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Title of research article

Analyzing the Dynamic Relationship between Money Supply (M2), Nominal Interest Rate, and Economic Growth in Algeria: An Empirical Investigation Using the ARDL Approach (2000–2024)

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Keywords Money supply; Nominal interest rate; ARDL model; Economic growth; Algeria; Financial development

Abstract
This study investigates the long-term and short-term dynamics between money supply (M2), nominal interest rates, and economic growth in Algeria over the period 2000–2024. Given the critical role of financial market variables in shaping macroeconomic performance, this research examines how monetary aggregates and interest rates contribute to stimulating or constraining Algeria's economic trajectory. Employing advanced econometric techniques, including Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests, the ARDL bounds testing approach for cointegration, and autoregressive distributed lag (ARDL) estimation, the study provides robust empirical evidence of the interconnectedness of monetary policy and growth. The results reveal a significant long-run equilibrium relationship among the variables, indicating that an expansion in M2 supply positively influences Algeria's real GDP, while the nominal interest rate exhibits a mixed effect—stimulating growth in the short run but imposing constraints in the long run. These findings underscore the dual role of monetary policy: while liquidity expansion supports economic activities, the interest rate mechanism requires cautious calibration to avoid inflationary pressures. The study contributes to the literature on monetary economics in developing economies, highlighting Algeria's unique financial landscape and offering policy implications for sustainable growth strategies.

JEL Classification: C30; E52; O11; I44

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Methodology and Research Method

The research adopts a **quantitative econometric methodology** designed to capture both short-term dynamics and long-run equilibrium relationships between financial variables and economic growth.

1. **Data Source:** Annual data covering the period 2000–2024 were obtained from the World Bank, International Monetary Fund (IMF), and the Bank of Algeria. Variables include real GDP growth (proxy for economic growth), broad money supply (M2), and nominal interest rate.
2. **Stationarity Testing:** The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests were applied to examine the time-series properties of the variables.
3. **Cointegration Analysis:** The ARDL bounds testing approach was used to identify long-run cointegration among the variables, due to its flexibility in handling variables integrated at I(0) and I(1).
4. **Model Estimation:** The ARDL model was applied to estimate both short-run and long-run relationships, while the Error Correction Term (ECT) captured the speed of adjustment toward equilibrium.
5. **Diagnostic Tests:** Serial correlation, heteroscedasticity, and stability tests (CUSUM and CUSUMSQ) were employed to validate the robustness of the model.

Findings

The empirical results provide several significant insights:

1. **Unit Root and Cointegration Results:** The ADF and PP tests confirmed that the series are integrated at mixed orders, justifying the ARDL methodology. The bounds test indicated the presence of a long-run cointegrating relationship among money supply, nominal interest rate, and economic growth.
2. **Short-Run Dynamics:** The short-run ARDL estimates reveal that increases in M2 positively and significantly affect GDP growth, suggesting that liquidity expansion stimulates investment and consumption activities. The nominal interest rate showed a temporary positive impact, indicating that moderate interest rate adjustments may encourage savings and improve capital allocation.
3. **Long-Run Relationship:** In the long run, the results suggest that M2 continues to exert a positive influence on growth, whereas the nominal interest rate demonstrates a negative effect, reflecting potential crowding-out and inflationary risks when rates remain elevated.
4. **Error Correction Mechanism:** The ECT was significant and negative, confirming a stable adjustment process toward equilibrium, with approximately 47% of disequilibrium corrected each year.

Overall, the findings highlight that Algeria's economic growth is sensitive to monetary aggregates and interest rate policies, with policy mismanagement potentially amplifying vulnerabilities.

Actuality and Significance of the Study

The study addresses a **critical gap in Algerian economic research**, where empirical investigations on the relationship between financial market variables and growth remain limited. Given Algeria's reliance on hydrocarbon revenues, monetary policy effectiveness is often overshadowed by fiscal dominance. This research demonstrates that monetary aggregates and interest rates are equally central to economic stability and growth, offering valuable insights for policymakers seeking diversification beyond oil-driven revenues. The study's originality lies in applying the ARDL framework to Algeria's financial sector over two decades marked by structural reforms, global financial crises, and fluctuating oil prices.

Introduction

Financial markets represent one of the fundamental pillars of modern economies, serving as a vital mechanism for channeling surplus resources from entities with excess liquidity to sectors facing financial constraints. By performing this intermediary function, financial markets ensure the optimal allocation of capital, support investment projects, and facilitate sustainable economic development. Through the mobilization of savings and the redirection of financial flows toward productive activities, these markets enhance national productive capacity, intensify competition, expand market mechanisms, and improve the efficiency of resource utilization. In this sense,

financial markets are not merely passive platforms for exchange; rather, they constitute dynamic drivers of economic transformation and long-term growth.

In general terms, financial markets may be defined as organized frameworks that enable the facilitation of diverse economic activities through the functions of financial institutions. These functions are typically divided into two primary roles: (i) the mobilization of savings, and (ii) the allocation of these savings to meet the funding needs of individuals, firms, and governments (University Lifestyle, 2025). The financial system is broadly segmented into two components: the **money market** and the **capital market**. The money market focuses on short-term instruments—characterized by maturities of less than one year—that are highly liquid and readily convertible to cash. Conversely, the capital market deals with long-term financial assets that provide financing for sustained investment and development initiatives. Both segments, together, form an essential foundation for economic growth by ensuring liquidity, investment continuity, and long-term capital accumulation.

Research Problem

Against this backdrop, the present study addresses the following core research question:

To what extent has the financial market contributed to stimulating economic growth in Algeria during the period 2000–2024?

This question is of particular importance in the Algerian context, where the economy remains heavily dependent on hydrocarbon revenues and where financial sector development has been relatively limited compared to regional peers. By analyzing the interaction between monetary aggregates, interest rates, and economic growth, this research seeks to clarify the extent to which Algeria's financial system has served as a catalyst—or a constraint—on its long-term growth trajectory.

