ISSN (Print): 1060-6076
ISSN (Online): Applied

The Journal of African Development
2025; Vol 6: Issue 1
https://www.afea-jad.com/

"The Impact of Foreign Trade on Economic Growth in Algeria: A Cointegration Study for the Period 2000–2021 Using the ARDL Model'"

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Cite This Paper as: Dr. Ahmed ouldmoumna, Dr. Adouka Lakhdar (2025) "The Impact of Foreign Trade on Economic Growth in Algeria: A Cointegration Study for the Period 2000–2021 Using the ARDL Model'". *The Journal of African Development l, Vol.6, No.1* 618-627

KEYWORDS
Foreign trade, economic growth and the autoregressive distributed lag (ARDL) methodology..

Received:19.04.2025
Revised : 28.08.2025
Accepted: 09.10.2025
Published: 12.11.2025

ABSTRACT
This study uses the Autoregressive Distributed Lag (ARDL) methodology to analyse the impact of foreign trade on economic growth in Algeria between 2000 and 2021. The results suggest the presence of a long-term cointegration relationship between the two variables.

INTRODUCTION

The rapid transformations that the global economy underwent during the 20th century made it difficult for countries to adopt protectionist trade policies. International trade has become a major driver of economic growth. Consequently, countries strive to enhance their exchange rates and ensure they are favourable, which consistently stimulates an increase in gross domestic product (GDP) and contributes to positive changes in economic growth rates.

Various theoretical frameworks support this approach, such as mercantilism, which posits that a trade surplus is a source of wealth (David Hume, 1758). Classical theories of international trade also argue that openness to other countries optimises the utilisation and direction of available resources in the local economy through the international division of labour (Adam Smith, 1776) and specialisation according to a country's relative cost advantage (Ricardo, 1817). Modern theories of international trade also support this approach, despite their differences with traditional theories concerning assumptions, particularly those relating to imperfect competition and increasing returns. This implies a peaceful economic system due to technological advancements enhancing total factor productivity (TFP) and raising long-term economic growth rates, as set out in endogenous growth theories (Aghion & Howitt, 2010). Modern theories of foreign trade can explain trade exchanges between industrialised countries, specifically horizontal trade (Vernon, 1966; Posner, 1961), which is considered a catalyst for economic growth in these countries.

Several empirical studies have focused on the relationship between foreign trade and economic growth given the importance of the topic. These studies include those by Balassa (1978), Grossman and Helpman (1991), Helpman and Coe (2013), and Singh (2010).

It is clear from these studies that foreign trade plays a significant role in stimulating economic growth. Consequently, many countries, including Algeria, whose production structure relies heavily on energy sources (oil and natural gas), have adopted open trade policies.

However, the collapse of commodity and energy prices (oil, natural gas, minerals, etc.) in 1985 thrust developing countries, including Algeria, into a prolonged economic crisis. The country changed its economic policies in response, starting with the adoption of the corrections and structural adjustments dictated by the International Monetary Fund (IMF). Several structural reforms were also implemented to align financial policy tools with market mechanisms, as set out in the 1990 Loan and Currency Law. Foreign trade was liberalised to support and stimulate economic growth. The aim of our study is to incorporate auxiliary variables that promote openness, such as foreign direct investment and gross fixed capital formation, as well as control variables representing economic stability, such as inflation. Thus, we attempted to combine policies of trade liberalisation (openness), financial liberalisation (foreign direct investment) and monetary policy (inflation) in order to monitor monetary stability (Levine & Renelt, 1992). The study is divided into four sections:

1. Theoretical relationship between economic growth and the following variables: foreign trade, foreign direct investment, gross fixed capital accumulation and inflation.

2. Empirical studies addressing the relationship between foreign trade and economic growth.

3. The evolution of the relationship between foreign trade and economic growth in Algeria.

4. An empirical study of the relationship between foreign trade and economic growth in Algeria.

This study will be conducted using time series analysis, leading us to pose the main research question:

What effect does foreign trade have on economic growth in Algeria?

