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Measuring and Analyzing the Effects of Money Supply Shocks on Economic Growth in Algeria (1996–2025): An Empirical Study Using the NARDL Model.

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Abstract:
This study aims to analyze the effects of money supply shock on economic growth in Algeria over the period 1996–2025, using the Nonlinear Autoregressive Distributed Lag (NARDL) model. The main findings reveal that there is a long-run relationship between economic growth and both positive and negative money supply shocks. The results also show that a positive money supply shock has a positive and statistically significant effect on economic growth in the long run, whereby a 1% increase in the money supply leads to an approximately 0.45% increase in the economic growth rate. In contrast, negative money supply shocks have a positive but statistically insignificant effect. Furthermore, the results indicate the presence of asymmetry in the effect of money supply shocks on economic growth. The study recommends improving the performance of the financial system and enhancing the efficiency of the banking sector to ensure the optimal allocation of credit toward productive sectors. It also recommends strengthening coordination between monetary and fiscal policies and diversifying economic resources to enhance the resilience of the Algerian economy and support sustainable economic growth.
Keywords: Money Supply Shocks, Economic Growth, Money Supply, NARDL Model.
JEL Classification: E51, E52, O47, C32.

1- Introduction

Money supply is one of the most important monetary variables affecting the economic activity of countries, as it is one of the key determinants of the *volume of* liquidity, available in the national economy, as well as the levels of expenditure and investment. Changes in the money supply are also of great importance due to their implications for macroeconomic equilibrium, particularly economic growth. Unexpected increases or decreases in the money supply may lead to imbalances that affect economic activity.

Numerous recent studies, both domestic and international, have examined the relationship between money supply shocks and economic growth. This interest stems from the effects of sudden changes in the money supply on economic performance, as such shocks may lead to changes in economic growth rates in both the short and long run. Positive money supply shocks may contribute to

promoting economic growth, whereas negative money supply shocks may have contractionary effects. Moreover, the nature and magnitude of these effects may differ between the short and long run. Hence, the importance of analyzing the effects of money supply shocks on economic growth in Algeria becomes evident, particularly given the country's heavy dependence on the hydrocarbons sector. This necessitates the use of nonlinear models to investigate the nature of this relationship and measure its effects over the study period 1996–2025.

1.1- Research Problem:

Based on the foregoing, the research problem can be formulated through the following question:

- To what extent do money supply shocks affect economic growth in Algeria over the period 1996–2025?

1.2- Research Hypotheses:

- There is an asymmetric relationship between money supply shocks and economic growth in Algeria.
- The effects of positive and negative money supply shocks on Algerian economic growth differ.
- The effects of money supply shocks on Algerian economic growth differ between the short and long run.

1.3- Objective

The main objective of this study is to examine and analyze the effects of money supply shocks on economic growth in Algeria and to determine the extent to which these shocks affect economic growth in both the short and long run. The findings may contribute to assisting policymakers in adopting appropriate economic measures.

1.4- Research Methodology

The study adopts a descriptive-analytical approach in the theoretical part in order to provide a comprehensive understanding of the various aspects of the research topic. In the empirical part, an econometric approach is employed to analyze the effects of money supply shocks on economic growth in Algeria, using the Nonlinear Autoregressive Distributed Lag (NARDL) model.

1.5- Study scope:

The study covers two dimensions:

- Spatial scope: The study focuses on the Algerian economy.
- Temporal scope: The study covers the period from 1996 to 2025.

1.6- Previous Studies

Numerous studies have examined money supply shocks and their effects on economic growth. The following section presents a selection of recent domestic, Arab, and international studies related to the subject.

- **Study by Ramadani Wafa, year 2021, doctoral thesis entitled: The response of macroeconomic stability indicators to changes in the money supply, an econometric analytical study of the case of Algeria 1990-2018).**

The study relied on the SVAR model to study the impact of the money supply shock during the study period. The results of the study found that a positive shock in the money supply leads to increased

economic growth and higher inflation, and its effect lasts for several years. This confirms that money supply represents an important source of support for economic growth.

- **Imane Senoussi and Manal Ghatouchi (2024), article entitled "Investigating the Effect of Broad Money Supply on Economic Growth in Algeria, 1970–2021."**

The study employed the Autoregressive Distributed Lag (ARDL) model to measure the asymmetric effects of money supply shocks on economic growth. The findings indicated that changes in the money supply affect Algerian economic growth rates asymmetrically in both the short and long run. Positive money supply shocks were found to promote economic growth, in contrast to negative shocks.

- **Bourdime Fatima Zahra (2022), PhD dissertation entitled "Analyzing the Relationship between Money Supply, Price Level, and Economic Growth in Algeria, 1990–2021."**

The study employed the Error Correction Model (ECM) to estimate short-run relationships and the Fully Modified Ordinary Least Squares (FMOLS) method to estimate long-run relationships, together with Asymmetric Causality Tests. The results showed that money supply had no statistically significant effect on economic growth in the short run, whereas a statistically significant effect was found in the long run. The study also found evidence of asymmetric money supply shocks in relation to economic growth over the study period.

- **Oziengbe Scott Aigheyisi and Julius Ovuefeyen Edore (2019), article entitled " Asymmetric Effects of Money Supply Growth on Economic Growth in Nigeria: An Empirical Investigation."**

The study employed the NARDL model, in addition to cointegration techniques and an Error Correction Model, to investigate the asymmetric effects of broad money supply shocks on economic growth in Nigeria over the period 1981–2016. The findings revealed an asymmetric relationship between money supply growth and economic growth. An increase in the money supply had a positive effect in the short run, whereas a decrease in the money supply had a negative effect. In the long run, however, an increase in the money supply had no significant effect, while a decrease in the money supply had a positive effect on economic growth.

- **Abdelhamid Al-Arabi Omar and Montaj Obeida (2026), article entitled "The Asymmetric Effects of Money Supply Shocks on Macroeconomic Indicators in Libya, 1980–2024."**

The researchers employed the NARDL model to analyze the relationship between the study variables. The findings indicated that money supply shocks have asymmetric effects on inflation, whereas no asymmetric effect on economic growth was observed in the long run. However, positive monetary shocks had a temporary positive effect on economic growth in the short run. The study recommended adopting monetary policies that take into account the asymmetric nature of the effects of money supply shocks, strengthening the independence of monetary institutions, and enhancing coordination among different economic policies.

- **Mohammad Al-Sumairan and Ibrahim Al-Mukhaymer (2025), article entitled "The Effect of Monetary Policy Shocks on Macroeconomic Variables: A Case Study of Jordan for the Period 1990–2020."**

The study aimed to analyze the effects of monetary policy shocks, represented by money supply, on economic growth, interest rates, and inflation in Jordan. The study employed a Vector Autoregressive

(VAR) model to analyze the relationships among the variables. The results showed that money supply shocks have a positive effect on economic growth and inflation. The study recommended maintaining appropriate levels of money supply given its important role in promoting economic growth.

