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Money Supply - Economic Growth Nexus in Algeria TYDL Methodology

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Abstract

This research paper investigates the nature of the relationship between money supply and economic growth in Algeria using econometric methods, specifically the TYDL causality approach, applied to time series data for the period1990-2024.

The results revealed a unidirectional causal relationship running from economic growth (LGDP) to the money supply variable (LM2).

Keywords: Money supply; Economic growth; TYDLmethodology.

Introduction :

The monetary and banking sector has witnessed notable development recently, owing to several variables. The role of money in economic life has expanded beyond its traditional function as an intermediary in exchanges and a measure of the value of goods and services, to directly influencing macroeconomic variables.

The money supply plays a crucial and vital role in determining price levels, interest rates, and investment. It is considered one of the fundamental concepts in economics, referring to the quantity of money circulating in a country's economy over a specific period. Accordingly, it is essential to distinguish between the concepts of money supply and the quantity of money. The former refers to the circulation of money, influenced by various entities including the central bank, while the latter denotes the issued amount of money determined by the monetary authorities of the country.

Economic growth is one of the primary objectives pursued by any nation, representing the outcome of a complex and intertwined process and the culmination of efforts by all active stakeholders in society. It entails the continuous expansion of the economy's capabilities to cumulatively maximize the productive capacity of goods and services. Therefore, both theoretical and applied economic literature have focused on studying and analyzing all aspects of economic growth—including its factors, determinants, and models—as well as testing its causal relationship with macroeconomic variables, particularly the money supply. This relationship manifests through monetary policies that influence the quantity of money in circulation, which can either stimulate or dampen economic activity.

Hence, the importance of studying this relationship becomes evident to understand how monetary policy can be directed to achieve a balance between economic growth and monetary stability (controlling the money supply).

Accordingly, the following main research question can be posed:
What is the nature of the causal relationship between the money supply and economic

growth in Algeria during the period 1990–2024?

Based on the research question, the following hypothesis can be formulated:

- There is a unidirectional causal relationship from the money supply variable to economic growth in Algeria during the period 1990–2024.

1. Results of the Causal Study between Money Supply and Economic Growth in Algeria (1990–2024)

Despite the ongoing heated debate regarding the nature of the relationship between money supply and economic growth in the literature, the prevailing view is that Algeria is in urgent need of this research. Consequently, among the previous studies addressing the causal nexus between money supply and economic growth is the study by (Ayad, 2020). This paper aimed to examine the relationship between money supply, inflation rates, and economic growth in Algeria using causality tests and cointegration methodology. Additionally, the study by (Ogunmuyiwa & Francis Ekone, 2010), titled "The Relationship between Money Supply and Economic Growth in Nigeria (1980–2006)," utilized Ordinary Least Squares (OLS), causality tests, and the Error Correction Model (ECM). The causality results indicated that GDP growth rates are influenced by the choice of either contractionary or expansionary monetary policy. Furthermore, the research by (Mahara, 2020) aimed to test the causality between the two variables; the results revealed a unidirectional causality running from money supply (M2) to Real GDP.

In this context, we present the results of the causal study of money supply and economic growth in Algeria for the period 1990–2024. This section involves the examination and analysis of key econometric tests, starting with the stationarity of time series, and testing the causality between the variables using one of the established types of causality in econometrics, which will be determined following the Unit Root tests.

1.1. Presentation of Study Variables

Based on previous empirical studies and economic theories, the variables for the causal study of money supply and economic growth in Algeria (1990–2024) have been identified, as illustrated in the following table:

Table 01: Study Variables

Variable code	Variable	Variable Definition	Data Source
GDP	Gross Domestic Product	Gross Domestic Product at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation	The World Bank https://data.albankaldawli.org/country/%D8%A7%D9%84%D8%AC%D8%B2%D8%A7%D8%A6%D8%B1

		of natural resources. Data are in current local currency.	
M2	Broad Money Supply	Broad Money (International Financial Statistics, Line: 35L.ZK) is the sum of currency outside banks; demand deposits other than those of the central government; time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	

Source: Prepared by the researchers

2.1 Statistical Analysis of the Raw Study Variables

We will present a descriptive statistical study of all raw study variables for the period 1990–2024, as shown in the table below.