Literature Review

The relationship between financial market development and economic growth has been the subject of extensive debate in economic literature, particularly in emerging and developing countries. Previous studies provide mixed evidence:

1. **Krouch & Belama Asma (2021)** – In their study on Algeria and Tunisia, the authors applied a multiple linear regression model to assess the impact of financial market indicators on growth. Their findings indicated that in Algeria, the financial market lacked a statistically significant effect on economic growth, whereas in Tunisia, the financial market had a clear and positive impact.
2. **Srah & Belkacem Ben Allal (2019)** – By analyzing financial development and growth in the Maghreb countries (Algeria, Morocco, and Tunisia) from 1980 to 2016, they applied unit root, cointegration, and Granger causality tests. Results confirmed a long-term positive relationship between financial development and growth across all countries. However, causality patterns differed: no causality was observed in Algeria, bidirectional causality emerged in Morocco, and unidirectional causality (from growth to financial development) was evident in Tunisia.
3. **Ahmed Amin Saadallah (2015)** – Examining Morocco, Tunisia, and Jordan, the study found heterogeneous results regarding the relationship between financial market size and growth. Tunisia's financial market had negligible influence, Morocco's effect was weak, and Jordan's was strongly positive. The study concluded that emerging economies require strong legislative and regulatory frameworks to ensure that financial markets play a meaningful role in fostering growth.

Taken together, these studies highlight the variability of financial development outcomes across countries, suggesting that the Algerian case requires a dedicated empirical investigation, particularly over the past two decades marked by global crises, fluctuating oil revenues, and structural reforms [2-5, 67].

Research Objectives

The principal objective of this study is to empirically examine the impact of financial market variables—specifically money supply (M2) and nominal interest rate—on Algeria's economic growth during the period 2000–2024. Secondary objectives include:

- Assessing the short-term and long-term dynamics between financial variables and economic growth.
- Evaluating the effectiveness of monetary policy as a tool for stimulating sustainable growth.
- Providing evidence-based recommendations to policymakers for strengthening Algeria's financial system and aligning it with development goals.

Research Methodology

To achieve these objectives, the study adopts both **descriptive** and **analytical econometric approaches**. The descriptive method traces the historical evolution of Algeria's GDP and economic growth rates, while the analytical framework employs econometric modeling to capture causal and long-term relationships.

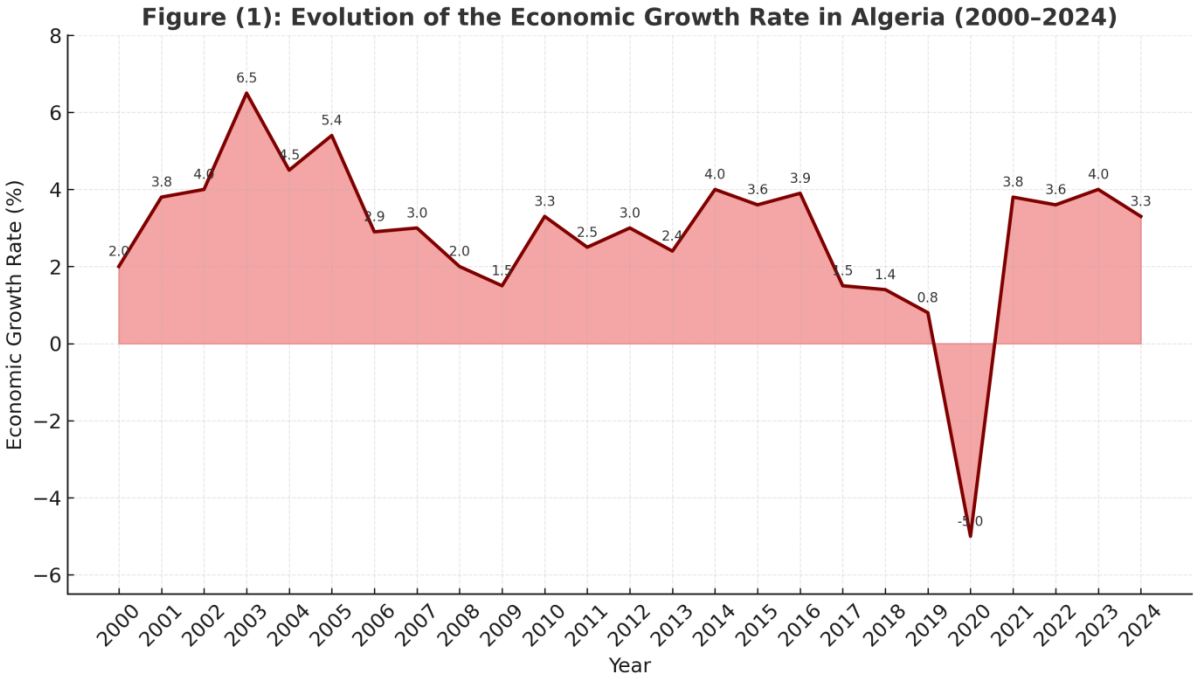
1. **Data:** Annual time-series data from 2000–2024 were obtained from the World Bank Open Data and the Bank of Algeria.
2. **Variables:** Real GDP at constant prices (economic growth indicator), broad money supply (M2), and nominal interest rate.
3. **Econometric Tools:**
    - Unit root tests (Augmented Dickey-Fuller and Phillips-Perron) to determine stationarity.
    - Bounds testing approach to identify cointegration among variables.
    - ARDL (Autoregressive Distributed Lag) model to estimate both short-run and long-run relationships.
    - Diagnostic tests for serial correlation, heteroscedasticity, and model stability.

Table 1. Evolution of Gross Domestic Product and Economic Growth Rate in Algeria (2000–2024)

Year	GDP at Constant Prices (Trillion DZD)	Growth Rate (%)
2000	4.454	3.8
2001	4.588	3.0
2002	4.835	5.4
2003	5.150	6.5
2004	5.381	4.5
2005	5.672	5.4
2006	5.836	2.9
2007	6.017	3.1
2008	6.168	2.5
2009	6.242	1.2
2010	6.541	4.8
2011	6.738	3.0
2012	6.899	2.4
2013	7.079	2.6
2014	7.369	4.1
2015	7.605	3.2
2016	7.901	3.9
2017	8.020	1.5
2018	8.132	1.4
2019	8.205	0.9
2020	7.795	-5.0

Year	GDP at Constant Prices (Trillion DZD)	Growth Rate (%)
2021	8.091	3.8
2022	8.383	3.6
2023	8.726	4.1
2024	9.014	3.3

Figure (1): Evolution of the Economic Growth Rate in Algeria during the Period 2000–2024



Source: PreparedbasedonthedataofTable 1

From the above figure, it is evident that the period 2000–2004 represents the most prosperous phase experienced by the Algerian economy in terms of achieving unprecedented growth rates. Beginning in 2001, the growth rate recorded a noticeable improvement, rising from 2.6% in 2001 to 6.5% in 2003, which was the highest rate attained during the study period. The average growth rate during this phase reached 4.64%, primarily due to the improvement in international oil prices and the achievement of political and security stability in the country. These factors encouraged investment and attracted foreign investors. Nevertheless, the hydrocarbons sector continued to dominate the Algerian economy, particularly when compared to other sectors such as industry and agriculture [20, 31].

