

Causality Between Money Supply And Real Economic Growth In Algeria: An Econometric Study For The Period 1990-2022

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Abstract

This study examines the causal relationship between the money supply (M_2) and Algeria's real economic growth rate (RGDP) from 1990 to 2022. Additionally, it aims to validate the assumptions of Keynesian theory and Friedman's monetary theory. The Augmented Dickey-Fuller test showed that M_2 was stationary at the level, while RGDP was non-stationary, becoming stationary at their first difference. Using the two-step Engel-Granger model, the cointegration analysis revealed a positive relationship. We ensured the residuals were stationary and used the Error Correction Model (ECM) to avoid spurious estimation. A causality test was conducted on the two variables in both the short and long term. The results indicated a significant bidirectional effect between changes in RGDP and the money supply at a significance level of less than 10%. This finding validates the Keynesian concept that augmenting the money supply can directly impact the economy and production.

Keywords: Money Supply, Real Economic Growth, Causality, Cointegration, Algeria
JEL Classification Codes: E51, O4, C13

1 Introduction

Economic growth is the most essential tool for reducing poverty and improving the standard of living for individuals in all countries, whether developed or developing. It serves as the primary catalyst for creating job opportunities, increasing income levels, expanding public investments, and enhancing the attraction of foreign investment, thereby supporting the achievement of comprehensive sustainable development goals. Recently, interest in research on the requirements for achieving sustained economic growth has increased because of its influential role in promoting technological progress and innovation by encouraging a culture of entrepreneurship in all its forms. Governments have expanded spending in this regard, especially after the COVID-19 health crisis, which has impacted all economic, social, and health activities.

Like other countries, Algeria has moved to expand spending to emerge from the crisis with minimal harm. Facing the challenges of a weak national production system, high demand for essential consumer goods, and the spread of illegal speculation, particularly on widely consumed food products subsidised by the government, coupled with the threat of a significant wave of inflation and the decline in oil prices and demand, decision-makers are confronted with a considerable challenge. They must revive the national economy to ensure its survival by investing in alternatives to oil and preserving the purchasing power of Algerian citizens, which is a significant challenge given the pursuit of an expansionary monetary policy. This situation leads us to the following central question:

How does expansionary monetary policy, represented by the money supply, support real GDP growth?

To answer this question, we assume that the money supply positively affects the real GDP growth rate. This study primarily aims to investigate and test the nature of the relationship between the growth rate of actual economic output and the broad money supply in Algeria from 1990 to 2022. We will use a standard analysis of the development of the time series of the variables under examination, along with a descriptive-analytical approach to understanding all external and internal

variables of the model that may impact the short and long term.

Following this introduction, an overview of the development of both the broad money supply and economic growth rates, represented by Algeria's real GDP growth rate from 1990-2022, will be presented. Subsequently, the study's literature review will be addressed, discussing the most critical theories indicating the nature and trajectory of the relationship between the variables under study. Additionally, recent studies closely related to the current research will be examined to understand the models used and the measurement and analysis methods employed.

The variables will be tested using a standard approach, beginning by determining the lag periods and the stationarity of the data to identify the appropriate model for short- and long-term analysis. Following this, we will assess the model's suitability for prediction. Finally, the summary will present and analyse the most important results.

2 Overview of the Development of the Monetary Supply in Algeria and Real Growth Rates During the Period 1990-2022

As Algeria transitioned towards a market economy, it initiated significant economic reforms, particularly in monetary policy and the independence of the monetary authority from the treasury. It is only possible to discuss a structured monetary policy after 1990 when the first economic and loan law established the institutional basis for an independent central bank and a new financial framework. This was part of the International Monetary Fund's Monetary and Fiscal Stabilization Program aimed at restoring stability and balance at the macroeconomic level (Nashashibi, 1998, p. 32). The key developments included:

- ✓ **Independence of the Central Bank:** The Bank of Algeria was reorganised administratively to manage monetary policy independently from the Ministry of Finance.
- ✓ **Establishment of the Monetary and Loan Council:** This body became the sole authority responsible for formulating loan and monetary policies, foreign exchange policies, and managing external debt.