Table 2: Statistical Study of the Raw Study Variables

	GDP	M2
Mean	1.25E+13	59.14577
Median	9.87E+12	60.71736
Maximum	4.37E+13	84.87179
Minimum	5.56E+11	33.00584
Std. Dev.	1.08E+13	13.33001
Skewness	0.915296	-0.235575
Kurtosis	3.300957	2.216803
Jarque-Bera	5.019062	1.218263
Probability	0.081306	0.543823
Sum	4.39E+14	2070.102
Sum Sq. Dev.	3.99E+27	6041.431
Observations	35	35

Prepared by the researchers based on the outputs of EViews-12.

According to Table No. 02, it is noted that most of the study variables exhibit significant volatility during the study period (1990–2024) and are therefore non-homogeneous. To mitigate the severity of heterogeneity, the natural logarithm was applied (given that all raw time series are positive).

3.1 Statistical Analysis of Logarithmic Study Variables

The table below illustrates the descriptive statistics of all logarithmic study variables for the period 1990–2024.

Table No. 03: Statistical Study of Logarithmic Study Variables

	LGDP	LM2
Mean	29.64799	4.052862
Median	29.92082	4.106230
Maximum	31.40734	4.441142
Minimum	27.04367	3.496684
Std. Dev.	1.175382	0.242881
Skewness	-0.548232	-0.641737
Kurtosis	2.226155	2.547342
Jarque-Bera	2.626559	2.701131
Probability	0.268937	0.259094
Sum	1037.680	141.8502
Sum Sq. Dev.	46.97174	2.005699
Observations	35	35

Prepared by the researchers based on the outputs of EViews-12

According to Table No. 03, which displays the study variables after introducing the natural logarithm, it is observed that most of the variables exhibit homogeneity.

4.1 Study of Time Series Stationarity

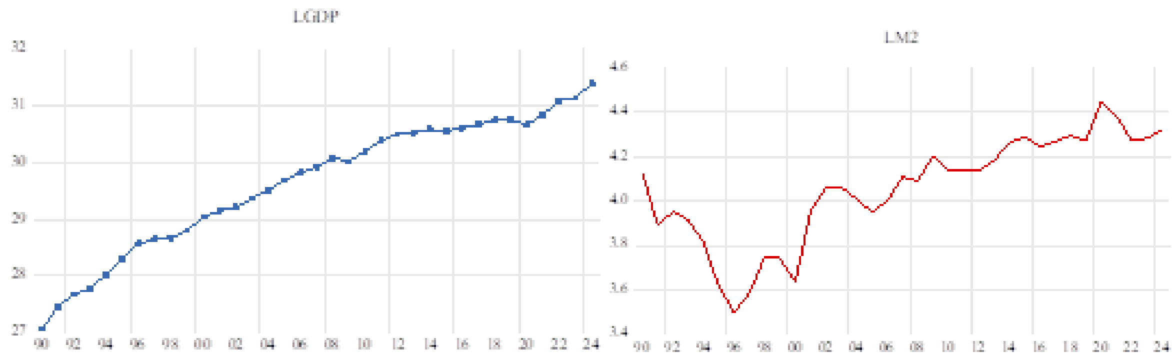
First, we will present a qualitative study, where we will assess stationarity through graphical representations of the logarithmic study variables as a preliminary insight into the stationarity of these time series, followed by confirmation through quantitative tests.

The time series data to be examined for stationarity are annual series, spanning from the year 1990 to 2024.

A. Study of the Trend of Logarithmic Time Series – Qualitative Study –

The following figures illustrate the trend of the logarithmic time series.

Figure No. 01: Changes in Values of Logarithmic Time Series



Source: Outputs from EViews.12 program.

From the two figures above, we observe that the values of the LM2 time series data exhibit fluctuation, while the LGDP series is stable at the level. To confirm the results of this qualitative test, we will apply the unit root test (PP).

B. Unit Root Test (PP) for Logarithmic Series – Quantitative Study –

The results of the PP unit root test for the logarithmic series are illustrated in the tables below.

Table 04: PP Test for the LGDP Series

Variables **I(0)**	**Unit Root Test (PP)**	
	LGDP	**LM2**
Intercept t-statistic critical -v (Prob)	-3.674007 -2.951125 **0.0092**	-1.108594 -2.951125 **0.7010**
Trend & intercept t-statistic critical (Prob)	-3.328756 -3.548490 **0.0784**	-3.625496 -3.548490 **0.0424**
None t-statistic critical -v (Prob)	5.432547 -1.951000 **1.0000**	0.278384 -1.951000 **0.7608**

Source:Prepared by the researchers based on outputs from EViews-12.

Through the results of Table No. 04, which displays the outcomes of the PP unit root test, we observe that the time series LGDP is stable at the level, considering that:

- The t-statistic is greater than the critical value;

- The probability (Prob) is less than 0.05.

