994, economic growth experienced steady improvement due to the betterment of the Algerian economy, driven by rising oil prices, which reached $28.77 per barrel in 2000 and $112.92 per barrel in 2011. Additionally, Algeria implemented economic reforms that contributed to increased economic growth until 2015. However, the remaining study period (2016-2021) saw a decline in economic growth rates due to falling oil prices. During this time, authorities began freezing all investment projects except for those with social priority (such as education and health).

4. An Econometric Study of the Impact of Public Expenditure on Economic Growth in Algeria during the Period (1980-2021)

The phase of understanding the data of the selected sample for the study and building the model is one of the most important stages leading to an econometric analysis that is very close to reality and matches economic theories and economic significance through the relationship of independent variables to the dependent variable. This section will address building the model, defining the study variables, and testing the cointegration using the Johansen model, then estimating the parameters in the long and short term using the FMOLS and ECM models.

4.1. Building the Study Model

For the study model, the FMOLS method will be used, which was first designed by Philips and Hansen (1990) to provide the optimal estimation of cointegrating regressions. This method works by purifying the estimated coefficients from spurious values estimated by the ordinary least squares (OLS) method to achieve the highest efficiency in estimation. Additionally, this method modifies the OLS method to eliminate the effect of autocorrelation while retaining the effect of internal variables that the cointegration relationship shows. Despite the quality of this method, it may encounter some problems in the case of small samples. To apply this method to estimate the long-term relationship, it is required that a cointegration relationship exists between the variables being studied (Al-Farra, 2012, p. 126).

Based on the theoretical framework and econometric analysis presented, the general model for the study will be chosen as follows: GROWTH=□(EAI,FCT,OIL,MDT,INF)GROWTH=f(EAI,FCT,OIL,MDT,INF)

Where:

- **GROWTH:** Per capita GDP at current local currency prices;
- **EAI:** Equipment and investment expenditures at current local currency prices;
- **FCT:** Final consumption expenditures at current local currency prices;
- **OIL:** Oil prices;
- **MDT:** Financial sector development index;
- **INF:** Inflation rate.

As is common in economic studies, the logarithmic form is applied to the variables because it has several advantages: removing the exponential trend of the variable, i.e., sharp trends, and transforming the model into a linear form if the original model is nonlinear (Driouch, 2013, p. 253). After several attempts to select the most important model form, the logarithmic form was found to be preferable as shown below: LGROWTH=□(LEAI,LFCT,LOIL,LMDT,LINF)LGROWTH=*f*(LEAI,LFCT,LOIL,LMDT,LINF)

4.2. Definition of Study Variables

The following is a description of these variables:

- **Per capita GDP (GROWTH):** This is the dependent variable in the study.
- **Equipment and investment expenditures (EAI):** Includes gross fixed capital formation (previously referred to as fixed domestic investment): improvements in land (fences, ditches, drains, etc.); purchases of plants, machinery, and equipment; and construction of roads, railways, schools, offices, hospitals, private residences, commercial and industrial buildings. Many studies have confirmed the positive impact of this variable on economic growth.
- **Final consumption expenditures (FCT):** According to economic theory and recent empirical studies, there is significant debate regarding this variable's impact (positive or negative). Some studies have found a negative effect of government consumption on economic growth, such as William (2006), LYS (2001, 2002), and Barro (1991). This is because the higher these expenditures, the greater the need for financial resources to cover the budget deficit. On the other hand, other studies have found a positive relationship between consumption expenditure and economic growth, such as Garofalo (2005) and Romer (1986). This is explained by the use of government expenditures to purchase local goods and services, stimulating demand.
- **Oil prices (OIL):** In Algeria, oil prices play an important role by funding the state's public revenues. Higher oil prices lead to increased public revenues, providing a strong boost to public investments, which in turn enhances economic growth.
- **Financial sector development (MDT):** Expressed as the ratio of loans directed to the private sector to GDP. It has been found that there is a positive relationship between financial sector development and economic growth.
- **Inflation rate (INF):** Inflation and economic performance are negatively correlated because higher price levels reduce people's purchasing power. Consequently, consumers will demand fewer goods because they can afford less with the same amount of money, leading to a decline in the number of goods produced and, subsequently, a reduction in GDP. Therefore, the inflation rate is expected to decrease the growth of per capita GDP.