- ✓ **Introduction of Transparency Rules:** These rules regulated the relationship between the public treasury and the financial system.
- ✓ **Equal Treatment Principle:** Public and private institutions were treated equally regarding access to loans and refinancing from the Central Bank at a single interest rate.
- ✓ **Discounting and Rediscounting Facilities:** All commercial banks operating in the national economy could discount and rediscount with the Central Bank without discrimination.

These reforms led to favourable, accurate interest rates through gradual liberalisation, with additional reforms introduced between 1991-1992. The period from 1990 to 2022 saw significant fluctuations in the growth rate of the monetary supply. An expansionary monetary policy from 1991 to 1993 initially led to increased wages and attempts to control prices. However, economic liberalisation and the devaluation of the Algerian dinar in 1994 caused inflation rates to rise. The monetary supply's growth rate decreased until 1995 as part of a complementary reform program to control inflation.

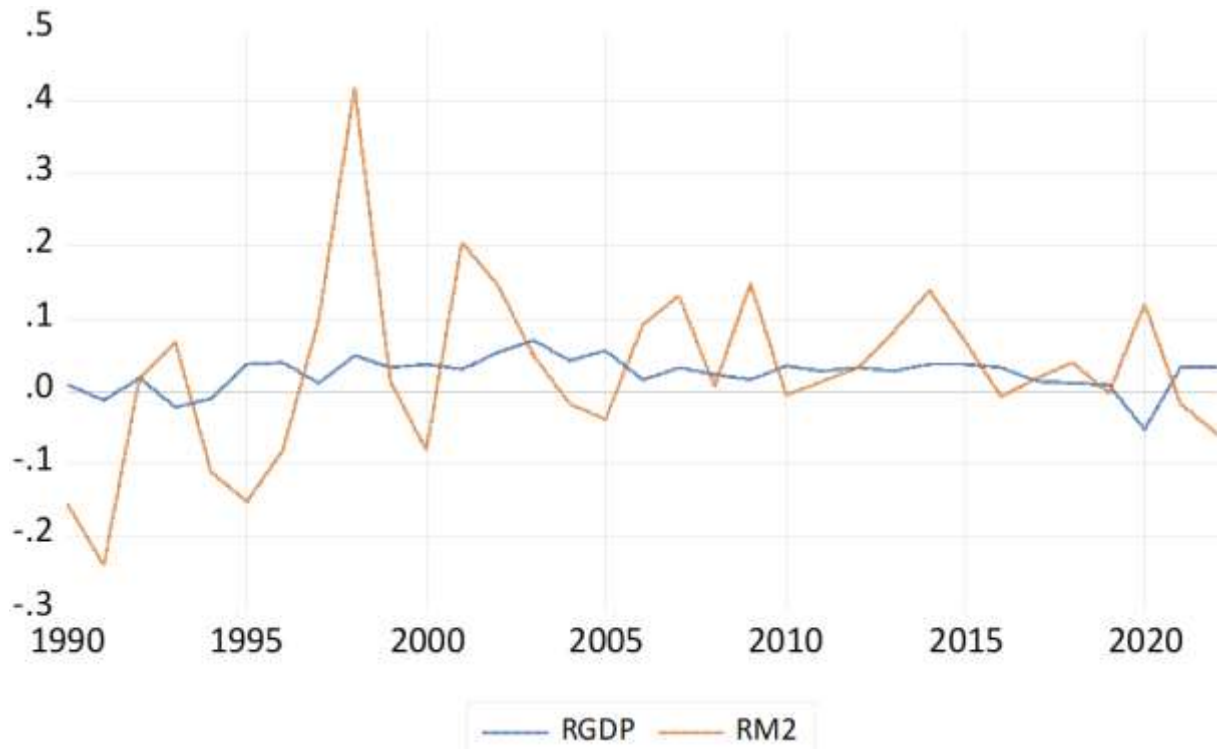
Between 1996 and 1997, global oil price increases led to a significant jump in the monetary supply, rising from 915.058 billion DZD in 1995 to 1081.518 billion DZD in 1996, an increase of 14.44%. The following year, it increased by 18.19%; in 1998, it grew by 47.24%, the highest growth rate during the study period. This was mainly due to rising oil prices, which contributed to national economic recovery and favourable growth rates, enabling structural adjustment programs to address external shocks during 1998-1999.