Thus, we reject the null hypothesis: the series are not stable at a 5% significance level, which implies the presence of a unit root in the time series, and we accept the alternative hypothesis.

We also note that the time series LM2 is not stable at the level, considering that:

- The t-statistic is less than the critical value;

- The probability (Prob) is greater than 0.05.

Therefore, we accept the null hypothesis: the series are not stable at a 5% significance level, which implies the presence of a unit root in the time series, and we reject the alternative hypothesis.

Consequently, we will proceed to test the series at the first difference I(1), as illustrated in the table below:

Table 05: PP Test for the DLM2 Series

Variables **I(0)**	**Unit Root Test (PP)**
	DLM2
Intercept **t-statistic** **critical -v** **(Prob)**	-6.537409 -2.954021 **0.0000**
Trend & intercept **t-statistic** **critical** **(Prob)**	-6.300894 -3.552973 **0.0001**
None **t-statistic** **critical -v** **(Prob)**	- 902840 -1.951332 **0.0000**

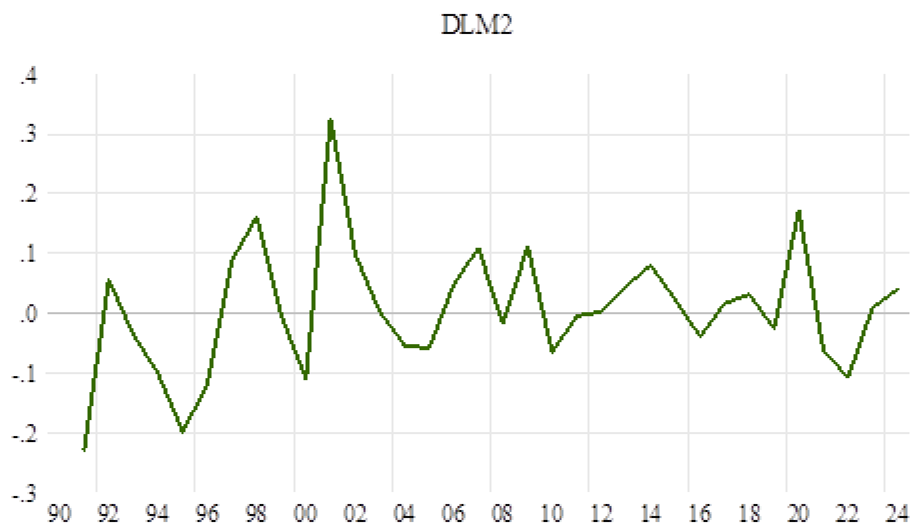
Source: Prepared by the researchers based on outputs from EViews-12

The results from the table above confirmed that the series is stationary at the first difference, meaning that the new time series derived from the original series is stationary at the level (see the figure below).

Therefore, the null hypothesis is rejected, and the alternative hypothesis—which states that the series is stationary at the level—is accepted.

Accordingly, after deriving the new time series from the original series, these series lost one observation following the application of first differences, resulting in 34 observations. The following graphical representation illustrates the changes in the values of this derived time series.

Figure 02: Trend of the Time Series at the First Difference I(1)



Source: Outputs from EViews.12 program.

After deriving the new time series from the original series (through first differencing), the results shown in Figure 02 revealed that the series exhibited a pattern parallel to the abscissa axis, indicating that the derived time series possess stationarity. (Absence of a trend problem).

Conclusion: Given that the two series differ in their degree of stationarity, it was decided to employ the TYDL causality test (Toda–Yamamoto–Dolado–Lütkepohl), commonly known as the Toda–Yamamoto methodology.

Introduction to the TYDL Methodology:

Three prominent tests are widely used to study causality, namely those by Sims (1969), Granger (1972), and Geweke (1983). Among these, the Granger methodology is the most commonly applied. However, one of its key requirements is that the time series must be stationary at the same level, particularly in levels. To address this limitation, Toda and Yamamoto proposed a new methodology, which serves as an alternative causality test based on the Granger causality equation. This approach was developed by incorporating lag lengths into the equation (Moftah & Dilek, 2021, p. 62). This causality test is referred to as the Toda–Yamamoto methodology and is originally termed the TYDL methodology, named after Toda, Yamamoto, Dolado, and Lütkepohl.

Consequently, the TYDL causality test is employed between time series with different orders of integration—I(0), I(1), or I(2)—by estimating a VAR(k + d_max) model. This is an enhanced approach to the Wald test, where:

- k: Lag length;

- d_max: The maximum order of integration among the variables.