During the period 2005–2009, growth rates declined compared to the preceding phase, despite the implementation of several large-scale development projects, including the Growth Support Program (2005–2009), which was allocated a budget of 8,705 billion Algerian dinars (equivalent to USD 114 billion). Its main objectives included eradicating precarious housing, improving infrastructure, implementing programs for the High Plateaus and the South, integrating into the global economy through partnership agreements, and encouraging the private sector (Bank of Algeria, 2008).

In the period 2010–2014, the government continued its efforts to sustain growth rates through the Growth Consolidation Program (2009–2014), which was allocated a massive budget of 21,214 billion Algerian dinars (equivalent to USD 286 billion) (Chahinaz, 2018, p. 248). This program aimed to consolidate growth and support

ongoing projects. However, despite these initiatives and the substantial financial allocations, growth rates did not improve significantly. The average growth rate stood at 3.38%, representing a decline of 1.16 percentage points compared to the previous period. This slowdown can also be attributed to the spillover effects of the 2008 global financial crisis, which negatively affected developing economies and their macroeconomic indicators, including growth rates.

During 2015–2019, the GDP growth rate continued to weaken, averaging 2.18%. In 2017, the rate stood at 1.6% compared to 3.3% in 2016, reflecting a decline of 2.1 percentage points from 2015. This weak performance was largely due to the continuous fall in oil prices, particularly in 2014, when prices reached levels not witnessed for more than two decades. In 2019 and 2020, the COVID-19 crisis severely impacted both global and Algerian economic growth, leading to significant economic and social repercussions. Consequently, growth rates deteriorated sharply during this period [6, 12].

Nevertheless, starting in 2021, the Algerian economy showed signs of recovery, with an average growth rate of 3.70% during the period 2021–2024, as clearly illustrated in Figure (1).

Section Two: The Evolution of Money Supply and Interest Rates in Algeriaduring the Period 2000–2024

Our analysis of the development of the money supply and nominal interest rates in Algeria during the period 2000–2024 will be based on the following table and figure.

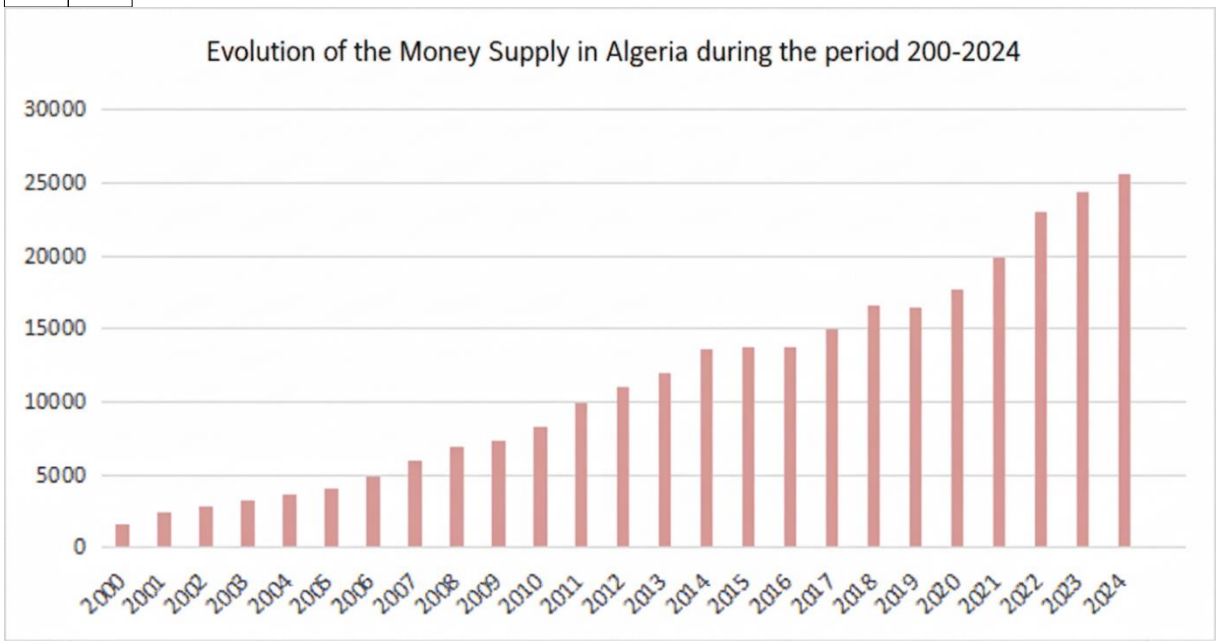
2024–nalInterestRateinAlgeriaduringthePeriod 2000Table (2): EvolutionofMoneySupply (M2) andNomi