At the start of the millennium, the Algerian economy showed strong financial performance. Continued oil price increases at the end of 1999 supported an expansionary spending policy, beginning with the economic recovery program (2001-2004) and extending to the growth consolidation program (2015-2019), which focused on economic diversification and steady growth rates. This policy created excess liquidity within the economy. In response, the Bank of Algeria implemented measures to absorb surplus liquidity in the banking sector, stabilising the increase in broad money supply with an average growth rate not exceeding 12%.

From 2007 to 2019, the broad money supply saw notable declines, especially in 2009, 2013, 2015, and 2016, with growth

rates falling below 10%, 3.12%, 8.41%, 0.13%, and 0.81%, respectively. These periods coincided with low and negative growth rates due to the 2007 mortgage crisis, declining oil prices, and the COVID-19 crisis beginning in 2019. However, there was an increase of 14.47% in the money supply in 2021-2022.

Figure 1: A Graphical Representation of the Evolution of Both the Size of the Money Supply in the Broad Sense and Economic Growth in Algeria (in Billion DZD) During the Period 1990-2022



Source: Prepared by the researchers based on Table No. 01 included in Appendix No. 01

3 Study Literature

3.1 The Theoretical Model of the Study

The relationship between money supply and economic growth has been a subject of discussion and controversy among many specialists and policymakers, especially with the rapid development of theories of monetary policy and economic growth over time. Some argue that increasing the money supply is necessary for economic growth, while others believe it inevitably leads to higher inflation rates, thus negatively impacting the economy.

Since the 19th century, the role of money in economic activity has been a contentious issue. Classical economists such as Adam Smith, David Ricardo, and others did not acknowledge the importance of money, considering it neutral and merely a medium of exchange. They believed that changing the quantity of money only increases the price level and that economic equilibrium occurs automatically when full employment is reached. Consequently, the quantity theory of money was developed by David Ricardo, who posits that changes in the money supply lead to changes in the economy's price level. Despite opposing Ricardo on many points, even Karl Marx supported this view.

In the early 20th century, American economist Irving Fisher developed the first equation for this theory: $MV=PY$, where M is the money supply, V is the velocity of money, P is the price level, and Y is the production volume (i.e., gross domestic product). Although this is a mathematical equation showing the relationship between the money supply and production volume, supporters of this theory assume that the velocity of money is constant and that production volume is independent of the money supply (Castex, 2003, pp. 32-34).

After the global depression of 1929, which lasted until the late 1930s, the dominance of Keynesian theory (1936) contrasted with classical and neoclassical theories. According to John Maynard Keynes's theory of demand for money and liquidity preference, increasing the money supply can directly impact the economy and production volume. If economic agents have more money, they will spend it on goods and services or invest it, increasing demand, employment, production and lower unemployment rates. This is particularly true during an economic crisis when full employment of production factors has yet to be achieved. In such cases, stimulating demand through increased money supply can promote economic activity more effectively (Jahan, Sarwat; Mahmud, Ahmed Saber; Papageorgiou, Chris, 2014, pp. 53-54).

By the end of the 1960s, critical analysis emerged against Keynesianism, particularly criticising the "soft" policies followed by the state in monetary and financial matters under the Keynesian approach. Critics, especially American economist Milton Friedman, argued that in the long run, these policies have no impact on economic activity but become a source of inflation and monetary crowding. Monetarists, led by Friedman, advocated for a controlled annual increase in the

money supply based on economic growth. The volume of currency in circulation must be sufficient to finance transactions corresponding to economic activity—no more, no less (Friedman, 2002).

The debate between Keynesians and monetarists remained heated even after the stagflation crisis of 1979. Monetarists, led by Friedman, believed that increasing the money supply might boost economic activity in the short term but could lead to higher inflation in the medium term due to rational expectations of market participants (La finance pour tous, 2023).