4.3. Testing the Stability of the Time Series for Study Variables

As a first step, we test the stability of the time series, which is a prerequisite for cointegration. Unit root tests are the most important method for determining the stability of time series. The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were used to test for unit roots or stationarity in all variables under study. This test examines the null hypothesis

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that the variable in question contains a unit root, i.e., it is non-stationary, against the alternative hypothesis that the variable in question does not contain a unit root, i.e., it is stationary. This means determining whether the time series for the variable is stable in its original level or not. If it is found to be unstable, differences must be taken until stability is reached.

We utilized the addition provided by Emad Al-Din Al-Musbih on the Eviews program, which conducts the Augmented Dickey-Fuller and Phillips-Perron tests in all forms and at both the original level and differences. The lag periods were chosen automatically through the Schwartz Info Criterion, and the results were as follows:

Table 1: Testing the Stability of Time Series in Their Original State

Variable	Dickey and Fuller	Dickey and Fuller	Phillips-Perron	Phillips-Perron
	Intercept only	Trend and intercept	Intercept only	Trend and intercept
LGROWTH	-1.4032	-2.8316	-0.8460	-1.5755
LEAI	-0.9682	-2.1811	-1.1245	-1.0935
LFCT	-1.5385	-1.3246	-1.8226	-0.6094
LOIL	-1.3430	-2.2653	-1.3430	-2.2167
LMDT	-1.3323	-0.9606	-1.5352	-1.2115
LINF	-2.8322 *	-3.1345	-2.8189 *	-3.1866

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

From Table 1, we observe that the time series for all variables are not stable in their original state, whether using the Augmented Dickey-Fuller test or the Phillips-Perron test, with a constant or with a constant and a general trend. We also observe that the inflation rate is stable at the 10% level with a constant, but it is not stable with a constant and a general trend, indicating the presence of a unit root for all time series at the level.

Since all the time series are not stable at the level, we will re-test by taking the first difference, and the results are shown in Table 2 below:

Table 2: Testing the Stability of Time Series after Taking the First Differences

Variable	Dickey and Fuller	Dickey and Fuller	Phillips-Perron	Phillips-Perron
	Intercept only	Trend and intercept	Intercept only	Trend and intercept
d(LGROWTH)	-3.9260 ***	-3.8861 **	-4.0207 ***	-3.9751 ***
d(LEAI)	-3.3026 **	-3.3590 *	-3.4292 ***	-3.3634 *
d(LFCT)	-3.2157 **	-3.5127 *	-3.1573 **	-3.5719 **
d(LOIL)	-5.0490 ***	-5.1208 ***	-6.2396 ***	-6.2708 ***
d(LMDT)	-5.1949 ***	-5.3232 ***	-5.2486 ***	-5.3170 ***
d(LINF)	-8.5015 ***	-8.3924 ***	-8.6126 ***	-8.4918 ***

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

Table 2 illustrates the application of the two previous tests after taking the first differences of the time series. The results indicate that all series are stable at the significance levels of 1%, 5%, and 10% in the Phillips-Perron test. Thus, it can be said that all variables under study are integrated of the first order, i.e., I(1). These results align with econometric theory, which assumes that most macroeconomic variables are non-stationary at their original level but become stationary at the first difference.

4.4. Testing Cointegration Using the Johansen Method

The cointegration test proposed by Johansen can be conducted by estimating the Trace test (λTrace). If the calculated test value is greater than the critical value, we reject the null hypothesis of no cointegration vector among the study variables (H0: $r = 0$) and accept the alternative hypothesis of at least one cointegration vector (H1: $r \neq 0$). Otherwise, the result would be the opposite, accepting the null hypothesis of no cointegration. Table 3 shows the results of the Trace test for testing the existence of a long-term relationship among the study variables.