- **Ahmed AbdulZahra Hamdan (2017), article entitled "Measuring the Effect of Monetary Shocks in Iraq during the Period 1990–2015."**

The study employed an SVAR model to measure the effects of monetary shocks in Iraq. The results showed that a positive money supply shock leads to an increase in economic growth, indicating a positive effect of monetary expansion in stimulating economic growth. The Impulse Response Functions (IRFs) also showed that the effect of money supply shocks on Gross Domestic Product (GDP) remained positive throughout the study period.

- **Esra N. Kılcı (2023), article entitled " A Study on the Impact of Money Supply Growth and Government Debt Increase on the Economic Performance in the Euro-Area."**

The study employed the ARDL model, as well as the Bootstrap ARDL Bounds Test, to examine the existence of a long-run equilibrium relationship among the variables over the period 2000–2020. The findings indicated that the expansionary policies adopted by the European Central Bank during the COVID-19 pandemic, including increasing the money supply and strengthening bank lending, contributed to supporting economic growth in the Euro Area. However, their effect on economic growth remained limited compared with their impact on inflation.

- **Piotr Borawski and Aneta Beldycka-Borawska (2024), article entitled " The Role of Money Supply in Shaping Poland's Gross Domestic Product."**

The study aimed to assess changes in the money supply and analyze the relationship between money supply and economic growth in Poland. A Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was employed to analyze the data, while the Ordinary Least Squares (OLS) method was used over the period 1996–2024. The findings revealed a strong relationship between money supply and economic growth in Poland. Money supply had a positive effect on economic growth in the short run, whereas in the long run its effect was limited to increasing the price level.

- **Apostolos Serletis and Khandokar Istiak (2016), article entitled "Does the U.S. Economy Respond Asymmetrically to Positive and Negative Money Supply Shocks?"**

The study employed the Kilian and Vigfusson (2011) test based on Impulse Response Functions (IRFs) to examine whether the U.S. economy responds asymmetrically to positive and negative money supply shocks over the period 1967–2014. The findings provided no statistical evidence of an asymmetric response of the U.S. economy to positive and negative money supply shocks, indicating that their effects on economic growth were symmetric during the study period.

2- The theoretical framework of the study:

First: Money Supply Shocks

Money supply shocks are defined as unexpected changes in the nominal money supply, which may be either positive or negative. A positive shock refers to an unexpected increase in the money supply, which may lead to higher investment and output, whereas a negative shock refers to an unexpected decline in the money supply, which may adversely affect output. Changes in the money supply also

affect the general price level, inflation, exchange rates, and business cycles (Al-Jubouri & Hassein, 2018, p. 13).

A money supply shock can also be defined as a sudden and unexpected change in the quantity of money available in the economy, resulting in a change in the level of liquidity. The shock may be positive when an unexpected expansion in the money supply occurs or negative when an unexpected monetary contraction takes place. Conrad argues that an expansion in the money supply, particularly through increased liquidity, may encourage investors to rebalance their portfolios toward financial assets, potentially leading to higher stock prices (Conrad, 2026, p. 67).

More generally, money supply shocks refer to sudden and unexpected changes in the quantity of nominal money available in the economy, which may be either positive or negative (Abu Al-Saud, 2014, p. 7):

- Positive monetary shock: An unexpected increase in the money supply.
- Negative monetary shock: An unexpected decrease in the money supply.

Changes in the money supply are reflected in the general price level, inflation, exchange rates, and business cycles. The nominal money supply (Ms) is considered an exogenous variable determined by the decisions and actions of the central bank.

The nominal money supply (Ms) is primarily determined by the decisions and policies of the central bank as an exogenous variable. The nominal money supply function can be represented as follows:

$$Ms=Ms0 \quad \text{..... 1-1}$$

If the nominal money supply is excessively low, the central bank can take the necessary measures to increase it through its direct and indirect policy instruments. Conversely, if the nominal money supply is excessively high, the central bank can adopt measures to reduce it.

Demand deposits constitute one of the components of the money supply (ΔH) in the narrow sense, given that they can be used to make payments and settle debts through checks or transfers. More generally, the money supply in most economies includes demand deposits and currency held by individuals, this total is called monetary reserves or the monetary base. Accordingly, the central bank can influence the volume of the money supply by making changes in the monetary base (ΔH).

Commercial banks retain part of their assets in the form of cash and deposits held at the central bank. These balances are referred to as Reserve requirements. The monetary authority may adjust the required reserve ratio as one of its monetary policy instruments in order to influence the amount of funds that banks can allocate to lending, thereby affecting borrowing levels and interest rates.

Balances held by commercial banks in excess of the required reserve level are referred to as excess or additional reserves. These reserves play an important role in the process of creating demand deposits, as they enable banks to expand their lending activities, resulting in successive increases in demand deposits until the available excess reserves are exhausted.

Accordingly, the initial change in reserves (ΔH\Delta H) is ultimately transformed through the deposit creation process into a change in required reserves (ΔR\Delta R). This relationship can be expressed as follows:

$$(\Delta H) = (\Delta R) \text{.....1-2}$$

Based on the above, the change in required reserves (ΔR\Delta R) can be expressed as the product of the required reserve ratio for demand deposits (rr) and the total increase in demand deposits (ΔD\Delta D). By substituting this relationship into Equation (1-2), we obtain:

$$\Delta H = r\Delta D \ldots\ldots\ldots\ldots\ldots\ldots \quad 1\text{-}3$$

Where:

- ΔD: represents the total change in demand deposits.
- ΔH: represents the initial change in reserves.
- R: represents the required reserve ratio for demand deposits.

Since demand deposits constitute part of the money supply and individuals do not increase their cash holdings during the expansion process, the increase in the money supply equals the increase in demand deposits. However, commercial banks, particularly smaller banks, may hold excess reserves above the required reserve level to protect against potential deposit losses and ensure liquidity. These excess reserves represent a leakage from the process of deposit creation (Al-Janabi, 2017, p. 110).

If banks maintain a fixed ratio of excess reserves (ee) relative to their demand deposits, the leakage equals eΔDe\Delta D. Therefore, the initial increase in reserves (ΔH\Delta H) is divided between changes in required reserves (rΔDr\Delta D) and excess reserves (eΔDe\Delta D), as follows:

$$\Delta H = r\Delta D + e\Delta D \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad 1\text{-}4$$

Individuals may also increase their holdings of currency and time deposits during the process of deposit expansion. This behavior results in a loss of bank reserves, thereby limiting the amount of loans banks can extend and consequently reducing the increase in demand deposits.