3.2 Previous Studies

The debate surrounding the relationship between money, finance, and economic growth has persisted, with various researchers contributing. Below, we present the latest published studies on this topic:

1. **Study by Maktout and Mustafa Qara (2023):** This study aimed to analyse the effectiveness of monetary policy in Algeria in reducing the size of the informal monetary mass during the period 1990-2022 and exploring ways to direct it towards official channels. The study analysed economic and social factors contributing to its increase, such as inflation and lack of confidence in the Algerian banking system. Key findings revealed limitations in monetary policy's ability to absorb or redirect the informal mass due to complex social and economic factors. Additionally, the study indicated the Bank of Algeria's inability to control these factors fully.
2. **Study by BENAZZAH (2022):** This study evaluated the impact of monetary policy on economic growth in Algeria from 1980 to 2017. Utilising a structural error correction vector model, it examined variables such as the discount rate, money supply, exchange rate, and inflation rate. Results highlighted the significant influence of controlling the money supply on the effects of monetary policy, suggesting relative effectiveness in achieving economic growth. The study recommended the independence of the Bank of Algeria to enhance the effectiveness of the monetary policy.

3. **Study by AYAD (2022):** This study investigated the relationship between money supply, inflation rate, and economic growth in Algeria from 1970 to 2018. Using cointegration with and without structural intervals, causality was tested in various ways. Results confirmed a long-term relationship between the variables, with no significant effect of money supply or inflation rate on economic growth in the short or long term. Causality study results indicated hidden causal relationships between cumulative components of variables, supporting the monetary theory's viewpoint on the effects of inflation rate despite the absence of any money supply on economic growth.
4. **Study by Awlad Al-Eid, Burnan, and Ben Muwayza (2021):** This study examined the causal relationship between money quantity and economic growth in Algeria from 1970-2019. The study found a short-term causal relationship between money quantity and gross domestic product (GDP) using cointegration and an error correction model. In the long term, causality existed in both directions, indicating a unique case in the national economy compared to traditional theoretical and Keynesian analysis.

Upon reviewing these studies, it is evident that the relationship between money supply and economic growth remains a subject of debate and disagreement. Despite focusing on the same variables in Algeria, previous studies differed in periods, additional variables, and methodologies. However, the complementary nature of their results underscores the complexity of this relationship. Thus, this study considered all variables affecting the national economy and incorporated them into the model as internal variables, enabling a linear study of the relationship. Distinguishing from previous studies, this research introduced external variables that cannot be controlled, allowing for the isolation of the two variables under study and testing their causal relationship using absolute values.

4 Model, Data, and Standard Study

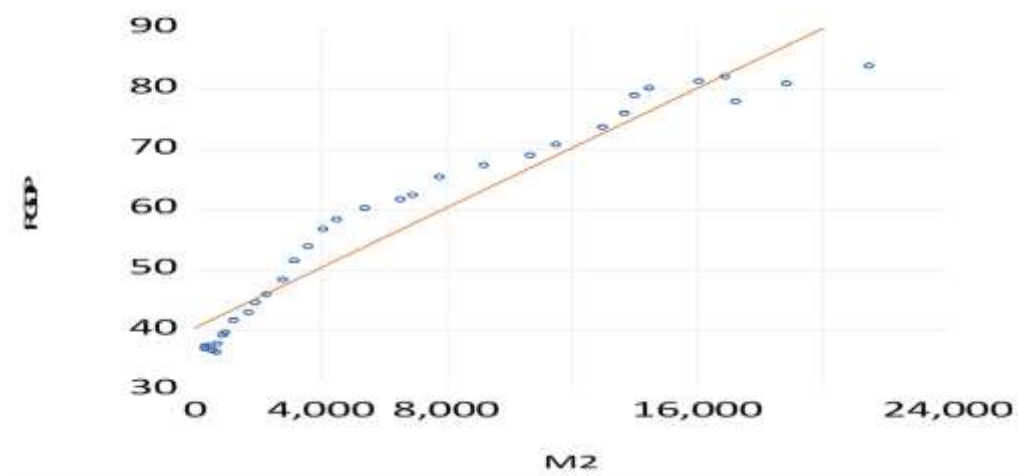
4.1 Study Model

Upon reviewing previous studies and considering various approaches to address the subject, we utilised Views 13

software to analyse the relationship between the increase in the monetary supply (M2) in its broad sense and the growth rates of Algeria's real GDP during the study period. By tracking the development of these variables, we aimed to depict their relationship.