Table 3: Johansen Cointegration Test

Sample (adjusted): 1982 2021
Included observations: 40 after adjustments
Trend assumption: Linear deterministic trend
Series: LGROWTH LEAI LFCT LOIL LMDT LINF
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.642030	103.4697	95.75366	0.0132
At most 1	0.447764	62.37744	69.81889	0.1697
At most 2	0.356586	38.62624	47.85613	0.2754
At most 3	0.241423	20.98756	29.79707	0.3584
At most 4	0.137439	9.935120	15.49471	0.2858
At most 5 *	0.095641	4.021139	3.841466	0.0449

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

The Johansen test results in Table 3 indicate the rejection of the null hypothesis of no cointegration at the 0.05 significance level. This is due to the Trace test results showing that the maximum likelihood estimate of 103.4697 is greater than the critical value of 95.75366. Therefore, we reject the null hypothesis and conclude the existence of at least one cointegration equation, confirming a long-term equilibrium relationship among the model variables.

4.5. Estimating Long-Term Model Parameters: Having confirmed the existence of long-term cointegration relationships among the study model variables, we move to the second step by estimating the study model using the FMOLS method, which takes the following form:

$$LGROWTH_t = c + \beta_1 LEAI + \beta_2 LFCT + \beta_3 LOIL + \beta_4 LMDT + \beta_5 LINF + \varepsilon_t$$

Where:

- C: Constant term;
- $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$: Long-term relationship parameters;
- εt: Random error term.

The estimation results for the model are shown in Table 4:

Table 4: Long-Term Parameter Estimates Using FMOLS

Dependent Variable: LGROWTH
Method: Fully Modified Least Squares (FMOLS)
Date: 11/07/22 Time: 09:19
Sample (adjusted): 1981 2021
Included observations: 41 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Prewhitening with lags = 0 from SIC maxlags = 3, Bartlett kernel, Newey-West automatic bandwidth = 1.5916, NW automatic lag length = 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEAI	0.074416	0.050272	1.480258	0.1478
LFCT	-0.024556	0.050838	-0.483028	0.6321
LOIL	0.071569	0.015646	4.574203	0.0001
LMDT	0.065060	0.009037	7.199025	0.0000
LINF	-0.017104	0.007414	-2.307146	0.0271
C	11.02907	0.157560	69.99927	0.0000

R-squared	0.939105	Mean dependent var	12.83422
Adjusted R-squared	0.930406	S.D. dependent var	0.131318
S.E. of regression	0.034643	Sum squared resid	0.042004
Long-run variance	0.001441		

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

Reducing the number of explanatory variables used in the final model reduces effort, time, and cost, and ensures ease of analysis and understanding. Therefore, there should be a balance between reducing the number of explanatory variables and increasing their number to obtain accurate predictive results. It is preferable to choose the equation explained by the fewest explanatory variables that are important and have an impact on the dependent variable. There are several methods for selecting the best regression model, and the following are the most commonly used methods (Dabdob and Ismail, 2013, p. 117):

- **Forward selection method:** This method starts by selecting the explanatory variables to include in the equation one by one, using the F-statistic for the partial hypothesis test.
- **Backward elimination method:** This method involves including all explanatory variables in the regression equation as a first step. Using the F-statistic for the partial hypothesis test, the explanatory variables that are not statistically significant are removed one by one until the final form of the equation, containing only the significant variables, is reached.

Using the backward elimination method on the previous model, the variable LFCT, which appears insignificant, will be excluded. After testing the final model, the following results were obtained:

Table 5: Final Long-Term Parameter Estimates Using FMOLS

Dependent Variable: LGROWTH
Method: Fully Modified Least Squares (FMOLS)
Date: 11/07/22 Time: 09:28
Sample (adjusted): 1981 2021
Included observations: 41 after adjustments
Cointegrating equation deterministics: C
Long-run covariance estimate (Prewhitening with lags = 1 from SIC maxlags = 3, Bartlett kernel, Newey-West automatic bandwidth = 5.4200, NW automatic lag length = 3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LEAI	0.047262	0.006347	7.446637	0.0000
LOIL	0.068028	0.014880	4.571705	0.0001
LMDT	0.068339	0.008875	7.699948	0.0000
LINF	-0.015782	0.007681	-2.054689	0.0472
C	11.11055	0.161931	68.61306	0.0000