Accordingly, an increase in currency holdings by individuals represents a leakage from the process of deposit expansion. If individuals maintain a fixed ratio between currency holdings (cc) and demand deposits, this leakage equals cΔDc\Delta D. Therefore, the initial increase in reserves (ΔH\Delta H) is distributed among changes in required reserves, excess reserves, and currency holdings by individuals (Afandi, 2014, p. 523):

$$\Delta H = r\Delta D + e\Delta D + c\Delta D \ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{(1-5)}$$

Since a portion of deposits is held as reserves against time deposits, this leads to a reduction in the amount of reserves available to cover and support demand deposits. Conversely, the increase in time deposits is limited, as this increase represents a form of leakage from the deposit creation process. If we assume that individuals hold time deposits at a fixed ratio **(1)** of demand deposits, and that **(1)** represents the required reserve ratio imposed on time deposits, then the amount of leakage resulting from this is equal to **(**rtAD**)**. Consequently, the initial increase in reserves (**ΔH**) is ultimately distributed, at the end of the deposit creation process, among the required reserves allocated to demand deposits **(1)**, excess reserves **(e)**, the currency held by individuals **(c)**, and the required reserves imposed on time deposits **(**rt**)**.

$$\Delta H = r\Delta D + e\Delta D + c\Delta D + rt\Delta D \ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{(1-6)}$$

Assuming the ratio of cash held by individuals to their demand deposits remains constant, the change in the cash balances they hold can be expressed as (cΔD). Consequently, the increase in the money supply (ΔMS) represents the sum of the change in demand deposits (ΔD) and the change in cash balances held by individuals (cΔD):

$$\Delta Ms = \Delta D + c\Delta D \ldots\ldots\ldots\ldots\ldots\ldots \quad \textit{(1-7)}$$

$$\Delta Ms = (1 + c)\, \Delta D \text{ …….. } \textit{(1-8)}$$

The central bank can influence the money supply by changing the monetary base. However, this depends on the money multiplier, which may change as a result of changes in the behavior of banks and individuals, as well as interest rate movements, potentially leading to a shock to the money supply. An increase in the interest rate may reduce the excess reserves held by banks and affect the currency-to-deposit ratio, thereby influencing the money multiplier. (Kadhim, 2016, p. 20)

Similarly, the ratio of currency in circulation to demand deposits, which is determined by individuals, may change in response to changes in interest rates. When interest rates increase, the ratio of currency to demand deposits may increase, resulting in a decline in the money multiplier. Likewise, the ratio of time deposits to demand deposits is influenced by interest rates. As interest rates increase, demand deposits decline relative to time deposits, which also contributes to a decrease in the money multiplier (Al-Ghali, 2011, p. 118).

Since the ratios of excess reserves, currency holdings, and deposits change in response to interest rates, the money multiplier itself also changes with the interest rate. Consequently, the money supply function can be written as follows:

$$Ms = f(H, i) \text{ ……..}$$

According to this revised money supply function, the nominal money supply is positively related to both the monetary base and the interest rate. A money supply shock occurs when an unexpected shift takes place in the money supply function. Such a shock can be expressed through changes in the stochastic component resulting from the behavior of the central bank or commercial banks (Al-Khatib & Diab, 2015, pp. 120–121).

Second: Economic Growth

Some economists define economic growth as an increase in national income or real national output over time. The economic growth rate is measured by changes in real national output or real national income over time. This definition highlights the importance of economic growth in improving living standards, providing goods and services, and creating additional employment opportunities (Abdel Hamid, 2007, p. 467).

Economic growth is also defined as an increase in the capacity of an economy to produce goods and services when compared with one period to another. It refers to the quantitative expansion of a country's economy and is usually measured by the annual increase in Gross Domestic Product (GDP) (Raisová & Ďurčová, 2014, p. 223).

In his book *Macroeconomic Analysis*, Dr. Omar Sakr defines economic growth as an increase in a country's capacity to produce goods and services, noting that a higher rate of economic growth relative to population growth is desirable because it contributes to improving individuals' standards of living (Sakhri, 2008, p. 12).

Economic growth also refers to the rate of increase in production within a given country over a specified period. It reflects changes in productive capacity and the extent to which this capacity is utilized. An increase in the growth rate of national income indicates a greater utilization of productive capacity (Abu Ahmed, 2006, p. 315).

Furthermore, economic growth represents a real increase in national output resulting from improvements in the quality and quantity of available resources and from the development of technological production methods (,Al-Sharafat 2010, p. 39).

Based on the preceding definitions, economic growth can be summarized through the following dimensions:

1. An increase in average per capita national income: This requires the growth rate of national income to exceed the population growth rate. Accordingly:
   Economic Growth Rate = National Income Growth Rate − Population Growth Rate
2. The increase in average individual income must be real rather than merely nominal: This requires the growth rate of individual income to exceed the inflation rate. Accordingly:
   Real Economic Growth Rate = Nominal Per Capita Income Growth Rate − Inflation Rate
3. The increase in individual income must be sustained over the long run: Temporary increases do not constitute economic growth in the full economic sense.

Indicators of Economic Growth

Several indicators are used to measure economic growth. The most important include:

1. Real Gross Domestic Product (Real GDP)

Real Gross Domestic Product is one of the fundamental variables used to analyze and measure economic growth (Henderson et al., 2012).

2. Real GDP Growth Rate

The real GDP growth rate is one of the main indicators used to measure economic growth, as it reflects changes in the real output of an economy over time (Bayer et al., 2022).

3. Real GDP per Capita

Real GDP per capita is an indicator used to measure economic performance, as it represents the economic output produced per individual in the population (OECD, 2026).

4. Real GDP per Capita Growth Rate

The growth rate of real GDP per capita is measured by the first difference of the natural logarithm of real GDP per capita (Eftimoski, 2022).

3- Empirical Study

Monetary policy, particularly through the management of the money supply (M2), represents one of the most important intervention tools available to monetary authorities for regulating economic activity. In a rentier economy such as Algeria's, changes in the money supply are often intertwined with fluctuations in hydrocarbon revenues and foreign exchange reserve levels, generating different economic growth responses to expansionary (positive) and contractionary (negative) monetary shocks.

The central issue of this empirical analysis is to measure the extent to which real Gross Domestic Product (GDP) responds to asymmetric money supply shocks and to determine the speed at which the Algerian economy returns to its long-run equilibrium.

The study covers a period of 30 years (comprising 30 annual observations). This period is both rich and pivotal in the contemporary economic history of Algeria, as it encompasses several distinct structural phases:

1- 1996–1999: The period of structural adjustment, the establishment of the foundations of a market economy, and efforts to control inflation and the money supply following the agreement with the International Monetary Fund (IMF).
2- 2000–2014: A period characterized by exceptional fiscal surpluses, the accumulation of foreign exchange reserves, and economic recovery programs accompanied by substantial monetary expansion.
3- 2014–2019: The period of the oil price shock and the erosion of banking liquidity, culminating in the adoption of the "unconventional financing" mechanism (direct monetary issuance), which generated an artificial and substantial positive shock to the M2 money supply.
4- 2020–2025: The COVID-19 pandemic shock and the sharp economic contraction, followed by structural recovery policies, the new Money and Credit Law, and efforts to mobilize savings outside the parallel banking system.