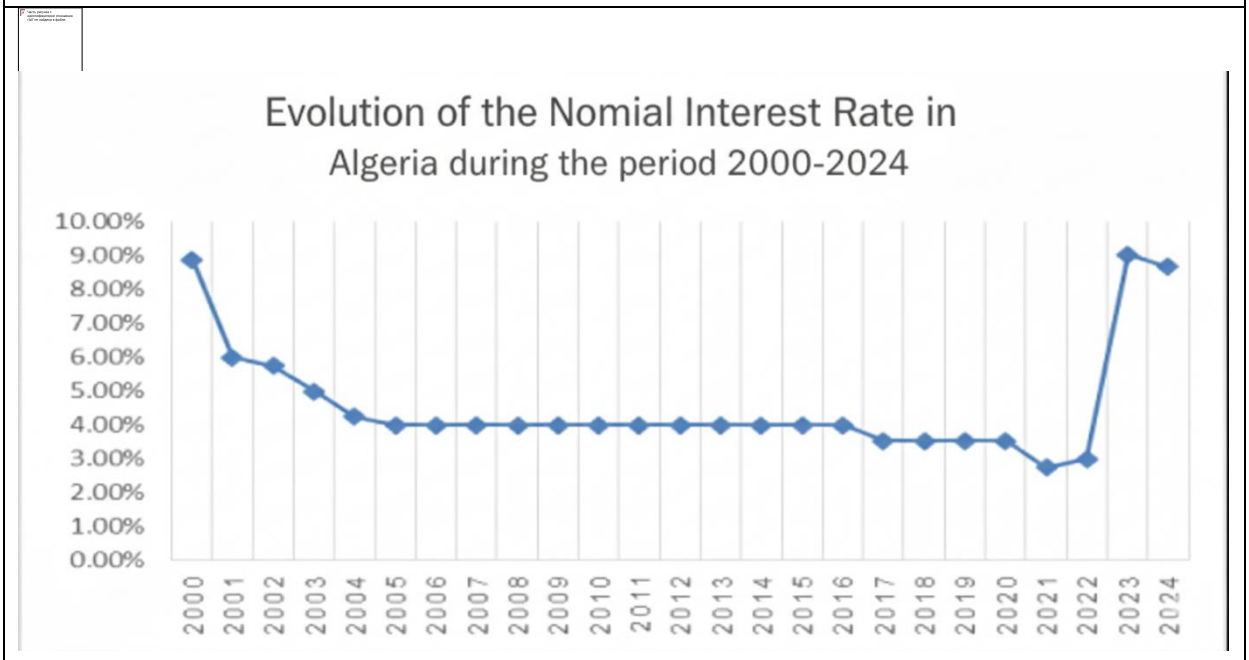
Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Money Supply (M2) at Current Prices (Billion DZD)	343.32	414.75	544.46	584.18	675.93	739.90	848.25	1003.14	1199.48	1366.77
Growth Rate of Money Supply (%)		20.80	31.27	7.30	15.70	9.46	14.64	18.26	19.57	13.95
Nominal Interest Rate (%)	8.75	11	11.5	11.5	13.25	14.5	13.5	12.125	10.25	9
Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Money Supply (M2) at Current Prices (Billion DZD)	1559.91	2403.07	2836.87	3299.46	3644.29	4070.44	4870.07	5994.61	6955.97	7292.69
Growth Rate of Money Supply (%)	14.13	54.05	18.05	16.31	10.45	11.69	19.64	23.09	16.04	4.84
Nominal Interest Rate (%)	8.87	6	5.75	5	4.25	4	4	4	4	4
Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019

16510	16636.70	14974.20	13816.30	13704.50	13663.90	11941.50	11015.10	9929.19	8280.74	Money Supply (M2) at Current Prices (Billion DZD)
–0.76	11.10	8.38	0.82	0.30	14.42	8.41	10.94	19.91	13.55	Growth Rate of Money Supply (%)
3.54	3.54	3.54	4	4	4	4	4	4	4	Nominal Interest Rate (%)
					2024	2023	2022	2021	2020	Year
					25610.62	24330.82	22964.47	19918.39	177740	Money Supply (M2) at Current Prices (Billion DZD)
					5.26	5.95	15.29	12.28	7.45	Growth Rate of Money Supply (%)
					8.66	9.02	3	2.75	3.54	Nominal Interest Rate (%)
										Nominal Interest Rate (%)

Source: Reports of the Central Bank of Algeria

Figure (2): Evolution of Money Supply (M2) and Nominal Interest Rate in Algeria during the Period 2000–2024





Source: Prepared by the researcher based on the data of Table (2).

Section Three: Econometric Analysis of the Impact of Selected Financial Market Variables on Economic Growth in Algeria (2000–2024)

1. Descriptive Overview of Key Variables

Money Supply (M2): As illustrated in *Figure 2*, the money supply in Algeria experienced substantial fluctuations during the study period. The sharpest increase was recorded in 2001, when the growth rate reached **54%**, coinciding with the launch of the **Economic Recovery Support Plan (2001–2004)**. This government-led expansionary policy was designed to stimulate growth, create employment opportunities, and mitigate structural

challenges. Thereafter, the money supply exhibited an uneven trajectory, peaking again at **23.09% in 2007**, but declining to its lowest level of **-0.76% in 2019**. Across the entire study period, the average annual growth rate of M2 stood at **10%**. During 2020–2024, the average fell slightly to **9.25%**, reflecting the continued economic disruptions triggered by the COVID-19 pandemic and its lingering effects on liquidity and investment flow [4-7].

Nominal Interest Rate (Tir): The nominal interest rate began at **8% in 2000**, before gradually declining during 2001–2004, eventually stabilizing at **4%** between 2005 and 2016. This development was closely linked to the **liberalization of interest rates**, which shifted their determination from state control to market-based mechanisms of supply and demand. In 2017, the rate decreased by **0.46 percentage points**, remaining at an average of **3.54%** during 2017–2020. However, in the subsequent period (2021–2024), the interest rate reversed its trend, rising sharply from **2.75% in 2021** to **9.02% in 2023**, the highest level observed in the entire study period. This surge reflected both inflationary pressures and policy adjustments in response to domestic and global financial instability [1, 45].

2. Presentation of Variables

1. **Gross Domestic Product (GDP):** Represents the total value of all final goods and services produced within the national economy over a specific period, serving as the principal indicator of overall economic performance and growth.
2. **Money Supply (M2):** Defined as the sum of M1 (currency in circulation and demand deposits) and time deposits in local currency, reflecting the broad liquidity available within the financial system.
3. **Nominal Interest Rate (Tir):** Refers to the lending interest rate unadjusted for inflation, directly influencing borrowing costs, investment incentives, and savings decisions.

3. Stationarity Testing of Variables

To ensure robust econometric modeling, the time-series properties of the variables were examined using the **Augmented Dickey–Fuller (ADF)** and **Phillips–Perron (PP)** unit root tests.

Table 3. Results of the Augmented Dickey–Fuller (ADF) Test

Variable	At Level	First Difference	Order of Integration
GDP	-1.04, -1.11, -4.48	-5.061, -4.98	I(1)
M2	-2.87, 0.16, -2.03	-4.05, -4.98	I(1)
Tir	-5.65, -4.68	Stationary	I(0)

Critical Values: 1% = -2.65 / -3.69 / -4.58; 5% = -1.95 / -2.97 / -3.58; 10% = -1.60 / -2.62 / -3.22
Source: Author's computation using EViews 10 outputs.

