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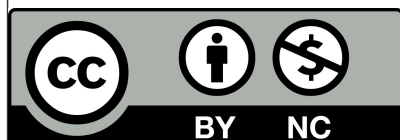
DETERMINANTS OF ECONOMIC GROWTH IN ALGERIA: EVIDENCE FROM AN ARDL BOUNDS TESTING APPROACH (1990–2024)



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Determinants of Economic Growth in Algeria: Evidence From an ARDL Bounds Testing Approach (1990–2024)

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ABSTRACT

This study analyzes the determinants of economic growth in Algeria over the period 1990–2024 using an Autoregressive Distributed Lag (ARDL) bounds testing approach. It examines the short- and long-run effects of public expenditure, trade openness, foreign direct investment, education expenditure, and oil rents on economic growth. The empirical findings confirm the existence of a stable long-run relationship among the variables. Estimation results show that public expenditure, trade openness, and education expenditure exert a positive and statistically significant impact on economic growth, highlighting the critical role of public investment, trade integration, and human capital accumulation. Foreign direct investment also contributes positively, although its impact remains relatively modest. Conversely, oil rents display a statistically significant negative effect, underscoring the structural limitations of a growth model reliant on hydrocarbon revenues. These findings emphasize the imperative to accelerate economic diversification, enhance human capital, and improve public policy effectiveness to foster sustainable and resilient growth in Algeria.

Keywords: Economic growth, ARDL model, Algeria, Public expenditure, Trade openness, Oil rents.

JEL Classification codes: O47, F43, H50, I25, O55.

1. INTRODUCTION

Economic growth remains a key indicator of macroeconomic performance and a cornerstone of development policy. Since Solow's (1956) seminal contribution, growth theory has evolved toward endogenous approaches emphasizing the roles of human capital, innovation, technological progress, and public policy (Lucas, 1988; Romer, 1986, 1990; Barro, 1990). These theories highlight that long-run growth depends primarily on structural determinants such as human capital, trade openness, institutional quality, and effective macroeconomic policies (Barro & Sala-i-Martin, 2004). Nevertheless, the relative

importance of these determinants varies across countries according to their structural characteristics, level of development, and institutional environment.

In resource-dependent economies, growth dynamics exhibit specific challenges. The literature on the "natural resource curse" argues that although resource abundance may initially support economic activity, it often creates vulnerabilities through dependence on export revenues, weak productive diversification, and greater exposure to external shocks (Sachs & Warner, 2001; Gylfason, 2001). Recent evidence further suggests that the impact of natural resources on growth depends largely on institutional quality, economic governance, and the implementation of effective diversification strategies (Alssadek&Benhin, 2023).

Algeria represents a typical example of a resource-dependent economy. Despite successive economic reforms introduced since the 1990s to promote economic openness and productive diversification, its growth model remains structurally dependent on the hydrocarbon sector. This dependence leaves the economy highly vulnerable to fluctuations in international oil prices, weakens fiscal sustainability, and constrains long-term economic growth.

Against this backdrop, identifying the determinants of economic growth in Algeria is essential for designing policies capable of reducing hydrocarbon dependence and promoting structural transformation. Although several studies have investigated Algeria's growth determinants, their findings remain mixed and sometimes contradictory (Issolah et al., 2021; Hammache, 2022; Belhadj&Mebarki, 2021; Belhimer&Helali, 2023). These differences mainly reflect variations in study periods, variable selection, and econometric methods. Moreover, the profound changes in Algeria's economic environment over recent decades call for an updated empirical assessment of the country's growth dynamics.

To address these gaps, this study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran, Shin, and Smith (2001). This methodology simultaneously estimates short- and long-run relationships and can be applied to variables integrated of order $I(0)$, $I(1)$, or a combination of both, making it particularly suitable for modeling macroeconomic dynamics in developing economies.

The main contribution of this study is to provide an updated and comprehensive empirical assessment of Algeria's growth determinants over the period 1990–2024. By jointly examining the short- and long-run effects of public expenditure, trade openness, foreign direct investment (FDI), education expenditure, and oil rents within a unified ARDL framework, the study extends the empirical literature on growth in resource-dependent economies while providing policy-relevant evidence to support economic diversification and sustainable development.

Accordingly, this study aims to quantify the short- and long-run effects of public expenditure, trade openness, foreign direct investment, education expenditure, and oil rents on economic growth in Algeria. Based on theoretical and empirical evidence, public expenditure, trade openness, FDI, and education expenditure are expected to exert positive effects on economic growth, whereas oil rents are hypothesized to have a negative impact because of the structural constraints associated with resource dependence and Dutch disease.

The remainder of this paper is organized as follows. Section 2 reviews the theoretical and empirical literature on the determinants of economic growth. Section 3 presents the empirical methodology, including the model specification, variables, data sources, and econometric procedures. Section 4 reports the empirical findings. Section 5 discusses the results and their policy implications. Finally, Section 6 concludes the study and outlines its main policy recommendations and directions for future research.

2. LITERATURE REVIEW

Identifying the drivers of economic growth occupies a central position in macroeconomic literature. Following Solow's (1956) neoclassical paradigm, growth research was revolutionized by endogenous growth frameworks, which explicitly modeled human capital, innovation, technological spillovers, and public sector interventions as internal drivers of long-run output (Lucas, 1988; Romer, 1986, 1990; Barro, 1990). In this setting, Aghion and Howitt (1992) demonstrated that innovation and "creative destruction" serve as fundamental engines of long-term growth by fostering technological renewal, enhancing factor productivity, and accelerating knowledge diffusion. Broadly, the literature identifies human capital, capital accumulation, financial development, trade openness, public expenditure, institutional quality, macroeconomic stability, and, in resource-rich settings, extractive resource rents as core determinants of output expansion.