The data analysis revealed a potential linear relationship between real economic growth and the size of the money supply in Algeria throughout the studied period. Figure 2 below illustrates the observed relationship:

Figure 02: Graphical representation of the possible relationship between RGDP and M2 in Algeria during the period 1990-2022



Source: Eview 13 Outputs

To test the nature of the relationship between them, we use the simple linear regression equation:

$$RGDP = \alpha + \beta M2 + \epsilon_t$$

Where:

- ✓ RGDP: represents the level of real GDP
- ✓ M2: Development of the level of monetary supply
- ✓ ϵ_t : ErrorCorrection

Based on the equation built above, we propose the following primary hypothesis: There is a positive relationship between the monetary supply and economic growth, expressed by the level of real GDP in Algeria during the study period.

4.2 Data

To test the nature of the relationship between the study variables, annual data for Algeria's gross domestic product in local currency was collected from the World Bank website. Additionally, the yearly GDP discount rate for the period 1990-2022 was obtained, as well as the size of the monetary supply in the broad sense of M2. This data was collected from various reports of the Bank of Algeria. The extracted data was converted to absolute values after being divided by the GDP deflator. This conversion aimed to conduct the unit root test for data stationarity, the cointegration test, and to examine the direction of the relationship between economic growth represented by the rate of change of the GDP (RealRGDP) and the change in the monetary mass or money supply (M2).

4.3 The Standard Study of the Direction of the Relationship between Money Supply M2 and RGDP

4.3.1 Data Rest Test (Unit Root Test)

To avoid false estimation of the relationship under study and to identify the degree of integration of the data, we test the stationarity of the data using the extended Dickey-Fuller test (Augmented Dickey-Fuller). At the level and when the first difference was taken, the test results were as shown in Table No. (1) indicates that the time series data for M2 is stable at a significance level of less than 10%. As for the series RGDP, it is unstable. When taking the first difference and retesting the stability, it is stable at a significance level of less than 1%.

Table 1: Results of the Expanded Dickey-Fuller Test for the Study Variables

Variables	Sample	Statistic ADF	Significance Level	Slowdown Period
Real GDP Growth Rate (GDP)	Level	Fixed Limit & Direction	-2.5808	01
Money Supply in the Broad Sense (M2)	Level	Fixed Limit & Direction	-3.5533*	01
Real GDP Growth Rate (GDP)	First Difference	No Fixed Limit & Direction	-4.4386***	0
Money Supply in the Broad Sense (M2)	First Difference	No Fixed Limit & Direction	-5.0241***	0

Note: *, **, and *** indicate rejection of the primary hypothesis at 10%, 5%, and 1% significance levels, respectively.

Source: Eview 13 Outputs

4.3.2 Cointegration Analysis and Estimating the Slope of the Equation under Study

Since the two variables are cointegrated of the same order $I(1)$, we adopt the cointegration test using the Engle-Granger two-step method. In the first step, we estimate the long-term equilibrium relationship using the Ordinary Least Squares (OLS) method to obtain the residuals. To avoid spurious regression, we test the degree of integration of these residuals. The result of estimating the tested model using the OLS method to determine the nature and direction of the relationship between the development of real GDP and the growth of the monetary mass in the expanded concept in real terms was as follows:

$$RGDP = 58.1962 + 0.8406 \times M_2$$

$$R^2 = 0.95195 \text{ DW} = 0.814452$$

According to the estimate, the relationship between monetary supply and real GDP growth is positive. By comparing the Durbin-Watson statistic (DW) with the correlation coefficient R^2 , we find that $DW > R^2$. Hence, there is a serial link.