Table 4. Results of the Phillips–Perron (PP) Test

Variable	At Level	First Difference	Order of Integration
GDP	-1.04, -1.18, -4.57	-5.07, -4.99	I(1)
M2	-2.79, 0.33	-4.03, -4.96	I(1)
Tir	-1.03, -0.90, -2.21	-3.99, -4.20, -4.09	I(1)

Critical Values: 1% = -2.65 / -3.69 / -4.58; 5% = -1.95 / -2.97 / -3.58; 10% = -1.60 / -2.62 / -3.22
Source: Author's computation using EViews 10 outputs.

Interpretation:
The results indicate that most variables (GDP and M2) are **non-stationary at level** but become stationary at **first difference (I(1))**, while the nominal interest rate is stationary at **I(0)** according to the ADF test but at **I(1)** under the PP test. This mixed integration order validates the application of the **Autoregressive Distributed Lag (ARDL) model**, which can accommodate both I(0) and I(1) variables.

4. Model Specification

Based on the stationarity results, the ARDL model is specified to capture both short-run dynamics and long-run equilibrium relationships between economic growth (GDP), money supply (M2), and nominal interest rate (Tir).

5. Cointegration Test Using the ARDL Bounds Testing Approach

The ARDL bounds testing approach is applied to examine whether a long-run cointegration relationship exists among the selected variables. This method simultaneously estimates both short-term and long-term coefficients, making it particularly suitable for small samples and mixed integration orders.

Prior to conducting the bounds test, the **optimal lag length** must be identified using selection criteria such as **Log Likelihood (LOGL)**, **Schwarz Criterion (SC)**, **Akaike Information Criterion (AIC)**, and **Bayesian Information Criterion (BIC)**. The model with the lowest criterion value is retained for estimation.

The figure below (not included here) illustrates the optimal lag length selected for the ARDL estimation.

Section Three: Econometric Analysis of the Impact of Selected Financial Market Variables on Economic Growth in Algeria (2000–2024)

1. Descriptive Overview of Monetary Indicators

Money Supply (M2): As shown in *Figure 2*, the money supply recorded its most pronounced increase in **2001**, with a growth rate of **54%**. This expansion coincided with the launch of the **Economic Recovery Support Plan (2001–2004)**, during which the Algerian government adopted an expansionary monetary policy aimed at achieving higher growth rates and alleviating structural challenges, notably unemployment. Thereafter, M2 followed a fluctuating trajectory, peaking at **23.09% in 2007** and declining to its lowest level of **–0.76% in 2019**. Over the full study period, the average growth rate of M2 was **10%**. During **2020–2024**, the average declined to **9.25%**, reflecting weaker monetary expansion, largely attributable to the economic disruptions associated with the COVID-19 crisis.

Nominal Interest Rate (Tir): The nominal interest rate stood at **8% in 2000** but fell gradually during 2001–2004, stabilizing at around **4%** between 2005 and 2016. This decline was largely the result of the **liberalization of interest rates**, whereby market mechanisms of supply and demand replaced direct state intervention in determining rates. In 2017, the nominal interest rate declined by **0.46 percentage points**, averaging **3.54%** between 2017 and 2020. However, in the subsequent period, a sharp reversal occurred: from **2.75% in 2021**, the rate rose to **9.02% in 2023**, the highest level observed throughout the study period. This increase reflected mounting inflationary pressures and tightening monetary policy responses.

2. Variables under Study

1. **Gross Domestic Product (GDP):** Represents the aggregate value of all final goods and services produced within the economy in a given year. It serves as the principal measure of economic activity and growth performance.
2. **Money Supply (M2):** Defined as M1 (currency in circulation plus demand deposits) combined with time deposits denominated in local currency.
3. **Nominal Interest Rate (Tir):** Refers to the stated interest rate on loans, unadjusted for inflation, which directly influences borrowing costs, investment behavior, and savings incentives.

3. Stationarity Testing of Variables

To ensure valid econometric estimation, the time-series properties of the variables were assessed using the **Augmented Dickey–Fuller (ADF)** and **Phillips–Perron (PP)** unit root tests [8-10].

Table 3. Results of the Augmented Dickey–Fuller (ADF) Test

Variable	At Level	First Difference	Order of Integration
GDP	-1.04, -1.11, -4.48	-5.061, -4.98	I(1)
M2	-2.87, 0.16, -2.03	-4.05, -4.98	I(1)
Tir	-5.65, -4.68	Stationary	I(0)

Critical Values: 1% = -2.65 / -3.69 / -4.58; 5% = -1.95 / -2.97 / -3.58; 10% = -1.60 / -2.62 / -3.22
Source: Author's calculations based on EViews 10 outputs.

Table 4. Results of the Phillips–Perron (PP) Test

Variable	At Level	First Difference	Order of Integration
GDP	-1.04, -1.18, -4.57	-5.07, -4.99	I(1)
M2	-2.79, 0.33	-4.03, -4.96	I(1)
Tir	-1.03, -0.90, -2.21	-3.99, -4.20, -4.09	I(1)

Critical Values: 1% = -2.65 / -3.69 / -4.58; 5% = -1.95 / -2.97 / -3.58; 10% = -1.60 / -2.62 / -3.22
Source: Author's calculations based on EViews 10 outputs.

Interpretation:
The results demonstrate that GDP and M2 are **non-stationary at level but stationary at first difference (I(1))**. The nominal interest rate (Tir) is stationary at level according to the ADF test, but the PP test suggests stationarity only after first differencing. On balance, the variables are considered integrated of order one, validating the use of the **Autoregressive Distributed Lag (ARDL) model** for estimation.

4. Model Specification

Given the mixed integration order of the variables (I(0) and I(1)), the ARDL model is applied. This specification allows for simultaneous estimation of both **short-run dynamics** and **long-run equilibrium relationships** between economic growth (GDP), money supply (M2), and the nominal interest rate (Tir).