Extending the neoclassical model, Mankiw, Romer, and Weil (1992) incorporated human capital accumulation into an augmented production function. Utilizing a cross-country sample of 98 nations, they demonstrated that physical and human capital accumulation account for a substantial portion of cross-country income variation. Similarly, Barro (1991) highlighted the positive effects of human capital, private investment, and political stability on output growth, while cautioning against the distortive impacts of political instability and policy misallocations. These findings were further corroborated by Barro and Sala-i-Martin (2004), who reinforced that human capital, technological progress, and macroeconomic governance represent indispensable determinants of long-run expansion.

Financial sector development also features prominently as a growth facilitator. Levine and Zervos (1998) established that a well-developed financial system mobilizes domestic savings, improves resource allocation efficiency, and lowers capital allocation costs, thereby bolstering long-run growth. Concurrently, trade openness fosters specialization, facilitates technology transfer, and generates total factor productivity gains. In this regard, Sachs and Warner (1995) showed that open economies systematically outperform closed economies in long-term growth performance.

Foreign Direct Investment (FDI) serves as an additional catalyst for economic expansion, particularly when paired with adequate domestic absorptive capacity. Borensztein, De Gregorio, and Lee (1998) argued that FDI drives technology transfers, knowledge spillovers, and managerial skill enhancement, though its ultimate efficacy remains conditional upon a host country's baseline stock of human capital.

Another strand of the literature emphasizes the importance of institutional quality and public policies. Barro (1990) showed that productive public expenditure, particularly on infrastructure, education, and public health, enhances private-sector productivity, whereas unproductive expenditure generates crowding-out effects. From an empirical perspective, Gebreyesus (2023) examines the relationship between public expenditure and economic growth in Ethiopia, Kenya, Tanzania, and Rwanda using panel data covering the period 2011–2020. Using linear regression and descriptive analysis, the author finds a positive but statistically insignificant relationship between public expenditure and economic growth across the four countries studied. This finding suggests that an increase in public expenditure does not necessarily translate into a significant acceleration of economic growth, thereby highlighting the importance of the efficiency and quality of public resource allocation.

Similarly, Acemoglu, Johnson, and Robinson (2005) argue that good governance, secure property rights, and political stability promote investment, whereas institutional weaknesses hinder economic performance. These findings are further supported by Trpeski, Tashevska, and Merdzan (2024), who show that strong institutions

enhance the benefits of human capital, financial development, and trade openness, as well as by Fischer (1993), who identifies macroeconomic stability as a prerequisite for sustained growth.

In resource-endowed economies, oil rents remain a key but controversial determinant of economic performance. Sachs and Warner (2001) argue that resource abundance may hinder long-run growth by crowding out manufacturing, increasing price volatility, and weakening institutions. Similarly, Gylfason (2001) shows that natural resource wealth may reduce incentives to invest in human capital. More recently, Alssadek and Benhin (2023) emphasize that the impact of resource wealth ultimately depends on institutional quality, economic governance, and successful economic diversification.

Recent cross-country empirical evidence reaffirms that growth outcomes stem from complex interactions among macroeconomic, structural, and institutional factors. Utilizing panel data from 78 nations, Zdilar, ObuljenZoričić, and Pušić (2025) confirmed that domestic investment, employment rates, and institutional quality serve as key drivers of growth, though their relative elasticities vary according to income levels. Notably, they emphasized that robust institutional frameworks enhance the marginal efficiency of public policies, reinforcing the foundational role of governance in sustainable development.

These theoretical and empirical considerations provide a compelling analytical lens for examining resource-dependent economies such as Algeria. Existing empirical studies on Algeria confirm that domestic economic performance remains tightly coupled with oil revenues, state expenditures, and macroeconomic fluctuations.

Employing an ARDL framework over the period 1965–2019, Belhimer and Helali (2023) documented that financial development positively drives economic growth, confirming a stable long-run cointegrating relationship among key macroeconomic variables. Conversely, Hammache (2022) found that while public expenditure supports growth in the long run, it exerts a negative impact in the short run due to allocative inefficiencies and implementation delays.

Human capital also emerges as a vital, albeit underutilized, driver of Algerian growth. Issolah, Djemaci, and Kertous (2021) demonstrated that improvements in educational attainment yield positive growth elasticities, whereas public health spending displays negligible effects, pointing to ongoing structural inefficiencies in resource allocation.

Regarding resource rents, empirical studies on Algeria consistently document the structural challenges posed by hydrocarbon reliance. Benabdallah (2006) highlighted the prevalence of Dutch disease dynamics within the national economy, while Jbir and Zouari-Ghorbel (2011) showed that oil price shocks propagate volatility directly across real macroeconomic aggregates. More recently, Belhadj and Mebarki (2021) confirmed that oil rents exert a statistically significant negative long-run effect on Algerian economic growth, aligning with global empirical evidence on the natural resource curse.

In summary, the literature shows broad consensus that human capital, trade openness, physical investment, financial development, and productive public expenditure promote economic growth. However, the role of natural resource wealth remains debated, particularly in hydrocarbon-dependent economies where outcomes depend on institutional quality and economic diversification. In Algeria, existing studies often examine only a limited set of determinants or relatively short time periods, resulting in mixed evidence and few integrated empirical analyses.