We conduct a unit root test on the residual series to verify the estimate's validity and ensure it is integrated at the level. By applying the extended Dickey-Fuller test to the residual series without adding the constant term or the time trend, the test result showed that the residual series is stationary at a significance level of less than 1%. This indicates that the two variables $RGDP$ and M_2 are characterised by first-order cointegration. Therefore, we accept the result of estimating the long-run equation as it is to prove that it does not contain spurious values. The appropriate short-term estimation model becomes the Error Correction Model (ECM), and the result was as follows:

$$D(RGDP) = 1.834 + 0.269 \times D(RGDP) + 0.2136 \times D(M_2) - 0.0716 \times E(-1)$$

From the previous equation, the speed of reaching long-term equilibrium can be deduced from any short-term imbalance between the growth rate of the monetary mass in the broad sense and the real economic growth rate in the model. The error correction limit parameter's value is -0.0716 , significantly less than 5%. It is negative, confirming the significance of the long-term relationship between the two variables and

Pairwise Granger Causality Tests

Sample: 1990-2022 / Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
M2 does not Granger Cause RGDP	31	2.87884	0.0742
RGDP does not Granger Cause M2	31	9.94493	0.0006

indicating that the speed of correction and return to equilibrium is 7.16% annually.

4.3.3 Causality Test

We use a VAR model to test causality using the Toda-Yamamoto approach in the long run. In contrast, the Angell-Grainger causality model is employed in the short term via the ECM. By conducting these tests with one lag period for the long term and two lag periods for the short term, the results were as follows:

Schedule (2): Causal Consequences - Toda-Yamamoto

VAR Granger Causality/Block Exogeneity Wald Tests

Dependent Variable: RGDP	Excluded	Chi-square	df	Prob.
	M2	5.75768	2	0.05619
	All	5.75768	2	0.05619
Dependent Variable: M2	Excluded	Chi-square	df	Prob.
	RGDP	19.8898	2	0.0000
	All	19.8898	2	0.0000

Source: Source: Eview 13 Outputs

The above results indicate the existence of a bidirectional causal relationship between the change in real GDP growth and the rate of money supply in the broad sense in the economy in the long run, with a significance level of less than 1%. There is causality from the growth of the money supply in the national economy towards the development of the actual domestic product rate at a significance level of less than 10%.

Schedule (3): Results of Causality Testing - Pairwise Granger Causality Tests

Source: Eview 13 Outputs

The results of the test indicate causality in the Pairwise Granger Causality Tests. There is a two-way causal relationship between the monetary supply in the broad sense (M2) and RGDP at a

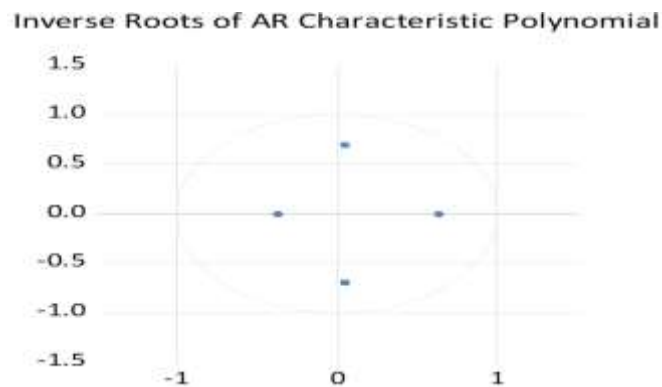
significance level of less than 10% and from RGDP to M2 at a significance level of 5%.

4.3.4 Efficiency and Safety Test Estimated Results

4.3.4.1 AR Roots Test

Through the AR Roots Graph test (Figure 3), four roots were observed inside the circle, confirming the stability of the estimated model. This indicates that there is no need to make modifications to it.

Figure 3. AR Roots Graph Test



Source: Eview 13 Outputs

4.3.4.2 Lagrangian Multiplier Test for Autocorrelation

The Lagrangian multiplier test for autocorrelation indicates that we accept the null hypothesis (H_0) for the remaining estimated equations and do not reject it due to the lack of a chronological sequence at a significance level of 5%.