In order to address this, we will attempt to answer the following two sub-questions:

1. What role does foreign trade play in stimulating economic growth in Algeria?

2. Is there a positive, statistically significant relationship between foreign trade and economic growth in Algeria?

Importance of the study:

This study is significant because of the importance of the topic of foreign trade, or more precisely, trade openness. This is a strategic option adopted by countries to support economic growth. However, the effectiveness of this strategy depends on the accompanying economic policies (Levine & Renelt, 1992). From this perspective, the study aims to examine the relationship between foreign trade and economic growth in Algeria, considering trade openness to be a choice and a policy intended to stimulate economic growth in the country.

Objectives of the study:

To build a model that explains the relationship between foreign trade and economic growth in Algeria while incorporating macroeconomic variables.

- To examine the effectiveness of economic policies, including trade policies and reforms regarding the liberalisation of foreign trade, that have been undertaken in Algeria.

- Track the process of Algeria's integration into the global economy through foreign trade, and examine its role as a primary driver in raising economic growth rates.

Methodology used:

Due to the nature of the subject, we adopted a descriptive and analytical approach in our study. Additionally, we adopted a statistical and econometric methodology that uses statistical and econometric methods to construct a model aiding the study of the relationship between foreign trade and economic growth in Algeria.

1. The Theoretical Relationship Between Economic Growth and Variables (Foreign Trade, Foreign Direct Investment, Gross Fixed Capital Accumulation, Inflation)

Relationship between economic growth and foreign trade:

Many economic theories and empirical studies have reached a consensus that foreign trade positively impacts economic growth. Classical economists such as Adam Smith (1776) focused on the international division of labour and specialisation for optimal resource utilisation, while Ricardo (1887) emphasised specialisation based on available comparative advantages, both of which encourage an increase in economic growth rates. Furthermore, trade liberalisation increases capital imports, including modern technologies that can be absorbed through learning and training. This facilitates the transfer of technology, allowing countries to benefit from technological advancements in the production process. Consequently, total productivity and national output increase (Grossman & Helpman, 1991; Greenway, Morgan & Wright, 1998). Conversely, exports stimulate economic growth by increasing output to meet external demand for local products (Ben Abed Al-Abdli, 2005).

Relationship Between Economic Growth and Foreign Direct Investment:

Most empirical studies and economic theory conclude that foreign investment raises economic growth rates in recipient countries, establishing a positive relationship between the two variables. Foreign direct investment facilitates the utilisation of the global capital stock and assists host countries in integrating into global value chains. It contributes to job creation and the transfer of modern production technologies via four primary channels of technology dissemination: positive externalities, competition and skill acquisition (Wang & Blomstrom, 1999). However, countries that fail to exploit opportunities are an exception, as foreign direct investment and trade openness can negatively impact their economic growth (De-Mello, 1999).

The Relationship Between Economic Growth and Inflation:

According to economic theory, this relationship can be positive or negative (the Mundell–Tobin effect), as noted in the study by Gregory and Watt (1995). In the short term, economic growth is related to savings and an increase in capital, both of which are affected by rising inflation rates. This causes economic agents to abandon liquidity, allowing capital to accumulate within financial institutions. This encourages investment and growth in output, so there is a positive short-term relationship between the two variables. Money complements capital and can be used to finance investment projects by firms. However, inflation erodes the cash balances of individuals and companies, causing a decline in purchasing power and affecting production rates. Consequently, the relationship between growth and inflation can become negative (Gokal & Hanif, 2004).