R-squared	0.935014	Mean dependent var	12.83422
Adjusted R-squared	0.927793	S.D. dependent var	0.131318
S.E. of regression	0.035287	Sum squared resid	0.044826
Long-run variance	0.001581		

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

From Table 5, we observe the following:

- There is a significant positive relationship between equipment and investment expenditures and economic growth in the long term. An increase of 1% in this indicator will lead to a 0.0472% increase in economic growth. This aligns with economic theory, as this type of expenditure is one of the most important aspects of total spending in any economy. It underpins growth levels and the competitiveness of economies in general. Therefore, the stable development of this type of expenditure is crucial for raising economic growth rates. The increase in equipment and investment expenditures within the framework of investment programs included in development plans has positively reflected economic growth rates. This spending represents a part of total demand, thereby increasing per capita GDP.

- There is a significant positive long-term relationship between oil prices and economic growth. An increase of 1% in oil prices will lead to a 0.0680% increase in economic growth. This result aligns with the nature of the Algerian economy as a rentier economy, where oil revenue covers more than 60% of public expenditures, which in turn have a significant positive relationship with growth, as highlighted by the study.

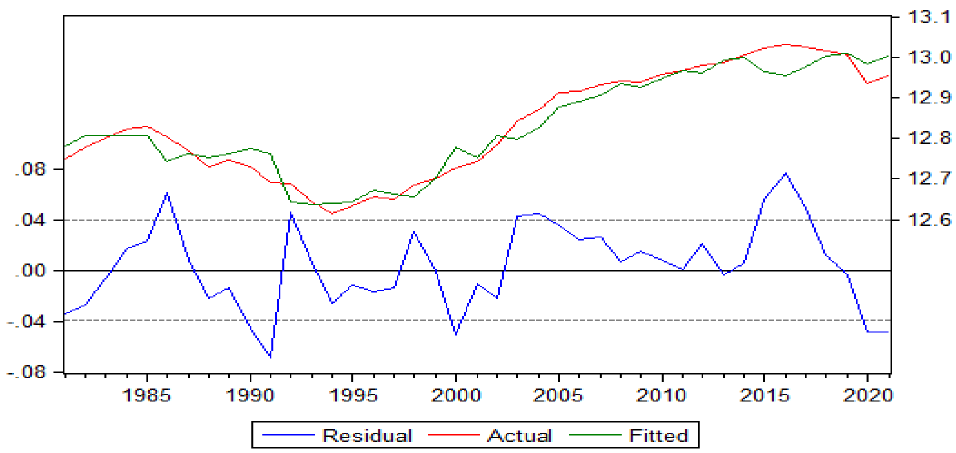
- There is a significant positive long-term relationship between the development of the financial sector and economic growth. An increase of 1% in loans directed to the private sector will lead to a 0.0683% increase in economic growth. This result aligns with economic theory, where increased funding in the form of loans directed to this sector is a major driver of increased private sector activity, leading to the expansion of active projects and the establishment of new institutions, resulting in increased per capita GDP growth.

- There is a significant negative long-term relationship between the inflation rate and economic growth in Algeria. An increase of 1% in the inflation rate will lead to a 0.01578% decrease in economic growth. This result aligns with economic theory, where an increase in the inflation rate inevitably leads to a decrease in aggregate demand, negatively affecting GDP (economic growth).

- There is no significant long-term relationship between operating expenditures and economic growth. This result does not align with economic theory (Keynesian theory), which posits that an increase in such expenditures will lead to an increase in local demand, activating the aggregate supply level to match demand, ultimately leading to increased economic growth. This result can be attributed to the low flexibility of the local production apparatus, which is relatively inflexible in the national economy.