To address these gaps, this study examines the effects of public expenditure, education expenditure, trade openness, foreign direct investment, and oil rents over the period 1990–2024 using an ARDL framework. By distinguishing short- and long-run effects, it provides updated evidence on the macroeconomic determinants of sustainable growth in a resource-dependent economy.

3. METHODOLOGY

3.1. Econometric Framework

The empirical analysis relies on the Autoregressive Distributed Lag (ARDL) bounds testing framework pioneered by Pesaran, Shin, and Smith (2001). This approach enables the simultaneous estimation of short-run dynamics and long-run equilibrium relationships among variables, provided that no series is integrated of order two, I(2). The ARDL framework offers distinct methodological advantages for small-sample time-series analyses and accommodates models containing a mix of I(0) and I(1) stationary variables.

3.2. Data and Variables

This study utilizes annual time-series data spanning the period 1990–2024. Statistical series are sourced from the World Bank’s World Development Indicators (WDI) database, recognized for its cross-country comparability, methodological rigor, and data reliability.

The dependent variable is the natural logarithm of real gross domestic product per capita (LGDP), serving as a proxy for economic growth. Grounded in theoretical growth frameworks and prevailing empirical literature, five explanatory variables are incorporated into the model: Foreign Direct Investment (FDI), trade openness (LOR), oil rents (LTO), public government spending (LGSE), and human capital (LGE).

Foreign Direct Investment (FDI), expressed as a percentage of GDP, measures net foreign capital inflows. Trade openness (LOR), defined as the ratio of total trade (exports plus imports) to GDP, captures the economy's integration into global markets. Oil rents (LTO), measured as a percentage of GDP, reflects the relative weight of hydrocarbon revenues in the Algerian economy. Public expenditure (LGSE), expressed as a percentage of GDP, captures the extent of state intervention in the economic process. Finally, human capital (LGE) is proxied by the gross secondary school enrollment rate, a widely accepted metric for skills accumulation. Table 1 summarizes the variable definitions, measurement units, expected signs, and theoretical foundations.

Table 1. Description of Variables and Theoretical Rationale

Variable	Abbreviation	Definition& Unit of Measurement	Expected Sign	TheoreticalRationale
Real GDP	GDP	Constant Real GDP per capita (LGDP)	Dependent	Solow (1956); Barro (1991)
Foreign Direct Investment	FDI	Net FDI inflows (% of GDP)	+	Capital accumulation, technologytransfer (Borensztein et al., 1998)
Trade Openness	OR	Trade Openness Rate (Exports + Imports) (% of GDP)	+	International trade, technology spillovers (Frankel &Romer, 1999)

OilRents	LTO	Oil Rents (% of GDP)	±	Fiscal revenue injection vs. Natural Resource Curse (Sachs & Warner, 1995, 2001)
Public Expenditure	GSE	General Government Final Consumption Spending (% of GDP)	+	Productive public infrastructure investment (Barro, 1990)
Education Spending	LGE	Gross Secondary School Enrollment Rate (%)	+	Human capital accumulation and endogenous growth (Lucas, 1988; Mankiw et al., 1992)

Source: Compiled by the authors

3.3. Model Specification

To empirically evaluate the determinants of economic growth in Algeria, the baseline relationship between real GDP per capita and the vector of explanatory variables is formulated as follows:

$$GDP_t = C + \beta_1 FDI_t + \beta_2 OR_t + \beta_3 LTO_t + \beta_4 GSE_t + \beta_5 LGE_t + \varepsilon_t$$

The empirical analysis follows the ARDL bounds testing approach of Pesaran et al. (2001). First, the stationarity of the variables is examined using the Augmented Dickey-Fuller (ADF) unit root test. Next, the optimal lag structure is selected according to the Akaike Information Criterion (AIC), followed by the ARDL bounds test to determine the existence of a long-run relationship. Once cointegration is established, the long-run coefficients and the error correction model (ECM) are estimated. Finally, a series of diagnostic and stability tests are performed to assess the validity and robustness of the estimated model.

4. RESULTS

4.1. Validation of the ARDL Approach

Prior to estimating the ARDL model, it is necessary to verify that the core underlying statistical conditions governing bounds testing are fully satisfied. To this end, the integration properties of the series are evaluated via the Augmented Dickey-Fuller (ADF) unit root test. Subsequently, the optimal lag structure is selected using the Akaike Information Criterion (AIC) before conducting the F-bounds test for long-run cointegration.

4.1.1. Unit Root Tests

Table 2 reports the empirical results of the Augmented Dickey-Fuller (ADF) unit root test applied to all variables in levels and first differences.