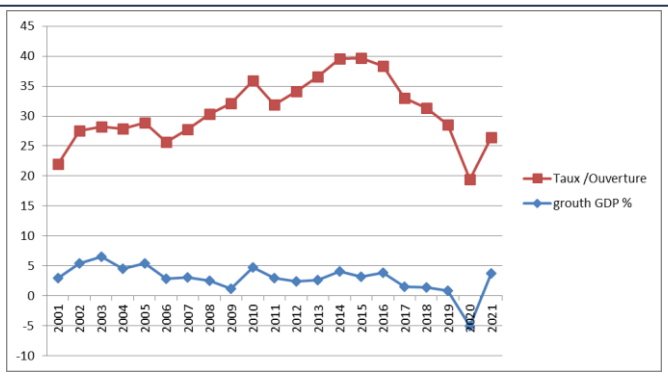
2. Empirical Studies Addressing the Relationship Between Foreign Trade and Economic Growth

Empirical studies examining this relationship have shown considerable diversity in terms of models and objectives, particularly during the 1990s. The majority of these studies supported the idea that trade openness stimulates economic growth. Imports enable the acquisition of goods and capital equipment, thereby contributing to total factor productivity growth (Rivera-Batiz & Romer, 1991a; Grossman & Helpman, 1991). Furthermore, total productivity growth tends to be higher in more open economies (Singh, 2003) as they facilitate the transfer and dissemination of technology from developed to developing countries. However, this only occurs if the latter have skilled workers capable of assimilating modern technologies (Benhabib & Spiegel, 1994). Geographical

specificity also positively stimulates economic growth (Frankel & Romer, 1999). Additionally, trade openness helps to reduce income disparities and improve living standards between countries, as measured by increases in per capita national income (Ben-David, 1993). However, trade openness can have a negative impact on economic growth if it leads to distortions affecting prices due to exchange rate fluctuations arising from implemented trade policies (Dollar, 1992).

3. The Evolution of the Relationship Between Foreign Trade and Economic Growth in Algeria

Figure No. (1): Index of the relationship between foreign trade and economic growth in Algeria during the period (2001-2012)



Source: Prepared by the researchers based on data from the World Bank (World Bank, 2025).

Figure 1 shows how the relationship between foreign trade (represented by the trade openness ratio) and economic growth (expressed as the GDP growth rate) evolved in Algeria during the study period (2001–2021). There is a clear direct relationship between the trade openness ratio and the GDP growth rate; however, the impact is weak. This is due to the sectors on which foreign trade relies, particularly hydrocarbon exports, which have low value-added ratios compared to the manufacturing sector and other productive sectors.

4. Empirical Study of the Relationship Between Foreign Trade and Economic Growth in Algeria

A standard model will be established to analyse the relationship between foreign trade, represented by the trade openness ratio, and economic growth, indicated by per capita GDP growth, for the period 2000–2022. For this purpose, econometric analysis methodology will be employed, with economic growth represented by per capita gross domestic product as the dependent variable, and foreign trade represented by the trade openness ratio as the explanatory variable. Other explanatory variables will include gross fixed capital formation, foreign direct investment and the inflation rate. Data for the selected variables were sourced from the World Bank's Economic Development Indicators website.

The econometric study will be divided into three sections. The first section will describe the model, addressing the theoretical relationship between the dependent and independent variables, and the statistical analysis of the study variables. The second section will focus on the econometric modelling of the relationship between foreign trade and economic growth in Algeria.

Model description:

This study used a time series model to analyse the relationship between foreign trade and economic growth from 2000 to 2021. The model's theoretical framework is based on the Cobb-Douglas production function and the Solow model (1956), incorporating technical progress as an internal variable. The model also draws on endogenous growth theories, such as the Romer (1986) model, Lucas (1988) and Mankiw, Romer & Weil (1992). These endogenous growth models emphasise the importance of knowledge accumulation, physical capital formation and skilled labour in raising economic growth rates and per capita GDP. As formulating the econometric model is one of the most important stages of an econometric study, this is reflected in the identification of the variables. The model is therefore formulated as follows:

$$PIB_t = f(K_t, L_t, Z_t) \quad \text{.....(1)}$$

Since the model is derived from the Cobb–Douglas production function, it is expressed as follows:

$$PIB_t = \beta_0 K_t^{\beta_1} L_t^{\beta_2} Z_t^{\beta_3} \quad \text{.....(2)}$$

Where GDP represents economic growth, indicated by per capita GDP; K represents capital, modelled in this study by the gross fixed capital formation variable; and L represents the labour force. L was omitted due to a lack of statistical properties to avoid linear multicollinearity. The variable Z encompasses the following variables: INF, IDE and OUV, respectively representing foreign trade (indicated by the trade openness ratio, which is the sum of exports (X) and imports (M) divided by GDP (Y): (X + M/Y), foreign direct investment (net inflows) and the inflation rate measured by the consumer price index (CPI).