Additionally, Table 5 shows that the adjusted coefficient of determination for the final estimated model reached 0.9350, meaning that the independent variables explain 93.50% of the variation in the dependent variable. For more precise estimation, the actual values can be compared with the estimated values using the model, as shown in Figure 3 below:

Figure 3: Actual and Estimated Values and Residuals of the Model



Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

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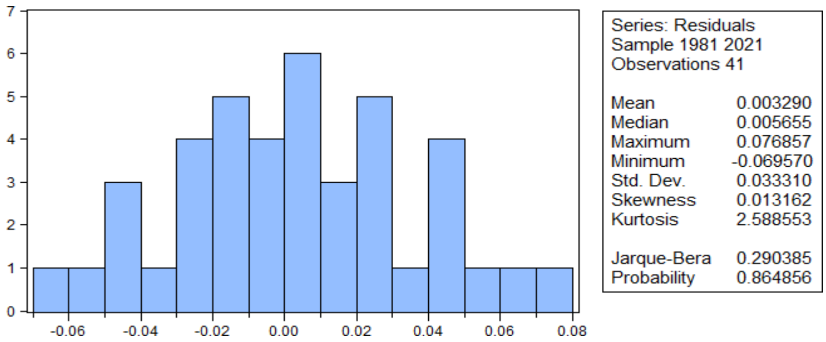
From Figure 3, it is observed that the estimated values are close to the actual values, indicating the quality of the estimated model. Thus, it can be relied upon for interpreting and analyzing the results.

- The Durbin-Watson statistic for the economic growth function is not present because the FMOLS method excels at addressing the issue of autocorrelation, rendering the Durbin-Watson test invalid for this method (Al-Farra, 2012, p. 138).
- The normality of residuals is verified using the Jarque-Bera test, which found the probability value to be non-significant. With a JB value of 0.290385, which is less than the chi-square critical value (5.99), it is confirmed that the model residuals follow a normal distribution. Figure 4 illustrates this:

Figure 4: Normal Distribution of Residuals for the Final Model



Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

It should also be noted that the independence of the explanatory variables is crucial to avoid multicollinearity, which negatively impacts estimation results. To verify the absence of this problem, we calculated the Variance Inflation Factor (VIF). A VIF value below 10 indicates a negligible negative impact on the model. Table 6 presents the results of this test:

Table 6: Variance Inflation Factor for the Error Correction Model

Variance Inflation Factors
Date: 11/07/22 Time: 09:41
Sample: 1980 2021
Included observations: 41

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LEAI	4.03E-05	796.4061	2.841835
LOIL	0.000221	77.92309	2.370606
LMDT	7.88E-05	18.94276	1.623238
LINF	5.90E-05	6.078020	1.275477
C	0.026221	680.0434	NA

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

Table 6 shows that the VIF values for all variables are below 10, indicating no significant negative impact from multicollinearity. Thus, the results of the estimated model are reliable.

4.6. Estimating Short-Term Parameters Using the ECM: The presence of cointegration implies that the variables should be represented by an error correction model (ECM) to estimate short-term effects. The ECM adjusts the short-term behavior of the variable to its long-term behavior, extracting the differences (errors) between the estimated and actual values of the dependent variable in the cointegrated model, and re-estimating the model by including the first difference of the errors as a new independent variable, according to the following equation: $\Delta Z_t = \alpha + \sum_{i=0}^{p} \beta_1 \Delta Z_{t-i} + \lambda u_{t-1} + e_t$

Where Z represents the vector of variables to be tested, β represents short-term elasticities, and λ represents the speed of adjustment between short and long-term. This variable is stable if its absolute value is less than one and its sign is negative (Al-Majali, 2011, p. 341). The Engel-Granger method for error correction is extracted through the following steps:

4.6.1. Testing the Stability of Residuals: This method involves two steps: first, estimating the relationship using the ordinary least squares method and obtaining the residuals (Resid) from this estimation, and second, testing the stationarity of the residuals (denoted as □*Z*). If the residuals are stationary at the level, it indicates the presence of cointegration among the variables, confirming that the estimated relationship is accurate and not misleading. If the residuals are not stationary at the level, there is no long-term equilibrium relationship among the variables, making the previous relationship misleading and unreliable (Belk, 2015, p. 365).