Table 2. Augmented Dickey-Fuller (ADF) Unit Root Test Results

	AtLevel		First difference		Order of Integration
	T-Statistic	Prob	T-Statistic	Prob	
LGDP	-2.418468	0.3641	-5.715475	0.0002	I(1)

FDI	-3.015848	0.1432	-6.258527	0.0001	I(1)
LOR	-2.114932	0.5194	-6.117779	0.0001	I(1)
LTO	-0.667811	0.9671	-7.380253	0.0000	I(1)
LGSE	0.100975	0.5960	-4.557752	0.0049	I(1)
LGE	-2.472468	0.3386	-4.337591	0.0083	I(1)

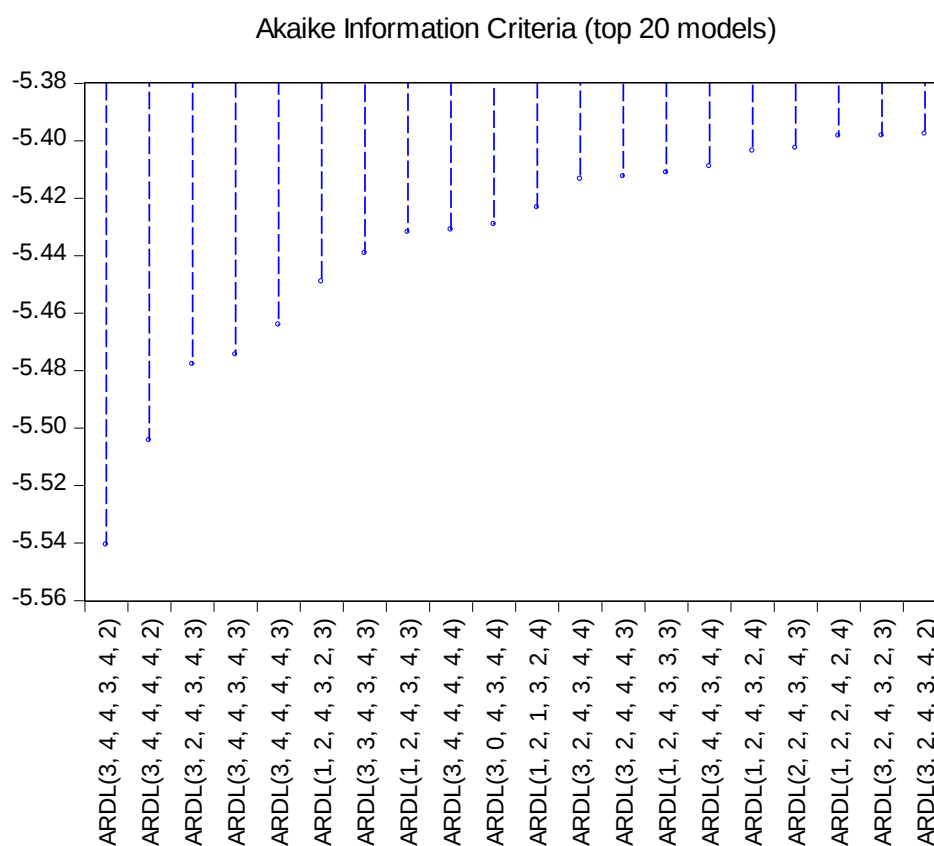
Source: Authors based on EViews 9 output

The empirical results demonstrate that all variables are non-stationary in levels, as their associated p-values exceed the standard 5% significance threshold. However, upon taking first differences, all series achieve stationarity at the 1% significance level ($p < 0.01$). This confirms that all variables are integrated of order one, I(1). These findings satisfy the structural precondition for applying the ARDL bounds testing methodology, which requires that no series be integrated of order two, I(2).

4.1.2. Optimal Lag Length Selection

Determining the optimal lag order represents a critical step in the empirical specification of an ARDL model to ensure white-noise residuals without over-parameterizing the dynamic structure. The optimal lag combination is selected by minimizing the Akaike Information Criterion (AIC), as illustrated in Figure 1.

Figure 1. Optimal Lag Length Selection Based on the Akaike Information Criterion (AIC)



Source: Authors based on EViews 9 output

Figure 1 indicates that the ARDL specification (3, 4, 4, 3, 4, 2) yields the minimum Akaike Information Criterion (AIC) value among all evaluated models. Consequently, this optimal lag specification is selected for subsequent empirical estimation.

4.1.3. Bounds Test for Cointegration

Following the determination of the optimal lag structure, the Pesaran et al. (2001) F-bounds test is conducted to evaluate the existence of a long-run equilibrium relationship among the variables. The empirical results are presented in Table 3.

Table 3. ARDL Bounds Test for Cointegration

SignificanceLevel	I(0) LowerBound	I(1) UpperBound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68
F-Statistic	11.02186	

Source: Authors based on EViews 9output

The empirical bounds test yields an F-statistic of 11.0219, which comfortably exceeds the upper critical bound value I(1) across all standard significance thresholds. Consequently, the null hypothesis of no cointegration is decisively rejected, confirming the presence of a stable long-run equilibrium relationship among the variables. This cointegration result validates the estimation of the long-run coefficients and the error correction model (ECM).

4.2. Estimation of Long-Run and Short-Run Dynamics

Following the empirical confirmation of cointegration, both long-run coefficients and short-run dynamics are estimated within the specified ARDL framework.

4.2.1. Long-Run Equilibrium Relationship

Table 4 presents the estimated long-run structural coefficients connecting real economic growth to the explanatory variables.

Table 4. ARDL Long-Run Relationship

Variable	Coefficient	Std. Error	t-Statistic	p-Value
LTO	-1.054103	0.446588	-2.360349	0.0476
LOR	0.553239	0.195970	2.823084	0.0477
FDI	0.151558	0.069155	2.191568	0.0935
LGE	0.471933	0.170527	2.767491	0.0405
LGSE	1.252222	0.316386	3.957896	0.0167
C	3.824769	1.584598	2.413716	0.0433

Cointeq = LGDP - (-1.0541*LTO + 0.5532*LRO + 0.1516*FDI + 0.4719*LGE + 1.2522*LGSE + 3.8248)

Source: Authors based on EViews 9output

The results highlight a statistically significant long-run relationship between economic growth and the selected explanatory variables. Public expenditure (LGSE) exerts the strongest positive effect on economic growth, with a coefficient of 1.2522 ($p = 0.0167$), indicating that a 1% increase in public expenditure is associated with an approximate 1.25% increase in real GDP in the long run. Trade openness (LOR) also has a positive and significant effect ($\beta = 0.5532$; $p = 0.0477$), suggesting that greater integration into international trade promotes economic growth.