Second: Description of the Econometric Variables and Data Sources

It should be noted that the data for the study variables were obtained from the World Bank database (World Bank, 2026).

To model this relationship using the Nonlinear Autoregressive Distributed Lag (NARDL) methodology, the following variables were specified:

- Dependent variable: The real Gross Domestic Product growth rate (GDPG), used as a proxy for economic activity.
- Main independent variable: Broad money supply as a percentage of GDP (M2). For the purpose of testing asymmetry, it was decomposed into two partial-sum processes:
- $M2^{+}$: The partial sums of positive monetary shocks (monetary expansion).
- $M2^{-}$:The partial sums of negative monetary shocks (monetary contraction).
- Control variables:
- The official exchange rate of the Algerian dinar to the US dollar (EXR).
- Domestic credit to the private sector (AST) as a percentage of GDP.
- The real interest rate (RINR), reflecting the real cost of capital.

Third: Descriptive Statistical Analysis and Data Distribution

Descriptive statistical analysis represents the preliminary step for understanding the behavioral and statistical characteristics of the data series over the period 1996–2025.

Table (1): Descriptive statistics

Descriptive Statistics	GDPG	EXR	AST	M2	RINR
Mean	3.1205	90.6342	14.2861	61.5842	2.0995
Median	3.4000	77.4655	13.3494	62.5798	1.5521
Max	6.5000	141.9950	26.1172	84.8718	16.5976
Min	5.0000-	54.7489	3.9074	33.0058	12.1382-
Std.\ Dev	2.0461	27.5289	6.1817	13.3041	7.5783
Skewness	2.0059-	0.6179	0.0040	0.5786-	0.0711
Kurtosis	9.4324	1.8758	2.0147	2.5612	2.2346

Source: Prepared by the researcher based on the outputs of EViews 13.

Based on the previous results, the following observations can be made:

- Economic Growth Rate (GDPG): The average economic growth rate over the past three decades was approximately 3.12%, reflecting a volatile growth pattern largely dependent on oil cycles. The standard deviation (2.05) indicates a moderate degree of volatility. However, the pronounced negative skewness (-2.005) and the very high kurtosis (9.43) reflect the substantial impact of exceptional shocks, particularly the -5.00% contraction recorded in 2020 during the COVID-19 crisis.
- Money Supply (M2): The average money supply amounted to 61.58% of GDP. The series exhibits considerable variation, ranging from a minimum of 33.01% during the early years of the study period, particularly during the structural adjustment phase, to a maximum of 84.87%, reflecting the substantial monetary effects of the unconventional financing policy (money creation).
- Exchange Rate (EXR): The average exchange rate of 90.63 DZD per USD reflects a policy of managed floating and the continuous depreciation of the national currency as a mechanism for absorbing budget deficits and adapting to declining oil revenues, eventually reaching levels close to 142 DZD.
- Domestic Credit (AST): A notable feature is the relatively low average level of domestic credit directed to the private sector, amounting to 14.28% of GDP, compared with the relatively large money supply. From both an economic and quantitative perspective, this may indicate limited financial intermediation efficiency and the accumulation of liquidity outside the formal banking system.

Fourth: Unit Root Test Results (ADF)

Before proceeding with model estimation, it is methodologically necessary to examine the stationarity properties of the time series using the Augmented Dickey–Fuller (ADF) test. The objective is to ensure that none of the variables is integrated of order two, I(2), thereby avoiding the problem of spurious regression. This constitutes a fundamental requirement for the application of the ARDL/NARDL methodology.

Table (2): Results of the Augmented Dickey-Fuller (ADF) Unit Root Test

Variable	Deterministic Specification (Trend)	*At Level*			*At 1st Difference*			Decision
		t-Statistic	p-value	Significance	t-Statistic	p-value	Significance	Order of Integration
GDPG	*Constant*	*-1.1725*	*0.2123*	Not significant	*-8.9137*	*0.0000*	***	*I(1)*
	Constant & Trend	*-1.3483*	*0.1191*	Not significant	*-8.7318*	*0.0000*	***	
	Without Constant &	*-0.9315*	*0.3045*	Not significant	*-9.0772*	*0.0000*	***	

	Trend							
EXR	*Constant*	*-0.2839*	*0.9158*	Not significant	*-3.7426*	*0.0088*	***	*I(1)*
	Constant & Trend	*-1.2696*	*0.8756*	Not significant	*-3.6639*	*|0.0422vert **{}*		
	Without Constant & Trend	*2.3492*	*0.9941*	Not significant	*-3.3194*	*0.0018*	***	
AST	*Constant*	*-1.2229*	*0.6506*	Not significant	*-4.6983*	*0.0008*	***	*I(1)*
	Constant & Trend	*-1.6084*	*0.7647*	Not significant	*-4.7961*	*0.0033*	***	
	Without Constant & Trend	*0.8657*	*0.8913*	Not significant	*-4.3833*	*0.0001*	***	
M2	*Constant*	*-2.0485*	*0.2658*	Not significant	*-3.0429*	*|0.0451vert **{}*	***	*I(1)*
	Constant & Trend	*-3.0105*	*0.1466*	Not significant	*-4.0160*	*0.0222*	**	
	Without Constant & Trend	*1.0714*	*0.9218*	Not significant	*-5.3988*	*0.0000*	***	
RINR	*Constant*	*-4.7903*	*0.0006*	***	*-6.7557*	*0.0000*	***	*I(0)*
	Constant & Trend	*-4.7289*	*0.0037*	***	*-6.7322*	*0.0000*	***	
	Without Constant & Trend	*-4.4866*	*0.0001*	***	*-6.8972*	*0.0000*	***	
Note: *** and ** indicate statistical significance at the 1% and 5% levels, respectively.								

Source: Prepared by the researcher based on the outputs of EViews 13.

The results indicate that the real interest rate (RINR) is the only variable that is stationary at its level. This stationarity was strongly confirmed across all deterministic specifications—whether including an intercept, an intercept and trend, or neither—as the corresponding p-values were below 0.01. Therefore, the variable is integrated of order zero, I(0).