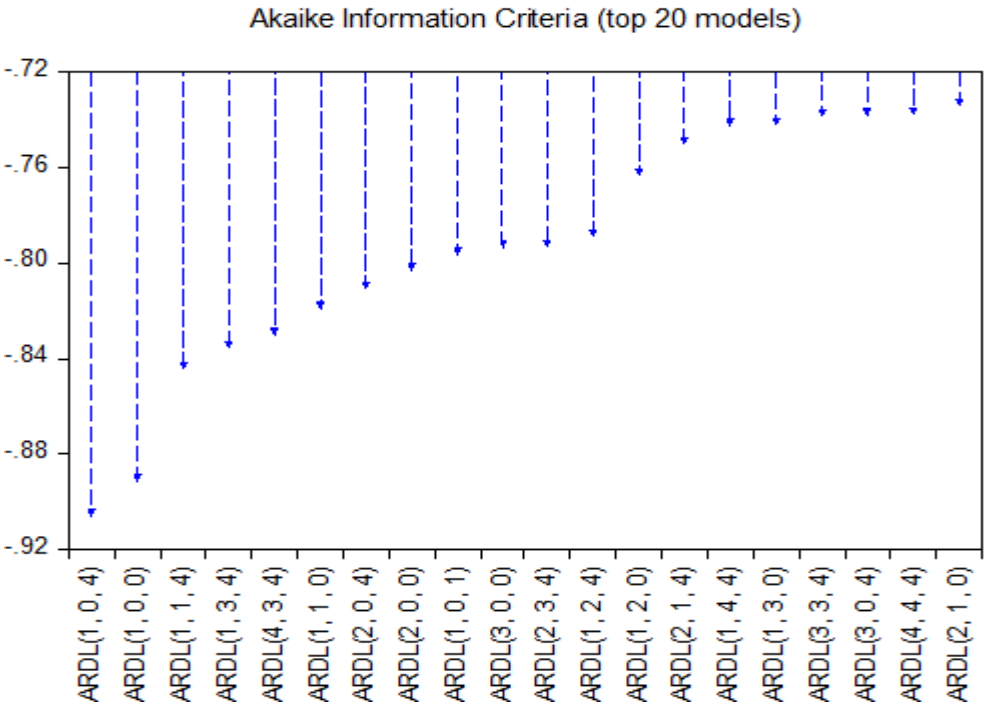
5. Cointegration Testing Using the ARDL Bounds Test

The ARDL bounds testing procedure is employed to examine whether a long-run cointegration relationship exists among the selected variables. This method is particularly advantageous in small-sample contexts and when variables are integrated at different orders. The test makes it possible to jointly estimate both short-term adjustments and long-term equilibrium coefficients.

Before implementing the bounds test, it is necessary to determine the **optimal lag length** based on standard selection criteria, including the **Log Likelihood (LOGL)**, **Akaike Information Criterion (AIC)**, **Schwarz Criterion (SC)**, and **Bayesian Information Criterion (BIC)**. The lag structure associated with the lowest criterion value is retained for estimation.

A graphical output (not shown here) illustrates the optimal lag length retained for the ARDL estimation.

Figure (3): Optimal Lag Length for the Bounds Test



Source: Prepared based on the outputs of EViews 10

From the above figure, the optimal lag length can be selected at **ARDL(1,0,4)**, which corresponds to the lowest values of the criteria (LOGL, SC, AIC, BIC) and the highest value of the Log Likelihood criterion.

Table (5): Results of the Bounds Test for Cointegration

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.175932	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	21		Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028
			Finite Sample: n=30	
		10%	2.915	3.695
		5%	3.538	4.428
		1%	5.155	6.265

Source: Prepared based on the outputs of EViews 10. *Note: K refers to the number of independent variables.*

From the above figure, the optimal lag length can be selected at **ARDL(1,0,4)**, which corresponds to the lowest values of the criteria (LOGL, SC, AIC, BIC) and the highest value of the Log Likelihood criterion.

Table (5): Results of the Bounds Test for Cointegration

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Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.175932	10%	2.63	3.35
k	2	5%	3.1	3.87
		2.5%	3.55	4.38
		1%	4.13	5
Actual Sample Size	21		Finite Sample: n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028
			Finite Sample: n=30	
		10%	2.915	3.695
		5%	3.538	4.428
		1%	5.155	6.265

Source: Prepared based on the outputs of EViews 10. *Note: K refers to the number of independent variables.*

Based on the results of the Bounds Test, it is observed that the calculated F-statistic lies outside the bounds of I(0) and I(1) at the 10%, 5%, and 1% significance levels. This indicates the rejection of the null hypothesis, which states that no long-run equilibrium relationship exists, and the acceptance of the alternative hypothesis, which affirms the existence of cointegration among the study variables; that is, a long-run equilibrium relationship exists between the variables.

5 - Estimation of the Autoregressive Distributed Lag (ARDL) Model:
The results of estimating the ARDL(1,0,4) model are presented in the following table:

Table (6): Results of the ARDL(1,0,4) Model Estimation

Dependent Variable: GDP
Method: ARDL
Date: 09/12/25 Time: 17:18
Sample (adjusted): 2004 2024
Included observations: 21 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): M2 TIR
Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(1, 0, 4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDP(-1)	0.708338	0.106053	6.679069	0.0000
M2	5.34E-05	1.84E-05	2.909851	0.0122
TIR	0.036309	0.037271	0.974214	0.3477
TIR(-1)	0.019777	0.040978	0.482631	0.6374
TIR(-2)	0.216427	0.196792	1.099773	0.2914
TIR(-3)	0.201416	0.169275	1.189874	0.2554
TIR(-4)	-0.185352	0.075657	-2.449905	0.0292
C	0.439762	0.833525	0.527593	0.6067

R-squared	0.989909	Mean dependent var	7.229350
Adjusted R-squared	0.984476	S.D. dependent var	1.072914
S.E. of regression	0.133681	Akaike info criterion	-0.904391
Sum squared resid	0.232317	Schwarz criterion	-0.506478
Log likelihood	17.49611	Hannan-Quinn criter.	-0.818034
F-statistic	182.1874	Durbin-Watson stat	2.452797
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Source: Prepared based on the outputs of EViews 10

From the results of estimating the ARDL model, it is observed that the coefficient of determination (R^2) equals **0.98**, which indicates that the independent variables explain **98%** of the variations in the dependent variable. This demonstrates the strong explanatory power of the model. In addition, the probability value corresponding to the Fisher statistic is zero, suggesting that the calculated Fisher value (F = 182.18) is greater than the tabulated value. Thus, the model as a whole is statistically significant.