Human capital (LGE) contributes positively to growth, with a coefficient of 0.4719 ($p = 0.0405$), confirming the favorable role of educational attainment in economic development. Foreign direct investment (FDI) has a positive coefficient, but is only weakly significant at the 10% level, indicating a relatively modest contribution to economic growth. This result should be interpreted with caution, particularly due to the strong concentration of FDI in the hydrocarbon sector, weak linkages with the domestic productive sector, and limited technology transfers. The volatility of FDI flows, along with certain shortcomings in the institutional and economic environment, may also explain their moderate long-term impact in Algeria.

Conversely, oil rents (LTO) display a negative and significant coefficient ($\beta = -1.0541$; $p = 0.0476$), indicating that greater dependence on oil revenues slows long-run economic growth. Overall, these findings suggest that economic growth in Algeria is primarily driven by public expenditure, trade openness, and human capital, whereas heavy reliance on oil resources remains a constraint on long-run growth.

4.2.2. Short-Run Relationship

Table 5 presents the results of the Error Correction Model (ECM), allowing for the analysis of short-run adjustments as well as the speed of convergence toward long-run equilibrium.

Table 5. Short-Run Estimation Results

Variables	Coefficients	Std.Error	T-Statistic	Prob
D(LGDP(-1))	-0.481432	0.083810	-5.744300	0.0046
D(LGDP(-2))	-0.098918	0.064631	-1.530493	0.2006
D(LTO)	-0.186106	0.091077	-2.043400	0.1105
D(LTO(-1))	0.230931	0.095132	2.427478	0.0722
D(LTO(-2))	0.094452	0.099601	0.948305	0.3967
D(LTO(-3))	0.142053	0.066091	2.149366	0.0981
D(LRO)	0.051554	0.031963	1.612895	0.1821
D(LRO(-1))	-0.097897	0.035966	-2.721942	0.0529
D(LRO(-2))	0.041739	0.039680	1.051891	0.3522
D(LRO(-3))	-0.189805	0.026523	-7.156348	0.0020
D(FDI)	-0.005118	0.008639	-0.592452	0.5854
D(FDI(-1))	-0.015570	0.008517	-1.828180	0.1415
D(FDI(-2))	-0.040981	0.008817	-4.648037	0.0097
D(LGE)	-0.081535	0.032610	-2.500334	0.0667
D(LGE(-1))	-0.091708	0.050082	-1.831171	0.1410
D(LGE(-2))	0.065984	0.053957	1.222896	0.2885

D(LGE(-3))	-0.277570	0.049746	-5.579713	0.0051
D(LGSE)	-4.072337	2.712721	-1.501200	0.2077
D(LGSE(-1))	13.633068	2.491924	5.470900	0.0054
CointEq(-1)	-0.510311	0.089230	-5.719049	0.0046

Source: Authors based on EViews 9output

The results of the error correction model highlight more nuanced short-run dynamics. The coefficient of the error correction term CointEq(-1) is negative (-0.5103) and highly significant ($p = 0.0046$), confirming the existence of a mechanism driving adjustment back to long-run equilibrium. This coefficient indicates that approximately 51% of the disequilibrium observed in one period is corrected in the following year, reflecting a relatively rapid speed of adjustment.

The effects of the explanatory variables appear more heterogeneous in the short run. Public expenditure has a negative but statistically insignificant contemporaneous effect before becoming positive and significant after a one-period lag. This dynamic may be explained by the transmission lags between public spending and economic activity in Algeria. Indeed, expenditures undertaken in a given period do not necessarily translate immediately into higher output, particularly when their implementation involves administrative procedures, project execution delays, and imports of goods and equipment. Their effects may therefore materialize in the subsequent period, once projects have been completed and investments become operational, through increased demand, employment, and productive activity. This finding also highlights that the impact of public expenditure depends less on its volume than on its efficiency and allocation toward productive sectors. Oil rents and trade openness, in turn, exhibit effects that vary depending on the lag considered. Foreign direct investment (FDI) has no immediate significant effect on economic growth, whereas human capital mainly exerts lagged effects. These findings suggest that the main determinants of economic growth in Algeria operate progressively, with their effects becoming more apparent in the long run than in the short run.