Schedule (4): Results of the Lagrangian Multiplier Test for Autocorrelation

Autocorrelation LM Test

VAR Residual Serial Correlation LM Tests

Included Observations: 31

Null Hypothesis: No Serial Correlation at Lag h	LRE* Stat	df	Prob.	Rao F-Stat	df	Prob.
	1.124208	4	0.8904	0.278388	(4, 46.0)	0.8905
Null Hypothesis: No Serial Correlation at Lags 1 to h	LRE* Stat	df	Prob.	Rao F-Stat	df	Prob.
	1.124208	4	0.8904	0.278388	(4, 46.0)	0.8905

*Edgeworth expansion corrected likelihood ratio statistic.

Source: Eview 13 Outputs

5 Conclusion

This study examined the nature of the short- and long-term causal relationship between the money supply in the broad sense (M2) and the development of real GDP (RGDP) in Algeria from 1990-2022. The study began by presenting the most essential theoretical trends in this regard, particularly the views of Keynesian analysis and monetarists. Then, it addressed some relatively recent national studies to analyse the development of the two variables during the study period.

To achieve the study's objective, a series of standard tests were conducted to determine the data characteristics used to establish appropriate estimation models while avoiding false estimation and ensuring the validity of the estimated models for prediction. Causality testing using the Toda-Yamamoto approach in the long run after one lag period revealed a two-way causality between M2 and RGDP, further confirmed by the Pairwise Granger Causality test. Additionally, testing confirmed the stability of the estimated model through the AR Roots Graph, which showed four roots inside the circle, indicating no need for modifications.

These findings confirm a direct and positive mutual effect between the money supply growth rate and economic growth in Algeria. This supports the Keynesian proposition and validates the central hypothesis that the study variables have a positive relationship.

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7 Appendices

Appendix No. 1: Study Data (Money Supply and GDP in Billion DZD)

YE AR	M2	GDP	GDP Defla tor	YE AR	M2	GDP	GDP Defla tor
19 89	308.1 46	423.3 00	4.90 7	20 06	4933 .7	8501.6 36	62.1 93
19 90	343.0 05	555.8 00	6.39 1	20 07	5994 .6	9352.8 86	66.1 70
19 91	415.2 70	844.5 00	9.82 9	20 08	6955 .9	11043. 704	76.3 01
19 92	515.9 02	1048. 200	11.9 84	20 09	7173 .1	9968.0 25	67.7 85
19 93	627.4 27	1166. 000	13.6 17	20 10	8280 .7	11991. 564	78.7 12
19 94	723.5 14	1491. 500	17.5 77	20 11	9929 .2	14588. 532	93.0 59
19 95	799.5 62	1990. 600	22.6 00	20 12	1101 5.1	16209. 598	100, 000
19 96	915.0 58	2570. 000	28.0 28	20 13	1194 1.5	16647. 919	99.9 07
19 97	1081. 518	2780. 200	29.9 91	20 14	1368 6.7	17228. 598	99.6 06
19 98	1592. 461	2830. 500	29.0 52	20 15	1370 4.5	16712. 686	93.1 76
19 99	1789. 350	3238. 198	32.2 06	20 16	1381 6.3	17514. 635	94.6 19
20 00	2022. 5	4123. 514	39.5 10	20 17	1497 4.5	18876. 176	100. 666
20 01	2473. 5	4227. 113	39.3 23	20 18	1663 6.7	20393. 500	107. 468
20 02	2901. 5	4522. 773	39.8 42	20 19	1650 6.6	20500. 200	106. 961
20 03	3299. 5	5252. 321	43.1 61	20 20	1765 9.6	18476. 900	101. 585

20 04	3644. 3	6149. 117	48.4 47	20 21	2005 3.5	22079. 300	117. 399
20 05	4070. 4	7561. 984	56.2 59	20 22	2295 5.3	27688. 800	142. 661

Source: International Monetary Fund Statistics Data and Bank of Algeria Reports and Statistics