6 – Estimation of the Short-Run and Long-Run Models Using ARDL and Causality Testing

6.1 – Estimation of the Short-Run Error Correction Model (ECM)

Table (7): Results of the Error Correction Model (ECM) for ARDL(1,0,4)

ARDL Error Correction Regression
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 0, 4)
Case 2: Restricted Constant and No Trend
Date: 09/12/25 Time: 17:25
Sample: 2000 2024
Included observations: 21

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TIR)	0.036309	0.025016	1.451479	0.1703
D(TIR(-1))	-0.232491	0.046257	-5.026018	0.0002
D(TIR(-2))	-0.016064	0.121349	-0.132381	0.8967
D(TIR(-3))	0.185352	0.056036	3.307738	0.0057
CointEq(-1)*	-0.291662	0.043395	-6.721147	0.0000

R-squared	0.538330	Mean dependent var	0.184030
Adjusted R-squared	0.422912	S.D. dependent var	0.158621
S.E. of regression	0.120498	Akaike info criterion	-1.190106
Sum squared resid	0.232317	Schwarz criterion	-0.941410
Log likelihood	17.49611	Hannan-Quinn criter.	-1.136132
Durbin-Watson stat	2.452797		

* p-value incompatible with t-Bounds distribution.

Source: Prepared based on the outputs of EViews 10

From the above table, it is observed that most of the model's parameters are statistically significant, and that the error correction term (–0.29) is negative and significant at the 5% level. This confirms the validity of the long-run equilibrium relationship and the presence of an error correction mechanism within the model. Accordingly, the Error Correction Model (ECM) is acceptable.

6.2 – Estimation of the Long-Run Relationship:

Table (8): Results of the Long-Run Relationship Estimation for the ARDL(1,0,4) Model

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(1, 0, 4)
Case 2: Restricted Constant and No Trend
Date: 09/12/25 Time: 17:29
Sample: 2000 2024
Included observations: 21

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.439762	0.833525	0.527593	0.6067
GDP(-1)*	-0.291662	0.106053	-2.750147	0.0165
M2**	5.34E-05	1.84E-05	2.909851	0.0122
TIR(-1)	0.288578	0.135027	2.137189	0.0522
D(TIR)	0.036309	0.037271	0.974214	0.3477
D(TIR(-1))	-0.232491	0.119635	-1.943343	0.0739
D(TIR(-2))	-0.016064	0.144303	-0.111323	0.9131
D(TIR(-3))	0.185352	0.075657	2.449905	0.0292

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
M2	0.000183	3.05E-05	6.011667	0.0000
TIR	0.989424	0.608088	1.627109	0.1277
C	1.507779	2.505055	0.601895	0.5576

EC = GDP - (0.0002*M2 + 0.9894*TIR + 1.5078)

Source: Prepared based on the outputs of EViews 10

From Table (...), it is observed that most of the coefficients are statistically significant, which indicates the influence of the independent variables on the dependent variable (economic growth) in Algeria during the study period.

7 – Granger Causality Test:

Table (9): Results of the Granger Causality Test

Pairwise Granger Causality Tests
Date: 09/13/25 Time: 13:12
Sample: 2000 2024
Lags: 2

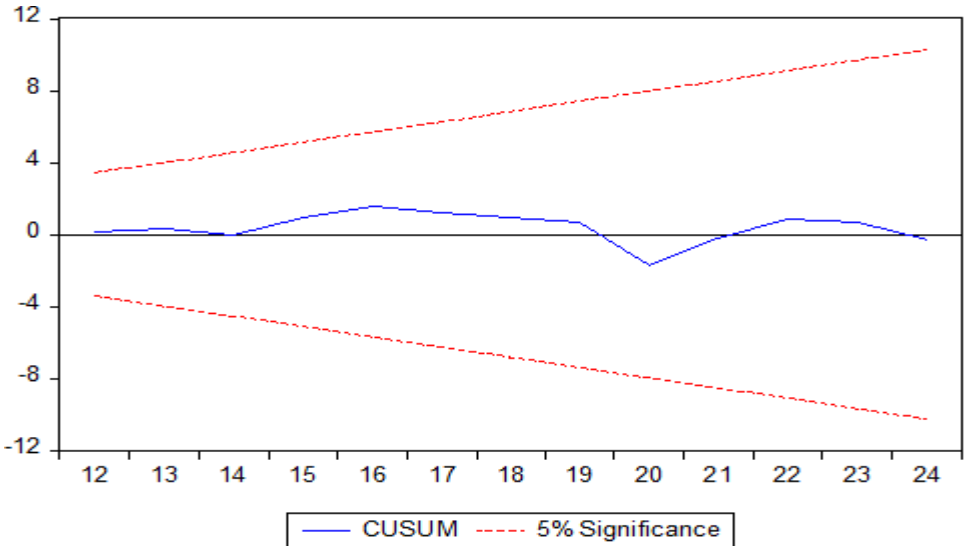
Null Hypothesis:	Obs	F-Statistic	Prob.
M2 does not Granger Cause GDP	23	4.00487	0.0364
GDP does not Granger Cause M2		0.47162	0.6315
TIR does not Granger Cause GDP	23	0.28773	0.7533
GDP does not Granger Cause TIR		1.26568	0.3060
TIR does not Granger Cause M2	23	0.49575	0.6172
M2 does not Granger Cause TIR		5.05425	0.0181

Source: Prepared based on the outputs of EViews 10

From the previous table, it is observed that there exists a unidirectional causal relationship between the money supply (M2) and both economic growth and the nominal interest rate.

8 – Model Stability Test: To ensure that the model is free from structural changes and to verify the consistency and stability of the long-run parameters with the short-run parameters, the Cumulative Sum of Residuals (CUSUM) test is applied. The results of this test are illustrated in the following figure:

Figure (4): Results of the Cumulative Sum of Residuals (CUSUM) Test



Source: Prepared based on the outputs of EViews 10

9 – Residual Diagnostics: Residuals are diagnosed through the application of stability tests and classical assumption tests (normality, autocorrelation, and homoscedasticity).