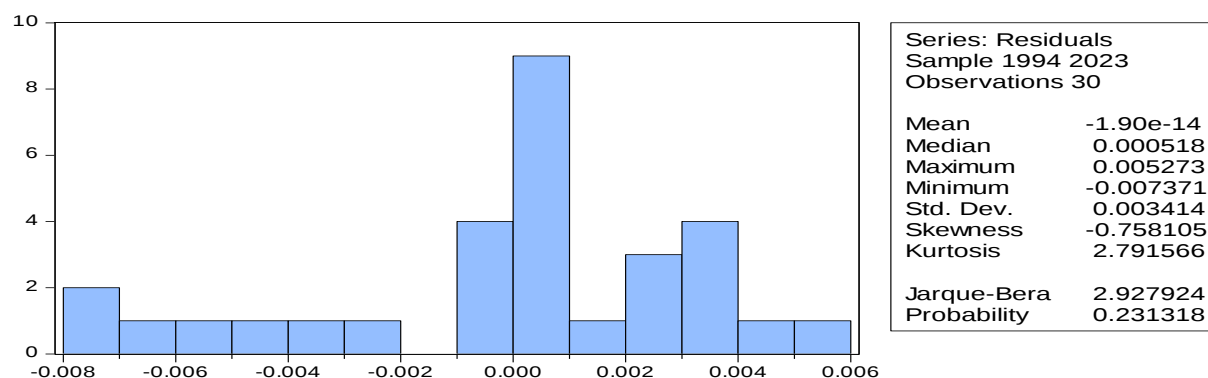
4.3. Model Diagnostic and Stability Tests

To ensure the reliability of the estimated parameters, several diagnostic and stability tests were conducted. These procedures evaluate residual normality, the absence of serial correlation and heteroskedasticity, and the structural stability of the estimated ARDL model.

4.3.1. Normality Test

Figure 2 presents the results of the Jarque–Bera test for residual normality.

Figure 2. Residual Normality Test Results (Jarque–Bera)



Source: Authors based on EViews 9output

The histogram indicates that the residuals are symmetrically distributed around zero and closely approximate a normal distribution. The Jarque–Bera test statistic ($JB = 2.928$; $p = 0.231$) is statistically insignificant at the 5% level, leading to the acceptance of the null hypothesis of residual normality. This outcome confirms the statistical validity of the model's estimations.

4.3.2. Serial Correlation Test

Table 6 reports the results of the Breusch–Godfrey LM test applied to the model residuals.

Table 6. Breusch–Godfrey Serial Correlation LM Test Results

F-statistic	0.509766	Prob. F(2,14)	0.6114
Obs*R-squared	2.104292	Prob. Chi-Square(2)	0.3492

Source: Authors based on EViews 9output

The p-values associated with the F-statistic (0.6114) and the Obs*R² statistic (0.3492) exceed the 5% significance threshold. Consequently, the null hypothesis of no serial correlation cannot be rejected, confirming that the model residuals are free from serial correlation issues.

4.3.3. Heteroskedasticity Test

The results of the Breusch–Pagan–Godfrey test are presented in Table 7.

Table 7. Breusch–Pagan–Godfrey Residual Heteroskedasticity Test Results

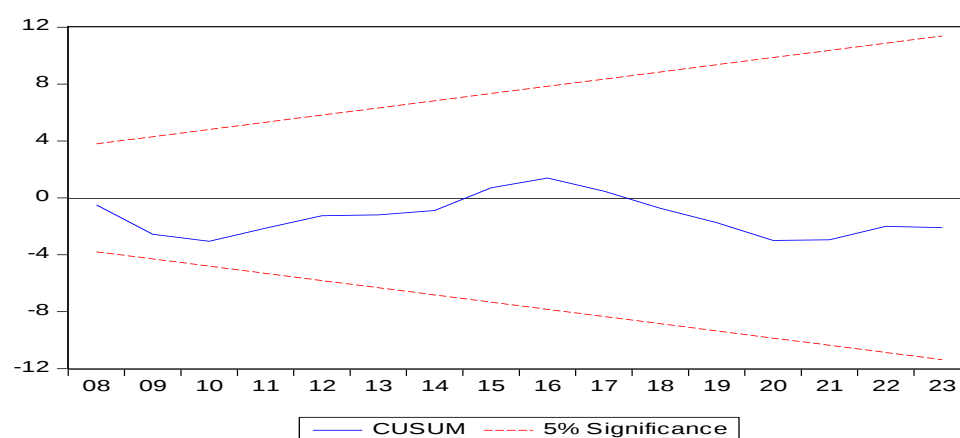
F-statistic	1.318724	Prob. F(14,16)	0.2953
Obs*R-squared	16.60739	Prob. Chi-Square(14)	0.2777
Scaledexplained SS	3.447023	Prob. Chi-Square(14)	0.9980

Source: Authors based on EViews 9output

The p-values associated with the test statistics are all greater than 5%, indicating that the null hypothesis of homoskedasticity cannot be rejected. The error terms therefore exhibit constant variance, validating the consistency and efficiency of the estimations.

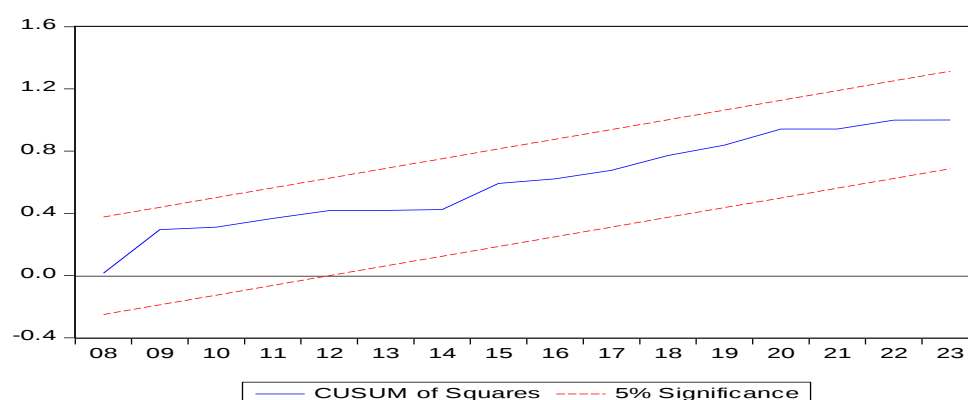
4.3.4. Parameter Stability Tests

The structural stability of the model coefficients is evaluated using the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests. The results are illustrated in Figures 3 and 4.