If the residuals of this model are stable, it indicates that the series forming this model are integrated and synchronized. To confirm the stability of the residuals (□*Z*) of this model, the Augmented Dickey-Fuller (ADF) test is used. The results are shown in Table 7 below:

Table 7: ADF Test Results for the Residuals □*Z* of the Model

UNIT ROOT TEST RESULTS TABLE (ADF)
Null Hypothesis: the variable has a unit root

	At Level	Z
With Constant	t-Statistic	-3.5712
	Prob.	*0.0109*
		**
With Constant & Trend	t-Statistic	-3.4300
	Prob.	*0.0616*
		*
Without Constant & Trend	t-Statistic	-3.5843
	Prob.	*0.0007*
		***

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

From Table 7, it is observed that the calculated ADF test value is lower than the critical MacKinnon values at the 10% significance level, indicating that the residual series *Z* is stable. Hence, the variables of the estimated model are integrated and synchronized, allowing the estimation of the error correction model.

4.6.2. Results of the Error Correction Model (ECM) Estimation: After confirming the presence of cointegration and the stability of the model residuals, the error correction model can be estimated. The results are shown in Table 8 below:

Table 8: Results of the Error Correction Model (ECM) Estimation

Dependent Variable: D(LGROWTH)
Method: Least Squares
Date: 11/07/22 Time: 10:02
Sample (adjusted): 1982 2021
Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LEAI)	0.071953	0.047265	1.522330	0.1375
D(LFCT)	-0.087641	0.050019	-1.752132	0.0890
D(LOIL)	0.031790	0.013082	2.429965	0.0207
D(LMDT)	0.019878	0.013302	1.494356	0.1446
D(LINF)	-0.002587	0.005394	-0.479582	0.6347
Z(-1)	-0.282542	0.137729	-2.051429	0.0482
C	0.008501	0.007694	1.104860	0.2772

R-squared	0.322598	Mean dependent var	0.005172
Adjusted R-squared	0.199435	S.D. dependent var	0.026431
S.E. of regression	0.023649	Akaike info criterion	-4.493378
Sum squared resid	0.018456	Schwarz criterion	-4.197824
Log likelihood	96.86756	Hannan-Quinn criter.	-4.386515
F-statistic	2.619261	Durbin-Watson stat	1.085217
Prob(F-statistic)	0.034540		

Source: Prepared by the researchers based on the outputs of the Eviews 9 program.

Based on Table (8), we can conclude the following:

- **No Short-Term Relationship**: There is no relationship between equipment and investment expenditures and economic growth in the short term, which contradicts economic theory (Keynesian theory). This result in the Algerian economy can be attributed to several reasons, including the allocation of these expenditures to sectors with low productivity, such as public works and infrastructure. The amount allocated to this sector in economic recovery programs has reached 30% of the total allocations of these programs since 2001. Additionally, the weak flexibility of the production system in Algeria, which showed a poor response to the significant increase in aggregate demand resulting from increased investment expenditure allocations, also contributed to this result.

- **Inverse Relationship**: There is a significant inverse relationship in the short term between operating expenses and economic growth. An increase in these expenses by 1% will lead to an increase in economic growth by 0.0876%. This result is inconsistent with economic theory, where an increase in operating expenses would lead to aggregate demand. Given the nature of Algeria's production system, which is characterized by low flexibility to this increase, this will lead to inflation resulting from increased demand, resulting in a decrease in economic growth.

- **Positive Relationship with Oil Prices**: There is a significant positive relationship in the short term between oil prices and economic growth. An increase in oil prices by 1% will lead to an increase in economic growth by 0.0317%. This result is consistent with the previous long-term result.