The tests further revealed that economic growth (GDPG), money supply (M2), domestic credit (AST), and the exchange rate (EXR) exhibit unit root problems at their levels across the different deterministic specifications, as indicated by p-values exceeding 0.05. However, after taking first differences, all these time series became stationary, with the corresponding t-statistics becoming statistically significant at the 1% and 5% levels, depending on the specification considered (intercept,

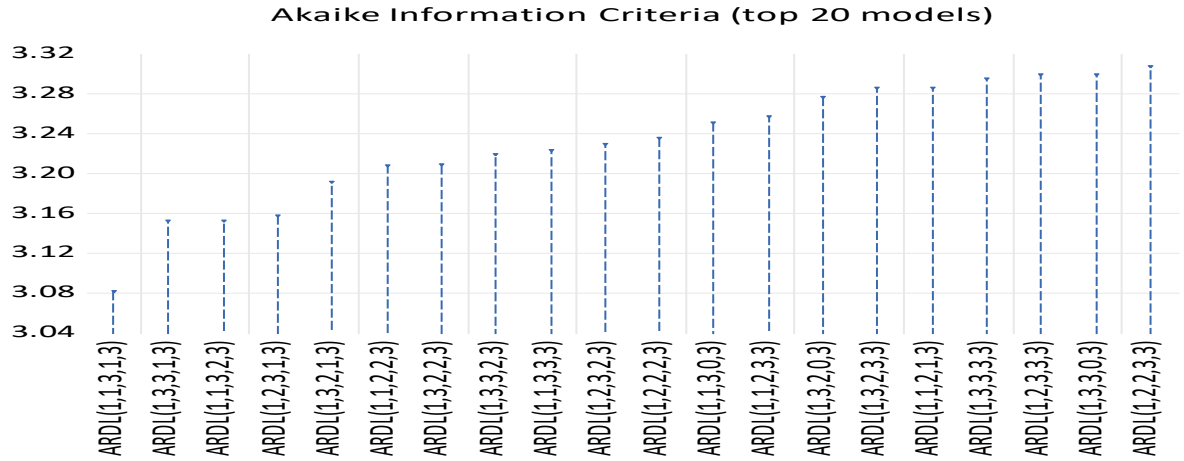
intercept and trend, or neither). Consequently, these variables are considered integrated of order one, I(1).

Based on a comprehensive assessment of the table across all deterministic specifications, the study variables can be characterized as a combination of variables integrated of order zero, I(0), and order one, I(1). Most importantly, there is no evidence of any variable integrated of order two, I(2). This result provides the econometric justification for proceeding with the estimation of the Nonlinear Autoregressive Distributed Lag (NARDL) model and conducting the Bounds Test for cointegration with a high degree of confidence.

Fifth: Estimation of the NARDL Model and the Bounds Test for Cointegration

The first step in constructing the Nonlinear Autoregressive Distributed Lag (NARDL) model is the accurate determination of the optimal number of lag orders for both the dependent variable and the explanatory variables. This is necessary to adequately capture the underlying time dynamics while avoiding an unnecessary loss of degrees of freedom. To achieve this objective, the Akaike Information Criterion (AIC) was employed to compare the possible model specifications. The estimation results showed that the procedure evaluated 256 different model specifications, ultimately selecting the optimal lag structure represented by the ARDL(1, 1, 3, 1, 3) model.

Figure 1: Akaike Information Criterion (Top 20 Models)



Source: EViews 13 outputs

Error Correction Equation and Short-Run Adjustment Dynamics

After establishing the optimal dynamic structure of the model, the short-run parameters were estimated in order to determine the speed of adjustment toward the long-run equilibrium.

Table (3): Estimation Results of the Error Correction Term (ECM_{t-1})

Variable	Coefficient (Coef.)	Std.Error	t−Statistic	Prob
Error Correction Term (COINTEQ*)**	0.995621-	0.173209	5.748084-	* {}^0.0000

Source: Prepared by the researcher based on the outputs of EViews 13.

The estimation results yielded an error correction coefficient (COINTEQ*) with the theoretically expected negative sign, with an estimated value of −0.9956. The coefficient is highly statistically significant at the 1% level (Prob < 0.01).

From an economic perspective, this coefficient indicates a very rapid adjustment process and a strong tendency toward equilibrium. Specifically, the Algerian economy absorbs short-run disequilibria

arising from monetary shocks and economic fluctuations and corrects approximately 99.56% of these deviations within one period (one year). This rapid return to the long-run equilibrium path may reflect the responsiveness of the financial and economic system to government intervention mechanisms, such as public expenditure, which contribute to closing existing gaps and restoring economic indicators to their equilibrium levels.

1- Bounds Test for Cointegration

To establish conclusively the existence of a genuine, rather than spurious, long-run equilibrium relationship between economic growth and asymmetric monetary shocks, the Bounds Test for cointegration was applied. The decision rule of this test is based on comparing the calculated test statistics with the corresponding critical values.

Table (4): Bounds Test Results for Cointegration

Test Statistic	Calculated Value	Significance Level	Lower Bound I(0)	Upper Bound I(1)
F-Statistic	13.3887	%\1	4.537	6.370
t-Statistic	5.7519-	%\1	3.430-	4.790-

Source: Prepared by the researcher based on the outputs of EViews 13.

The calculated F-statistic reached a high value of 13.3887, clearly exceeding the upper critical bound of 6.370 at the 1% significance level. To further confirm this result, the t-statistic was also examined. Its absolute value (|−5.7519|) exceeded the absolute value of the upper critical bound (|−4.790|).

Based on the convergence of these two test statistics, the null hypothesis of no cointegration is decisively rejected. Therefore, the results confirm the existence of a stable long-run equilibrium relationship between economic growth in Algeria, positive and negative money supply shocks, and the other control variables included in the model.

Sixth: Long-Run Analysis and Asymmetry Tests

1. Estimation of Long-Run Parameters and Economic Interpretation

After establishing the existence of a cointegration relationship among the model variables through the Bounds Test, the long-run parameters were estimated to determine how the economic growth rate (GDPG) responds to structural changes in monetary and financial variables.

Table (5): Estimated Long-Run Parameters of the NARDL Model

Explanatory Variable	parameters (Coefficient)	Std .Error	t−Statistic	Prob.	Statistical Significance
Positive Shocks ($M2^{+}$)	0.4499+	0.2063	2.1804	0.0407	Significant at the 5% level
Negative Shocks ($M2^{-}$)	0.4362+	0.2914	1.4965	0.1493	Not statistically significant
Domestic Credit (AST)	1.2195-	0.3468	3.5162-	0.0020	Significant at the 1% level
Exchange Rate (EXR)	0.0611+	0.0372	1.6432	0.1152	Not statistically significant
Real Interest Rate (RINR)	0.1234-	0.1975	0.6249-	0.5387	Not statistically significant

Source: Prepared by the researcher based on the outputs of EViews 13.

Based on the estimation results, the following findings can be highlighted:

The results indicate that expansionary monetary shocks have a positive and statistically significant effect on economic growth at the 5% significance level. Specifically, a 1% increase in the M2 money supply through positive shocks increases the economic growth rate by approximately 0.45% in the long run. This finding may be explained by the expansionary monetary policies adopted by the Algerian monetary authorities, particularly during economic recovery programs and the period of unconventional financing, which increased market liquidity in order to support the financing of public investment and aggregate demand. Such policies may have contributed to maintaining positive growth rates, particularly in sectors associated with public expenditure.

The coefficient associated with negative monetary shocks is also positive (+0.4362), but it is not statistically significant (Prob = 0.1493). This result suggests that monetary contraction does not produce an immediate or statistically significant decline in real economic growth. One possible explanation lies in the rent-based characteristics of the Algerian economy, where hydrocarbon export revenues and foreign exchange reserves may partially cushion the economy against contractionary monetary shocks.