After introducing the logarithm, model (2) is expressed as follows:

$$lPIB_t = \alpha_{0t} + \alpha_{1t} lFCBF_t + \alpha_{2t} OU_t + \alpha_{3t} lIDE_t + \alpha_{4t} lINF_t + \mu + \varepsilon_t \ldots\ldots \quad (3)$$

Study of stationarity:

We will use the Augmented Dickey-Fuller (ADF) test for unit roots on all the following model variables: economic growth (GDP), trade openness (TO), gross fixed capital formation (GFCF), foreign direct investment (FDI) and the inflation rate (INF). This ensures that all variables are stationary at level or at the first difference I(1), as conducting the 'bounds test' is invalid if any variable is integrated at the second difference I(2) or higher. The ADF test relies on the degree of lags, which was determined to be one based on the partial autocorrelation function.

Table 1: Unit Root Test for the Model Variables Using ADF

Variable	Stability at the level		Stability at the first difference		Degree of integration
	ADF^c	ADF^t	ADF^t	ADF^c	
$lPIB_t$	1.82	-1.95	-1.96	-1.99	I(1)
$lOUV_t$	0.13	-1.96	-1.96	-3.01	I(1)
$lFCBF_t$	0.88	-1.95	-1.96	-2.98	I(1)
$lINF_t$	-0.78	-1.96	-1.96	-5.67	I(1)
$lIDE_t$	-3.56	-1.96			I(0)

Source: Prepared by the researcher based on the outputs of EViews 10.

According to the results of the unit root test (ADF) in Table 1, we observe that the calculated test statistic of the Augmented Dickey-Fuller is greater than the tabulated value at the 5% level for the original series of the model variables (_ _ _ _). Based on this test, we can reject the null hypothesis of no unit root, indicating that the series is non-stationary. This led us to examine the stationarity of the first differences for all previous series. The outcome showed that the calculated Augmented Dickey-Fuller statistic was less than the tabulated value at the 5% significance level. This suggests that the series are stationary at the first difference, with the exception of foreign direct investment (FDI), where the calculated Augmented Dickey-Fuller statistic was less than the tabulated value. This indicates that the FDI series is stationary at level I(0) at the 5% significance level. According to these results, some series are stationary at the first difference and some at level, making it possible to apply the ARDL methodology.

Cointegration Test:

The ARDL model for the study variables can be expressed as follows:

$$lPIB_t = \beta_0 + \sum_{i=1}^{P} \delta_i \Delta lPIB_{t-i} + \sum_{i=1}^{P} \alpha_i \Delta lOUV_{t-i} + \sum_{i=1}^{P} \omega_i \Delta lFCBF_{t-i} + \sum_{i=1}^{P} \lambda_i \Delta lIDE_{t-i} + \sum_{i=1}^{P} \lambda_i \Delta lINF_{t-i} + \varphi_1 \mathrm{lOUV}_t + \varphi_2 \mathrm{lFCBF}_t + \varphi_3 \mathrm{lIDE}_t + \varphi_4 \mathrm{lINF}_t + \mathrm{U}_t$$

Where β are the coefficients of the independent variables in the short run and θ are the coefficients of the independent variables in the long run, and e represents the residuals.

The ARDL model indicates that economic growth can be explained by its own lagged values and the lagged values of the independent variables, as well as by the concept of cointegration (Pesaran et al., 2001). In ARDL models, the test centres

on the null hypothesis (H0), which states that there is no cointegration among the model variables, versus the alternative hypothesis (H1), which asserts that there is cointegration among the model variables. This can be expressed as follows:

$$\begin{cases} H_0 : \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = 0 \\ H_1 : \varphi_1 \neq \varphi_2 \neq \varphi_3 \neq \varphi_4 \neq 0 \end{cases}$$

To conduct the cointegration test, we use the ARDL bounds testing approach, which relies on the F statistic. The decision-making process is as follows:

If the F-statistic value is greater than the upper bound of the critical values, the null hypothesis of no cointegration relationship is rejected.