Figure 3. CUSUM Stability Test Results for the ARDL Model

Source: Authors based on EViews 9output

The CUSUM plot remains within the 5% critical bounds across the entire sample period, indicating the absence of structural breaks and confirming the stability of the model parameters.

Figure 4. CUSUM of Squares (CUSUMSQ) Stability Test Results

Source: Authors based on EViews 9output

Similarly, the CUSUMSQ plot remains within the 5% critical boundaries, confirming the parameter stability of the estimated model. Overall, the diagnostic and stability test results demonstrate that the ARDL model is correctly specified and that the empirical estimates are highly robust.

5. DISCUSSION

The empirical results demonstrate the existence of a stable long-run relationship between economic growth and the key macroeconomic determinants included in the ARDL model. They show that public expenditure, education expenditure, trade openness, and foreign direct investment contribute positively to economic growth in Algeria, whereas oil rents exert a statistically significant negative effect. Overall, these findings indicate that long-run growth depends more on structural factors related to public policy, human capital, and economic openness than on the mere availability of natural resources.

Public expenditure emerges as the primary driver of long-run economic growth, reflecting the pivotal role of the state in an economy where public investment remains an essential lever of development. This result is consistent with the theoretical predictions of Barro (1990), according to which productive government spending stimulates growth by enhancing infrastructure, human capital, and private sector productivity, and corroborates the empirical findings of Hammache (2022) for Algeria. However, the magnitude of the estimated coefficient highlights that expenditure quality is more important than its volume. Allocating public resources to productive infrastructure, innovation, and value-added sectors is therefore more likely to generate sustainable growth than prioritizing current consumption expenditures.

Trade openness also exerts a positive and significant effect, confirming that integration into international trade promotes economic growth. This finding supports the seminal work of Sachs and Warner (1995), who argue that openness enhances productivity, facilitates technology transfers, and improves resource allocation. However, in Algeria, these benefits remain constrained by the predominance of hydrocarbon exports, which limits spillover effects to non-resource sectors. Consequently, trade openness can become a genuine engine of growth only when accompanied by export diversification and stronger domestic competitiveness.

Education expenditure contributes positively to economic growth, confirming the central role of human capital in the development process. This result is fully consistent with endogenous growth theory (Lucas, 1988; Romer, 1990; Mankiw, Romer, & Weil, 1992) and with the empirical evidence of Barro (1991) and Issolah, Djemaci, and Kertous (2021). Nevertheless, the findings suggest that growth depends not only on the level of education spending but also on its effectiveness. Improving educational quality, strengthening technical and digital skills, and better aligning educational outcomes with labor market needs remain essential for sustaining long-run growth.

Foreign direct investment (FDI) has a positive, although relatively modest, effect on long-term economic growth in Algeria. This finding is partly consistent with the conclusions of Borensztein, De Gregorio, and Lee (1998), who argue that FDI can promote growth through technology and knowledge transfers when the host economy has sufficient absorptive capacity. It is also consistent with the recent findings of Ziani and Ziani (2025), who highlight a positive long-term relationship between FDI and economic growth in Algeria using an ARDL approach. However, in our study, this effect remains weakly significant and should therefore be interpreted with caution. This limited contribution can be explained, in particular, by the concentration of FDI in Algeria in the energy sector and by certain institutional constraints that reduce its spillover effects on non-hydrocarbon sectors. Thus, despite their potential contribution to capital accumulation and technology transfer, FDI has not yet become a sufficiently diversified driver of Algerian economic growth. This interpretation is consistent with the institutional analyses of Acemoglu, Johnson, and Robinson (2005) and Alssadek and Benhin (2023).

The most significant empirical finding concerns oil rents, whose negative coefficient supports the resource curse hypothesis proposed by Sachs and Warner (2001). It is also consistent with the arguments of Gylfason (2001) and with previous empirical findings for Algeria (Benabdallah, 2006; Jbir and Zouari-Ghorbel, 2011; Belhadj and Mebarki, 2021). However, this result does not imply that natural resources are inherently detrimental to economic growth. Rather, their long-term contribution depends on the quality of institutions and the ability to transform resource rents into productive investments, as emphasized by Alssadek and Benhin (2023). In the Algerian context, reducing this vulnerability therefore requires more effective use of hydrocarbon revenues. The efficiency of public spending should be strengthened through more rigorous selection and monitoring of investment projects, with priority given to productive infrastructure and high-value-added sectors. Part of oil revenues should also be

allocated to human capital development, particularly by improving the quality of education and vocational training. Finally, more prudent management of resource rents, through stabilization and sovereign wealth-saving mechanisms based on transparent fiscal rules, would make it possible to better absorb fluctuations in hydrocarbon prices and preserve part of these resources to finance economic diversification. The objective is therefore to gradually transform oil rents into physical, human, and technological capital in order to reduce the structural dependence of the Algerian economy on hydrocarbons.

The short-run estimates display more heterogeneous patterns, reflecting temporary economic adjustments. The negative and statistically significant error correction term confirms the stability of the long-run equilibrium and indicates that approximately 51% of disequilibrium is corrected annually. The lagged effects mainly capture policy transmission delays and temporary external shocks without altering the underlying long-run structural relationships.