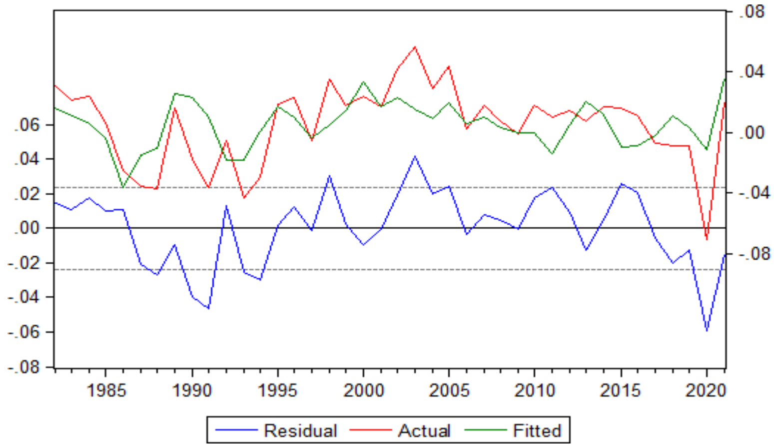
- **No Significant Relationship with Financial Sector and Inflation**: There is no significant relationship between the development of the financial sector and the inflation rate with economic growth in Algeria during the short term.

- **Error Correction Term**: The error correction term Z(-1) was found to be negative at a significance level of 1% with a value of 0.2825, which confirms the accuracy and validity of the long-term equilibrium relationship and that the error correction mechanism is present in the model.

To ensure that the error correction model is free from econometric problems, several diagnostic tests were used, confirming that the estimated model is correct, such as:

Comparison of Real and Estimated Values: The real values were compared to the estimated values using the model through the following graph:

Figure (5): Real and estimated values and residuals of the error correction model.



Source: Prepared by the researchers based on Eviews 9 outputs. The figure shows that the estimated values are close to the real values, indicating the quality of the estimated model, which can be relied upon in interpreting and analyzing the results.

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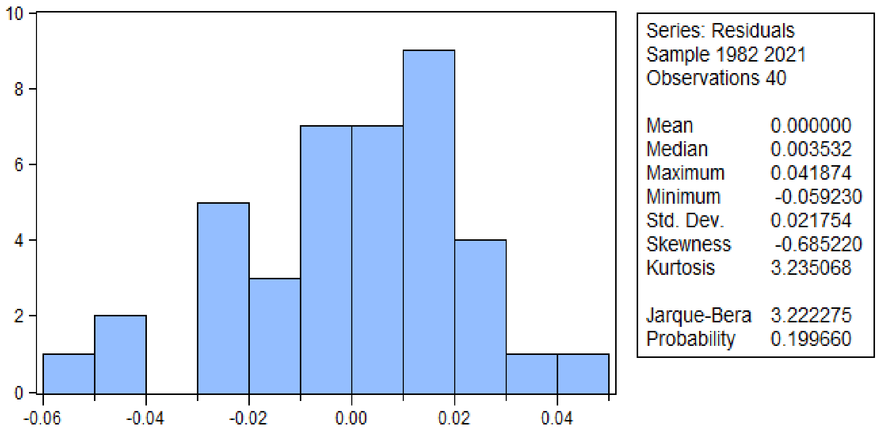
Normal Distribution of Residuals: Using the Jarque-Bera test, it was found that the probability value is not significant. The value of JB = 3.222275, which is less than the chi-square value of 5.99 at a 5% significance level, confirms that the model's residuals follow a normal distribution, as shown in:

Figure (6): Normal distribution of the residuals of the error correction model.



Source: Prepared by the researchers based on Eviews 9 outputs. It is also important to note the condition of independence among the independent variables to avoid the problem of multicollinearity, which negatively affects the estimation results. To verify the absence of this problem, we extracted the variance inflation factor (VIF). Typically, a VIF value less than 10 indicates a weak negative effect of this problem on the model, as shown in:

Table (9): Variance inflation factor of the error correction model.