- If the F-statistic is less than the lower bound of the critical values, we accept the null hypothesis of no cointegration relationship.

If the F-statistic value falls between the upper and lower bounds of the critical values proposed by Pesaran et al. (2001), a decision cannot be made.

The following table summarises the bounds tests.

Table 2: ARDL Bounds Test

	Calculated value	Number of variables (k)
F-statistics	**8.637454**	4
Critical value limits		
Level of significance	Minimum I(0)	- Maximum I(1)
10%	**2.2**	3.09
5%	**2.56**	3.49
2.5%	**2.88**	3.87
1%	**3.29**	4.37

Source: Prepared by the researcher based on the outputs of EViews 10.

Table 2 shows that the calculated Fisher F-statistic value (8.637) is greater than the critical values at the maximum bound for all significance levels. Therefore, we reject the null hypothesis (H0), which posits no cointegration, and accept the alternative hypothesis (H1), which asserts the existence of a long-term cointegration relationship. This indicates an equilibrium relationship among the study variables over the long run.

Estimation of the Static Equation:

The static equation was estimated using EViews 10 as follows:

$$lPIB_t = \underset{(17,16)}{9,14} + \underset{(2,95)}{0,33}lOUV_t - \underset{(-1,06)}{0,13}lFCBF_t - \underset{(-1,12)}{0,01}lIDE_t + \underset{(0,88)}{0,02}lINF_t$$

Model diagnosis:

Model quality

To assess the quality of the model, we conducted the following diagnostic tests:

- Breusch-Godfrey Serial Correlation LM Test: Tests for serial correlation of the residuals.

- Heteroskedasticity test (ARCH): Tests for the presence of non-constant variance.

- Jack-Bera normality test: Tests for normal distribution of random errors.

- Ramsey Reset Test: Assesses the adequacy of the model specification in terms of its functional form.

- Structural Stability Test: Evaluates the structural stability of the model.

Table 3 summarises the results of the diagnostic tests for the model.

Table 3: Results of Diagnostic Tests for the Model

Test for Autocorrelation of Residuals (Breusch-Godfrey Serial Correlation LM Test)			
Null hypothesis (H0): There is no issue with serial autocorrelation in the residuals of the regression equation.			
F-statistique	1.712229	Prob F (2,11)	0.2252
Obs*R-squared	4.748126	Probability of Chi-Square (2)	0.0931
Test for heteroskedasticity (Heteroskedasticity Test ARCH).			
Null hypothesis (H0): Constancy of variance			
F-statistique	0.573579	Prob F (1,17)	0.4592
Obs*R-squared	0.620135	Probability of Chi-Square (1)	0.4310
Jarque-Bera normality test: Test for normal distribution of random errors			
Null hypothesis (H0): The residuals are normally distributed.			
0.13	Prob	3.99	Jarque-Bera
Ramsey RESET test Test for model specification			
Null hypothesis (H0): The model is correctly specified.			
t-statistique	0.102483	Probability	0.9201
F-statistique	0.010503	Probability	0.9201

Source: Prepared by the researchers using EViews 10.

Table 3 shows that the results of the diagnostic tests for the model confirm the following:

- The Breusch-Godfrey Serial Correlation LM Test indicates a Fisher probability of 0.22, which is greater than the 5% significance level. Therefore, we can reject the alternative hypothesis that there is serial correlation in the residuals of the regression equation.