The domestic credit variable (AST) exhibits a statistically significant negative effect at the 1% level (−1.2195). This result may reflect structural weaknesses in the Algerian financial and banking system, as increases in domestic credit do not necessarily translate into productive investments that generate additional real output. A portion of credit may instead be directed toward imports, consumption-oriented activities, or inefficient enterprises, thereby limiting its potential contribution to economic growth.

2. Structural Asymmetry Test (Wald Test)

To determine whether the effect of positive monetary shocks is significantly and statistically different from the effect of negative shocks, the Wald test was performed to determine symmetry versus asymmetry in the long and short run.

Table (6): Wald Test Results for Asymmetry

Type of Asymmetry	)F−statistic(	)Prob(	Econometric Decision
Long-Run\ Asymmetry	0.0116	0.9161	Fail to reject the null hypothesis (symmetry)
Short-Run\ Asymmetry	1.7241	0.2252	Fail to reject the null hypothesis (symmetry)
Joint\ Asymmetry	1.3174	0.3201	Fail to reject the null hypothesis (symmetry)

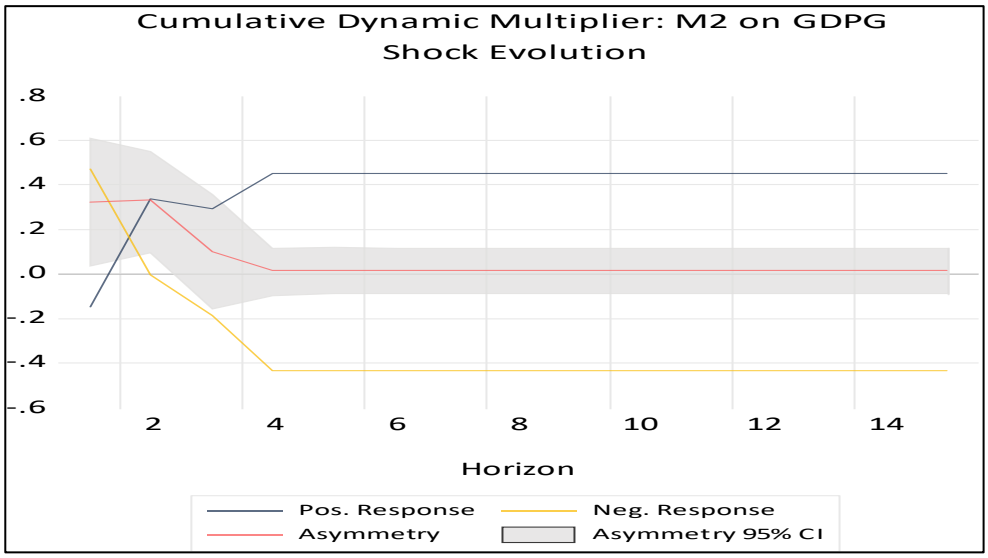
Source: Prepared by the researcher based on the outputs of EViews 13.

All probabilities showed values significantly higher than the significance level of 0.05 ($p > 0.05$). Therefore, we reject the alternative hypothesis and accept the null hypothesis of symmetry, this means that the response of economic growth in Algeria to an increase in the money supply is not statistically significant compared to its response to a decrease in the money supply in the long run.

3. Analysis of the Dynamic Asymmetric Cumulative Multiplier

The dynamic cumulative multiple function is used to track the time-adjustment path taken by the dependent variable (GDPG) in response to positive and negative shocks to the money supply across different time horizons (from the t period until convergence toward the long-run equilibrium.).

Figure 2: Asymmetric dynamic cumulative effect function of the multiplier



Source: EViews 13 outputs.

The cumulative effect function reveals that the transmission mechanism of monetary policy in Algeria is characterized by a relatively rigid structure and a broadly symmetric response pattern. The real productive apparatus reacts to a similarly limited extent whether monetary authorities expand or restrict liquidity. This is because the economy is primarily governed by the oil price cycle and public expenditure, making the cumulative effect of monetary shocks relatively symmetrical and neutral in shaping the growth structure outside the hydrocarbon sector.

Seventh: Short-Run Dynamics and the Error Correction Mechanism (ECM)

The error correction coefficient (COINTEQ^*) came in with a logically negative sign and was very accurately significant at the 1% level (Prob = 0.000067) with a strong value of -0.9956.

Standard and Extended Economic Interpretation:

This coefficient reflects the equilibrium strength of the economy. The value (-0.99) signifies an exceptionally rapid adjustment rate, as the Algerian economy corrects approximately 99.56% of short-term disequilibria resulting from monetary shocks within a single period (one year).

This rapid adjustment does not necessarily reflect productive economic flexibility, but rather a swift "rent-financial" nature; monetary shocks are immediately injected or absorbed through government intervention mechanisms (equity budget and public spending) to return the economy to its usual fragile point of stability.

Eighth: Diagnostic Tests, Econometric Issues, and Statistical Robustness

To ensure the reliability of the estimated parameters in the NARDL model and its usability in forecasting and economic policymaking, it was necessary to examine the model's compliance with the classical assumptions of the Ordinary Least Squares (OLS) method. To achieve this, the estimated model residuals were subjected to a suite of the most rigorous standard diagnostic tests.

Based on the diagnostic test results, the following findings can be summarized:

Table (7): Diagnostic Tests and Robustness Checks for the Estimated Model

Econometric Issue Tested	Econometric Test	Test Statistic	Probability (Prob.)	Statistical Decision and Test Result

Normality of residuals	Jarque-Bera\ Normality	JB = 1.3976	0.4971	Fail to reject the null hypothesis: the residuals are normally distributed.
Serial correlation	Breusch-Godfrey\ LM\ Test	F = 3.7494	0.0940	Fail to reject the null hypothesis (at the 5% level): the model is free from serial correlation.
Heteroskedasticity	Harvey\ Heteroskedasticity	F = 0.7192	0.7308	Fail to reject the null hypothesis: the error variance is constant and homoskedastic.
Functional form specification	Ramsey\ RESET\ Test	F = 3.1843	0.1175	Fail to reject the null hypothesis: the model is correctly specified.
Overall explanatory power	Adjusted\ R-squared	R^2 = 0.9001	---	The model explains 90.01% of the variation in economic growth.

Source: Prepared by the researcher based on the outputs of EViews 13.

Based on the Jarque–Bera test, the calculated statistic was 1.3976, with an associated probability value of 0.4971, which exceeds the adopted significance level of 0.05. Accordingly, the null hypothesis that the model residuals follow a normal distribution cannot be rejected. This represents a vital indicator that the model is not significantly affected by outliers over the study period, despite the fluctuations experienced by the Algerian economy.