Variance Inflation Factors
Date: 11/07/22 Time: 10:06
Sample: 1980 2021
Included observations: 40

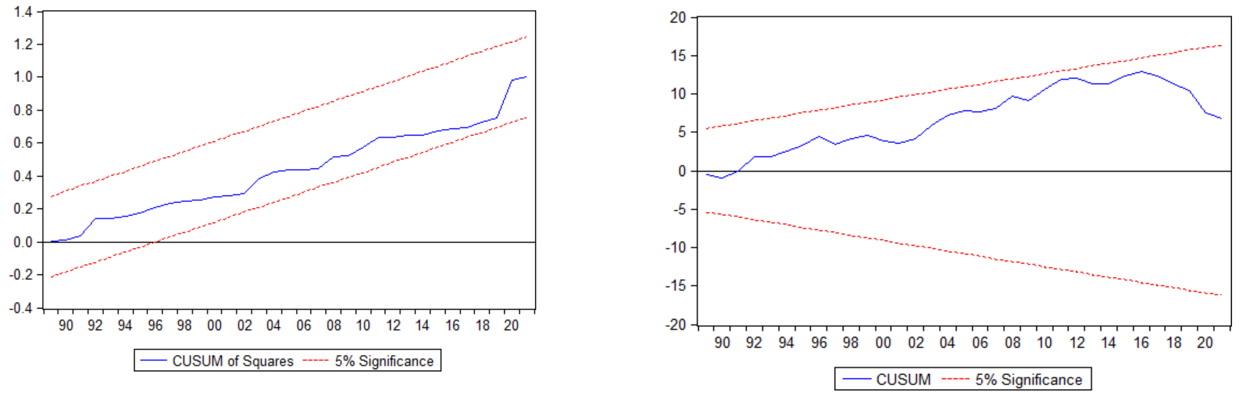
Variable	Coefficient Variance	Uncentered VIF	Centered VIF
D(LEAI)	0.002234	3.957740	1.556971
D(LFCT)	0.002502	4.377397	1.645059
D(LOIL)	0.000171	1.079183	1.078525
D(LMDT)	0.000177	1.327935	1.325023
D(LINF)	2.91E-05	1.190561	1.189911
Z(-1)	0.018969	1.440309	1.411761
C	5.92E-05	4.233685	NA

Source: Prepared by the researchers based on Eviews 9 outputs. The table shows that the VIF values for all variables are less than 10, indicating the absence of a significant negative effect of multicollinearity, allowing us to rely on the estimated model results.

To ensure that the data used in this study are free from structural changes, appropriate tests, such as the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squared recursive residuals (CUSUM of Squares), proposed by Evans and Dublin (1975) and Brown, should be used. These tests are among the most important in this field, as they demonstrate the presence of any structural changes in the data and the stability and consistency of long-term and short-term parameters. The structural stability of the estimated error correction model parameters is confirmed if the CUSUM and CUSUM of Squares test graphs fall within the critical bounds at a 5% significance level (Adriouch and Nasour, 2013, p. 23).

After performing these tests on the model, the results are shown in:

Figure (7): Model stability test.



Source: Prepared by the researchers based on Eviews 9 outputs. The graph indicates that the CUSUM test for this model lies within the critical region bounds, indicating a type of stability in the model at a 5% significance level. The same applies to the CUSUM of Squares test, indicating stability and consistency in the model between long-term and short-term results, allowing us to rely on the model estimation results.

Conclusion:

From the study of this subject, the following results were obtained:

- Public expenditures, especially in their investment aspect, are a fundamental source of economic growth achieved in Algeria.
- Johansen's cointegration results show a balanced relationship between public expenditures and economic growth.
- The study partially confirmed the first hypothesis, revealing a significant long-term relationship between equipment and investment expenditures and economic growth, while indicating no significant relationship between operating expenses and economic growth.
- The study refuted the second hypothesis, showing no significant short-term relationship between equipment and investment expenditures and economic growth, while revealing a significant inverse relationship between operating expenses and economic growth.

Based on the above results, the following recommendations can be proposed:

- Adopt a strategy to diversify the Algerian economy by directing public expenditures towards productive sectors, such as agriculture and industry, to increase the flexibility of the local production system.
- Implement measures to stimulate the private sector to increase its competitiveness and consequently increase non-hydrocarbon exports.

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