9.1 – White Noise Test:

Figure (5): Results of the White Noise Test

Date: 09/12/25 Time: 17:51
Sample: 2000 2024
Included observations: 21
Q-statistic probabilities adjusted for 1 dynamic regressor

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	-0.230	-0.230	1.2755	0.259
		2	-0.051	-0.110	1.3418	0.511
		3	0.002	-0.039	1.3419	0.719
		4	-0.153	-0.180	2.0112	0.734
		5	-0.141	-0.251	2.6097	0.760
		6	-0.008	-0.173	2.6116	0.856
		7	0.020	-0.108	2.6248	0.917
		8	0.066	-0.040	2.7859	0.947
		9	0.107	0.033	3.2491	0.954
		10	-0.165	-0.222	4.4417	0.925
		11	0.075	-0.076	4.7153	0.944
		12	0.027	-0.005	4.7559	0.966

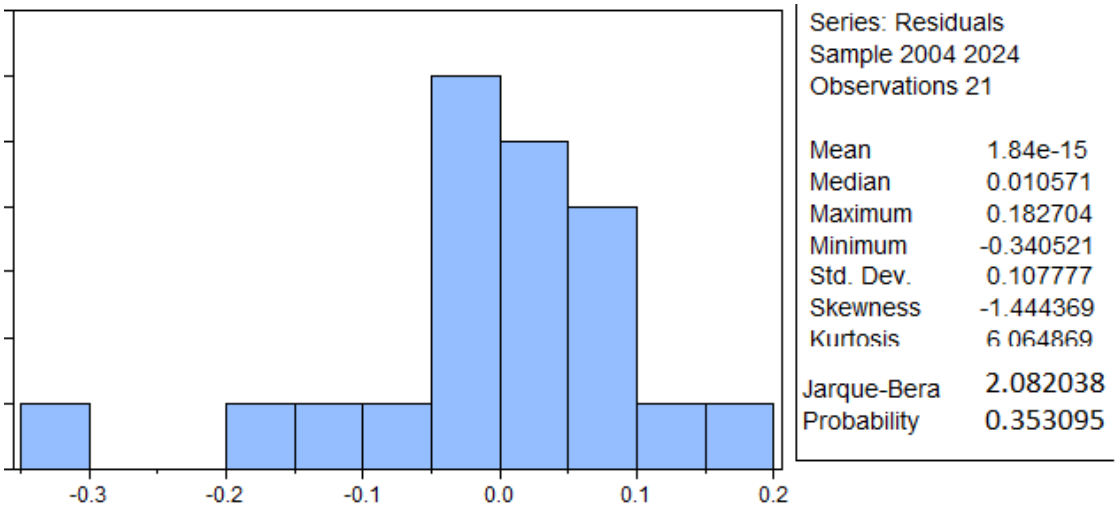
*Probabilities may not be valid for this equation specification.

Source: Prepared based on the outputs of EViews 10

From the above figure, it is observed that the residuals are stable since all the bars fall within the confidence interval. This is further confirmed by the Ljung-Box statistic (Qstat = 4.75), which is lower than Qtable = 34.03. Therefore, we accept the null hypothesis (H0), which states that all autocorrelation coefficients are equal to zero. Hence, the residual series is stable and represents white noise.

9.2 – Jarque-Bera Normality Test:

Figure (6): Results of the Jarque-Bera Normality Test



Source: Prepared based on the outputs of EViews 10

It should be noted that the null hypothesis (H0) is accepted, since the probability corresponding to the Jarque-Bera statistic is greater than the 5% significance level. Hence, the residual series follows a normal distribution.

9.3 – Residual Autocorrelation Test (LM Test):

Table (10): Results of the Residual Autocorrelation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.332984	Prob. F(2,11)	0.3031
Obs*R-squared	4.096697	Prob. Chi-Square(2)	0.1289

Source: Prepared based on the outputs of EViews 10

It should be noted that the null hypothesis (H0) is accepted, since the probability corresponding to the LM Test statistic is greater than the 5% significance level. Therefore, there is no autocorrelation in the residuals.

9.4 – Heteroskedasticity Test (ARCH):

Table (11): Results of the ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	0.046261	Prob. F(1,18)	0.8321
Obs*R-squared	0.051270	Prob. Chi-Square(1)	0.8209

Source: Prepared based on the outputs of EViews 10

It should be noted that the null hypothesis (H0) is accepted, since the probability corresponding to the ARCH Test statistic is greater than the 5% significance level. Therefore, there is no heteroskedasticity problem.

Conclusion: The study reached the following results:

- The Granger causality test showed that there is a unidirectional causal relationship between the money supply (M2), economic growth, and the nominal interest rate.
- The error correction coefficient (–0.29) is negative and statistically significant at the 5% level, which confirms the existence of a long-run equilibrium relationship.
- There exists a positive long-run relationship between the money supply (M2) and the economic growth rate, and an inverse relationship between the interest rate and the economic growth rate in both the short and long run.

Appendices
Appendix (01): Database

years	GDP Trillion dinars	M2 billion dinars	Tir%
2000	4.454	1,559.91	8.87
2001	4.588	2,403.07	6
2002	4.835	2,836.87	5.75
2003	5.150	3,299.46	5
2004	5.381	3,644.29	4.25
2005	5.672	4,070.44	4
2006	5.836	4,870.07	4
2007	6.017	5,994.61	4
2008	6.168	6,955.97	4
2009	6.242	7,292.69	4
2010	6.541	8,280.74	4
2011	6.738	9,929.19	4
2012	6.899	11,015.10	4
2013	7.079	11,941.50	4
2014	7.369	13,663.90	4
2015	7.605	13,704.50	4
2016	7.901	13,816.30	4
2017	8.020	14,974.20	3.54
2018	8.132	16,636.70	3.54
2019	8.205	16,510.00	3.54

2020	7.795	17,740.00	3.54
2021	8.091	19,918.39	2.75
2022	8.383	22,964.47	3
2023	8.726	24,330.82	9.02
2024	9.014	25,610.62	8.66

Ethical Considerations

This research adheres to the highest standards of academic integrity and ethical responsibility. All data used were obtained from publicly accessible and reputable international financial institutions. No personal, confidential, or proprietary information was utilized. The study does not involve human participants or experimental procedures requiring ethical approval. Proper attribution and referencing were ensured throughout the manuscript to maintain academic honesty and transparency.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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