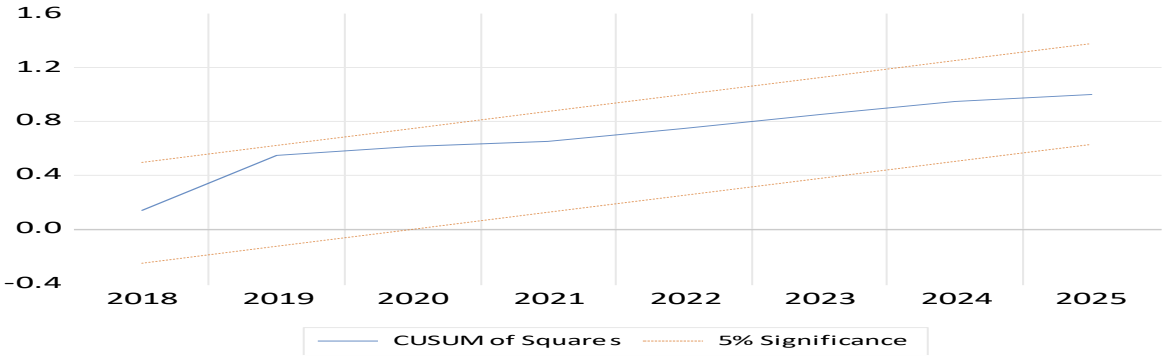
To ensure that the random errors are not correlated with their past values—which, if present, could artificially inflate the statistical significance of the estimated parameters—the Breusch–Godfrey test was employed. The results show that the probability associated with the F-statistic (Prob = 0.0940) is greater than 0.05, confirming the absence of first-order serial correlation in the estimated model and supporting the adequacy of the lag structure and distributed lags adopted in the model.

The Harvey test was used to examine the stability of the variance of the random errors over time. The probability value (0.7308) is substantially greater than 0.05, supporting the null hypothesis of homoskedasticity. This indicates that the fluctuations in the residuals neither widen nor narrow over time, ensuring that the standard errors of the estimated parameters are accurate and unbiased.

To verify that the model does not omit important explanatory variables or suffer from functional form misspecification, the Ramsey RESET test was applied. The relatively high probability value (0.1175 > 0.05) supports the null hypothesis, indicating that the model is linear in its parameters, correctly specified, and free from omitted-variable problems that could distort the relationship between money supply and economic growth.

The Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) tests were conducted to examine the stability of the estimated short-run and long-run parameters over the entire extended study period of 30 years, as illustrated in the following figure:

Figure 3: Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ)



Source: EViews 13 outputs.

The graphical results indicate that the cumulative residual plots fluctuate entirely within the 95% confidence bounds, that is, between the two critical lines.

4. Conclusion

This study aimed to analyze the effects of money supply shocks on economic growth in Algeria over the period 1996–2025, using the Nonlinear Autoregressive Distributed Lag (NARDL) model to examine both short-run and long-run dynamics. The main findings of the study can be summarized as follows:

- ❖ There is a long-run relationship between economic growth, positive and negative money supply shocks, and the other variables included in the study.
- ❖ Positive money supply shocks have a positive and statistically significant effect on economic growth in the long run. A 1% increase in the money supply leads to an approximately 0.45% increase in economic growth.
- ❖ The response of economic growth to positive money supply shocks does not differ substantially from its response to negative shocks; in other words, the relationship is statistically symmetric.
- ❖ The Algerian economy demonstrates a high speed of adjustment toward the long-run equilibrium, with approximately 99.56% of disequilibria corrected within one year.

Overall, the findings indicate that money supply shocks affect economic growth in Algeria. The effect of positive shocks was positive and statistically significant, whereas the effect of negative shocks was positive but statistically insignificant, with no statistically significant difference between the effects of positive and negative shocks. Based on these findings, the following recommendations can be made:

- ✓ Working to develop the performance of the financial system and improve the efficiency of banks to ensure optimal allocation of credit towards productive sectors.
- ✓ Working to increase and strengthen coordination between monetary and fiscal policy in Algeria.
- ✓ Working to diversify economic resources, which increases the resilience of the Algerian economy and improves the performance of economic policy in supporting sustainable growth.

Finally, it can be said that this topic raises many questions due to the particular nature of money supply shocks, their different directions, and the variation in their effects on economic activity in general and on economic growth in particular.

Appendices

Appendix (01): Unit Root Test Results Using the Augmented Dickey–Fuller (ADF) Test

UNIT ROOT TEST TABLE (ADF)

		GDPG	EXR	AST	M2	RINR
At Level						
With Con...	t-Statistic	-1.1725	-0.2839	-1.2229	-2.0485	-4.7903
	Prob.	*0.2123*	*0.9158*	*0.6506*	*0.2658*	*0.0006*
		n0	n0	n0	n0	***
With Con...	t-Statistic	-1.3483	-1.2696	-1.6084	-3.0105	-4.7289
	Prob.	*0.1191*	*0.8756*	*0.7647*	*0.1466*	*0.0037*
		n0	n0	n0	n0	***
Without C...	t-Statistic	-0.9315	2.3492	0.8657	1.0714	-4.4866
	Prob.	*0.3045*	*0.9941*	*0.8913*	*0.9218*	*0.0001*
		n0	n0	n0	n0	***
At First Difference						
		d(GDPG)	d(EXR)	d(AST)	d(M2)	d(RINR)
With Con...	t-Statistic	-8.9137	-3.7426	-4.6983	-3.0429	-6.7557
	Prob.	*0.0000*	*0.0088*	*0.0008*	*0.0451*	*0.0000*
		***	***	***	**	***
With Con...	t-Statistic	-8.7318	-3.6639	-4.7961	-4.0160	-6.7322
	Prob.	*0.0000*	*0.0422*	*0.0033*	*0.0222*	*0.0000*
		***	**	***	**	***
Without C...	t-Statistic	-9.0772	-3.3194	-4.3833	-5.3988	-6.8972
	Prob.	*0.0000*	*0.0018*	*0.0001*	*0.0000*	*0.0000*
		***	***	***	***	***

Notes: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant
*MacKinnon (1996) one-sided p-values.