Overall, these findings indicate that sustainable economic growth in Algeria depends primarily on effective public policies, human capital development, trade openness, and institutional quality, whereas excessive dependence on hydrocarbons remains a structural source of economic vulnerability. Accordingly, public expenditure should increasingly target productive infrastructure, research and development, innovation, and human capital accumulation. Likewise, improving educational quality, strengthening workforce skills, promoting export diversification, enhancing institutional quality, and attracting productivity-enhancing FDI are essential to support long-term growth. Hydrocarbon revenues should therefore be strategically invested in economic diversification and high-value-added sectors to accelerate the transition toward a knowledge-based economy.

Beyond reinforcing the existing literature, this study provides an original empirical contribution by jointly examining the effects of public expenditure, education investment, trade openness, FDI, and oil rents over the period 1990–2024 using an ARDL framework. The findings confirm that the determinants emphasized by endogenous growth theory remain the principal drivers of Algeria's long-run economic growth, whereas excessive reliance on oil rents constitutes a persistent structural vulnerability. Ultimately, the success of Algeria's diversification strategy will depend on its institutional capacity to transform hydrocarbon revenues into productive investment, human capital, innovation, and stronger institutions capable of supporting sustainable, resilient, and inclusive growth.

6. CONCLUSION

This study aimed to identify the key determinants of economic growth in Algeria over the period 1990–2024 using an Autoregressive Distributed Lag (ARDL) bounds testing approach, enabling the disentanglement of short- and long-run macroeconomic dynamics. The empirical findings confirm the presence of a stable long-run cointegrating relationship among the investigated variables.

The long-run estimations reveal that public expenditure, trade openness, and human capital (proxied by the gross secondary school enrollment rate) exert positive and statistically significant effects on economic growth. These results highlight the critical importance of public policies, international trade

integration, and human capital accumulation as key drivers of sustainable development. Foreign direct investment also contributes positively to growth, though its impact remains modest due to its concentration in the hydrocarbon sector and limited spillovers to non-resource industries. Conversely, oil rents exhibit a negative long-run relationship with growth, confirming the structural limitations of a resource-dependent growth model and underscoring the urgent need to accelerate economic diversification.

Beyond these empirical insights, this research contributes to the literature on growth determinants in resource-rich economies by providing an updated quantitative evaluation covering the 1990–2024 period and distinguishing short-run adjustments from long-run equilibrium dynamics.

From a policy standpoint, the findings highlight the necessity of enhancing fiscal spending efficiency by prioritizing productive investments, strengthening human capital through higher educational quality, and establishing an institutional environment conducive to attracting high-quality FDI. Furthermore, sustained efforts toward economic diversification—particularly by fostering non-hydrocarbon productive sectors, supporting innovation, encouraging entrepreneurship, and developing small and medium enterprises (SMEs)—are imperative to build economic resilience against external shocks.

6.1. Limitations and Future Directions

This study presents certain limitations. The empirical specification relies on a focused set of macroeconomic variables and does not explicitly control for institutional quality, financial development, governance indicators, or disaggregated innovation metrics. Future research could incorporate these dimensions, utilize panel or sector-level data, or employ complementary econometric methodologies to deepen the understanding of growth dynamics in Algeria and similar resource-dependent economies.

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Əlcəzairdə İqtisadi Artımın Determinantları: ARDL Testi Yanaşmasına Əsaslanan Empirik Təhlil (1990–2024)

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Xülasə

Bu tədqiqat 1990–2024-cü illər ərzində Əlcəzairdə iqtisadi artımın determinantlarını ARDL testi yanaşmasından istifadə etməklə təhlil edir. Tədqiqat dövlət xərclərinin, ticarət açıqlığının, birbaşa xarici investisiyaların, təhsil xərclərinin və neft gəlirlərinin iqtisadi artıma qısamüddətli və uzunmüddətli təsirlərini araşdırır. Empirik nəticələr dəyişənlər arasında sabit uzunmüddətli əlaqənin mövcudluğunu təsdiq edir.

Qiymətləndirmə nəticələri göstərir ki, dövlət xərcləri, ticarət açıqlığı və təhsil xərcləri iqtisadi artıma müsbət və statistik cəhətdən əhəmiyyətli təsir göstərir ki, bu da dövlət investisiyalarının, ticarət integrasiyasının və insan kapitalının toplanmasının mühüm rolunu vurğulayır. Birbaşa xarici investisiyalar da iqtisadi artıma müsbət töhfə verir, baxmayaraq ki, onun təsiri nisbətən məhduddur. Əksinə, neft gəlirləri iqtisadi artıma statistik cəhətdən əhəmiyyətli mənfi təsir göstərir ki, bu da karbohidrogen gəlirlərindən asılı olan artım modelinin struktur məhdudiyyətlərini ortaya qoyur. Bu nəticələr Əlcəzairdə davamlı və dayanıqlı iqtisadi artımı təmin etmək üçün iqtisadi şaxələndirmənin sürətləndirilməsinin, insan kapitalının inkişaf etdirilməsinin və dövlət siyasətinin səmərəliliyinin artırılmasının zəruriliyini vurğulayır.

Açar sözlər: İqtisadi artım; ARDL modeli; Əlcəzair; Dövlət xərcləri; Ticarət açıqlığı; Neft gəlirləri.

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