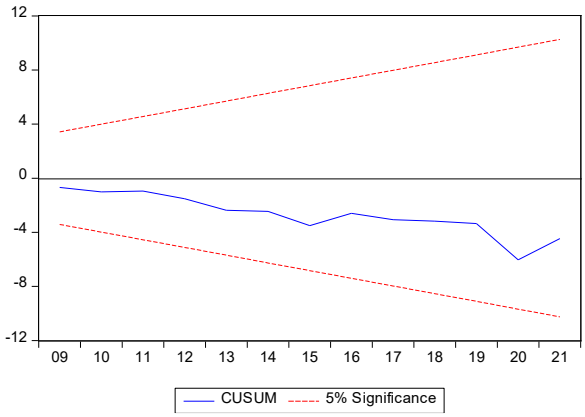
- The Heteroskedasticity Test suggests a Fisher probability of 0.45, which is also greater than the 5% significance level. This leads us to accept the null hypothesis of constant variance in the residuals.

- Regarding the normal distribution of random errors, the Jack-Bera probability is 0.13, which is greater than the 5% significance level. This confirms acceptance of the null hypothesis that the residuals are normally distributed.

- The Ramsey Reset Test shows that the model does not suffer from an inadequate functional form, as indicated by the probability value of 0.92, which is greater than the 5% significance level.

- The CUSUM test indicates that the model is structurally stable.

Figure 1: CUSUM test for structural stability of the model



Source: Prepared by the researchers using EViews 10.

Statistical and economic interpretation of results:

The model has strong explanatory power, as indicated by the coefficient of determination, which reached 0.96. Thus, the independent variables (trade openness, foreign direct investment, gross fixed capital formation and the inflation rate) explain 96% of the dependent variable (economic growth), with the remaining 4% being explained by other variables.

Economically, the estimated function aligns with the previous empirical and theoretical considerations, as follows:

- For the trade openness coefficient, the positive sign indicates a direct relationship between the dependent variable (economic growth) and the independent variable (trade openness). This aligns with the expected sign in economic theory: a one-unit change in the trade openness ratio causes a corresponding 0.33-unit increase in economic growth in Algeria.

For the foreign direct investment coefficient, the negative sign indicates an inverse relationship between the dependent variable (economic growth) and the independent variable (foreign direct investment). This contradicts economic theory, as Algeria has failed to leverage opportunities effectively, and certain conditions and constraints have been placed on foreign direct

investment, such as restrictions on capital movement. Furthermore, local companies are less competitive than foreign companies, making it difficult for them to maintain their market positions. In this case, foreign direct investment has a negative impact on economic growth. The estimated equation in our study shows that a one-unit increase in foreign direct investment leads to a 0.016-unit decrease in economic growth.

Regarding the gross fixed capital formation coefficient, its negative sign indicates an inverse relationship with economic growth. This is contrary to economic theory, which asserts a positive relationship. An increase in the gross fixed capital formation ratio by one unit results in a corresponding negative change in economic growth of 0.13 units. This is due to structural imbalances in the Algerian economy leading to suboptimal utilisation and allocation of resources, as well as total dependency on the hydrocarbon sector and a lack of economic diversification. Additionally, slow progress in the private sector — such as a shortage of productive private investments that create added value and wealth — and a lack of qualified human capital capable of utilising, managing and maintaining fixed capital (factories, equipment, machinery and production chains) adversely affects productivity levels and thus reduces economic growth rates in Algeria.

For the inflation rate coefficient, a positive sign indicates a direct relationship between economic growth and the inflation rate. This aligns with economic theory in the long term and with the results of empirical studies (Gokal & Hanif, 2004). According to the estimated equation, an increase in the inflation rate by one unit results in a positive change in economic growth of 0.021 units in Algeria.

1. CONCLUSION:

Through studying the impact of foreign trade on economic growth in Algeria between 2000 and 2021 using the Autoregressive Distributed Lag (ARDL) methodology, the results showed a positive and statistically significant relationship with the trade openness coefficient. This suggests a direct correlation between economic growth and trade openness, which is consistent with the predictions of economic theory. Each unit change in the trade openness ratio results in a positive change in economic growth of 0.33 units, confirming the presence of a long-term cointegration relationship. Therefore, in the long term, there is an equilibrium relationship between foreign trade and economic growth in Algeria.

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