This Result is The Out-Put of Program Has Developed By:
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Appendix (02): Nonlinear Autoregressive Distributed Lag (NARDL) Model Estimation

Dependent Variable: D(GDPG)
Method: ARDL
Date: 08/17/26 Time: 11:19
Sample: 2000 2025
Included observations: 26
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (3 max. lags): EXR AST RINR
Automatic-lag dual non-linear regressors (3 max. lags): M2
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 256
Selected model: ARDL(1,1,3,1,3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDPG(-1)	-0.995621	0.265362	-3.751942	0.0056
EXR(-1)	0.060883	0.035192	1.730011	0.1219
AST(-1)	-1.214175	0.343549	-3.534215	0.0077
RINR(-1)	-0.122950	0.196077	-0.627048	0.5481
@CUMDP(M2(-1))	0.447997	0.198461	2.257358	0.0539
@CUMDN(M2(-1))	0.434302	0.277980	1.562351	0.1568
D(EXR)	-0.056906	0.068787	-0.827274	0.4321
D(AST)	-0.187512	0.532831	-0.351917	0.7340
D(AST(-1))	1.633024	0.609448	2.679513	0.0279
D(AST(-2))	0.459941	0.285395	1.611597	0.1457
D(RINR)	0.063519	0.101193	0.627704	0.5477
@DCUMDP(M2)	-0.148312	0.105114	-1.410958	0.1959
@DCUMDN(M2)	-0.469368	0.330440	-1.420433	0.1933
@DCUMDP(M2(-1))	-0.108964	0.143032	-0.761818	0.4680
@DCUMDN(M2(-1))	-0.427389	0.181049	-2.360632	0.0459
@DCUMDP(M2(-2))	-0.158358	0.098967	-1.600112	0.1482
@DCUMDN(M2(-2))	-0.245226	0.206436	-1.187904	0.2689
C	0.630598	3.324283	0.189694	0.8543

R-squared	0.948079	Mean dependent var	0.023675
Adjusted R-squared	0.837746	S.D. dependent var	2.529733
S.E. of regression	1.018997	Akaike info criterion	3.081476
Sum squared resid	8.306844	Schwarz criterion	3.952466
Log likelihood	-22.05918	Hannan-Quinn criter.	3.332289
F-statistic	8.592883	Durbin-Watson stat	2.829819
Prob(F-statistic)	0.002152		

Appendix (03): Error Correction Model (ECM)

Dependent Variable: D(GDPG)
Method: ARDL
Date: 08/17/26 Time: 11:19
Sample: 2000 2025
Included observations: 26
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (3 max. lags): EXR AST RINR
Automatic-lag dual non-linear regressors (3 max. lags): M2
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 256
Selected model: ARDL(1,1,3,1,3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.995621	0.173209	-5.748084	0.0001
D(EXR)	-0.056906	0.037624	-1.512495	0.1543
D(AST)	-0.187512	0.183072	-1.024253	0.3244
D(AST(-1))	1.633024	0.271199	6.021498	0.0000
D(AST(-2))	0.459941	0.199067	2.310487	0.0379
D(RINR)	0.063519	0.044521	1.426713	0.1772
@DCUMDP(M2)	-0.148312	0.054567	-2.717956	0.0176
@DCUMDN(M2)	-0.469368	0.167653	-2.799535	0.0150
@DCUMDP(M2(-1))	-0.109964	0.095517	-1.140788	0.2745
@DCUMDN(M2(-1))	-0.427389	0.130717	-3.269584	0.0061
@DCUMDP(M2(-2))	-0.158358	0.053195	-2.976924	0.0107
@DCUMDN(M2(-2))	-0.245226	0.137837	-1.779098	0.0986
C	0.630598	0.528976	1.192111	0.2545

R-squared	0.948079	Mean dependent var	0.023675
Adjusted R-squared	0.900151	S.D. dependent var	2.529733
S.E. of regression	0.799367	Akaike info criterion	2.696860
Sum squared resid	8.306844	Schwarz criterion	3.325909
Log likelihood	-22.05918	Hannan-Quinn criter.	2.878003
F-statistic	19.78153	Durbin-Watson stat	2.829819
Prob(F-statistic)	0.000002		

* p-values are incompatible with t-Bounds distribution.

Appendix (04): Cointegrating Coefficients and Long-Run Cointegration Time Series

Deterministics: Unrest. constant (Case 3)

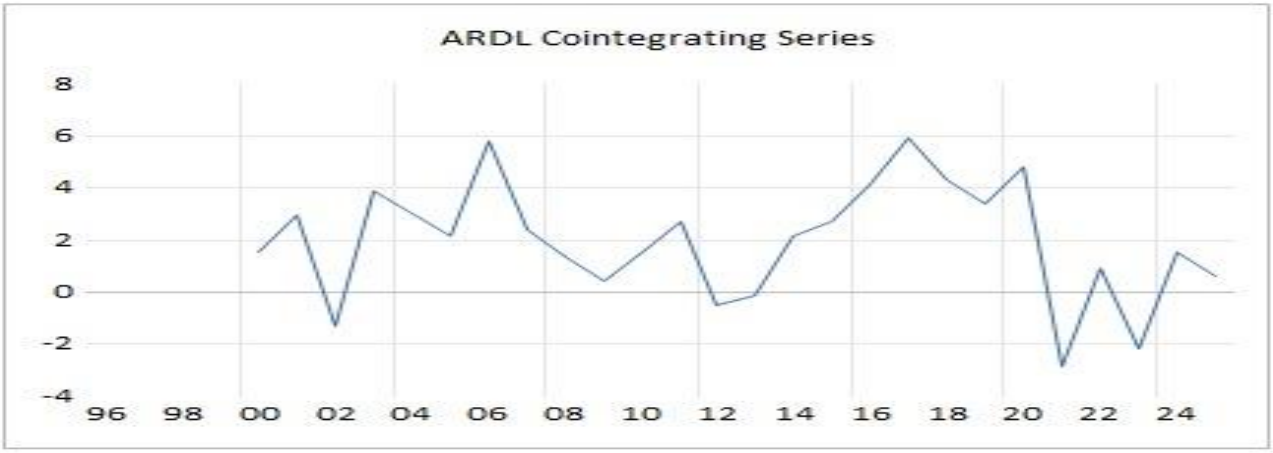
CE = GDPG(-1) - (0.061150*EXR(-1) - 1.219515*AST(-1) - 0.123490*RINR(-1) + 0.449967*@CUMDP(M2(-1),"1997") + 0.436212*@CUMDN(M2(-1),"1997"))

Cointegrating Coefficients

Variable *	Coefficient	Std. Error	t-Statistic	Prob.
EXR(-1)	0.061150	0.037213	1.643274	0.1152
AST(-1)	-1.219515	0.346825	-3.516223	0.0021
RINR(-1)	-0.123490	0.197589	-0.624986	0.5387
@CUMDP(M2(-1))	0.449967	0.206368	2.180416	0.0407
@CUMDN(M2(-1))	0.436212	0.291470	1.496594	0.1494

Note: * Coefficients derived from the CEC regression.

Cointegrating Series



Appendix (05): Coefficient Symmetry Tests

Coefficient symmetry tests
Null hypothesis: Coefficient is symmetric
Degrees of freedom (simple tests): F(1,8), Chi-square(1)
Degrees of freedom (joint tests): F(2,8), Chi-square(2)
Equation:

Variable	Statistic	Value	Probability
	Long-run		
M2	F-statistic	0.011629	0.9168
	Chi-square	0.011629	0.9141
	Short-run		
M2	F-statistic	1.724508	0.2255
	Chi-square	1.724508	0.1891
	Joint (Long-Run and Short-Run)		
M2	F-statistic	1.317087	0.3203
	Chi-square	2.634174	0.2679

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