Thus, for two variables, the model can be expressed in the following form:

$$X_t = \beta_0 + \sum_{k=1}^{m} B_k X_{t-k} + \sum_{e=1}^{n} \grave{\alpha}_e Y_{t-1} + u_t$$

$$Y_t = Y_0 + \sum_{k=1}^{m} Y_k Y_{t-k} + \sum_{e=1}^{n} \partial_e X_{t-1} + V_t$$

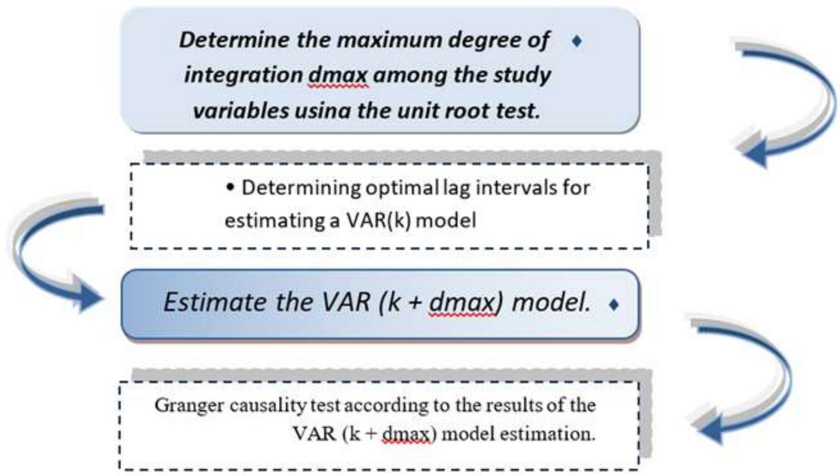
Whereas:
- Yt, Xt: The two variables under study;
- Vt, Ut: White noise errors for both equations, which are linearly uncorrelated;
- T: Time;
- e K: Number of lag periods.

This method tests the null hypothesis that there is no causal relationship from X to Y, expressed mathematically as:
H_0: $\alpha_e = \partial_e = 0$

The TYDL methodology offers several advantages compared to other alternatives:

- It is applicable regardless of the stationarity or integration order of the variables at different levels, even if the variables are stationary at the second difference, and irrespective of the presence of cointegration between the variables;
- This methodology employs the modified Wald test (MWALD) with a chi-square distribution to restrict the parameters of VAR(k), where k is the appropriate lag length for the VAR system;
- The method increases the current lag order k by the maximum order of integration (dmax), thus determining VAR(k + dmax). The TYDL methodology proceeds according to the following form:

Figure 3: TYDL Methodological Steps



Source: Prepared by the researchers based on what has been previously mentioned.

5.2.3 Testing the Causal Relationship Between Money Supply and Economic Growth in Algeria During the Period 1990–2024 Using the TYDL Methodology

The direction of the relationship between the study variables LGDP and LM2 will be determined according to the TYDL methodology, after verifying the necessary conditions for conducting this test.

To perform the TYDL causality test, we will follow the econometric analysis methodology, beginning by determining the optimal lag order for the VAR model at the level of the series (not the differenced series) using the Akaike Information Criterion (AIC), denoted as P = K. Subsequently, we will estimate a VAR(K + dmax) model, where dmax represents the maximum order of integration of the time series. Finally, we will conduct the test based on the modified Wald statistic, which follows a chi-square distribution with V degrees of freedom, where V represents the number of specified restrictions.

a. VAR Lag Order

Table 04: Optimal Lag Order Results

Sample: 1990 2024
Included observations: 27

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-2.427890	NA	0.004759	0.327992	0.423980	0.356534
1	67.00413	**123.4347***	**3.74e-05***	**-4.518824***	**-4.230860***	**-4.433197***
2	68.20455	1.956248	4.64e-05	-4.311448	-3.831509	-4.168737

3	68.56992	0.541280	6.17e-05	-4.042216	-3.370301	-3.842420
4	69.36771	1.063721	8.05e-05	-3.805015	-2.941124	-3.548135
5	72.52414	3.740964	8.98e-05	-3.742529	-2.686662	-3.428565
6	78.62457	6.326370	8.27e-05	-3.898116	-2.650274	-3.527067
7	80.28602	1.476845	0.000110	-3.724891	-2.285072	-3.296757
8	80.97448	0.509966	0.000165	-3.479591	-1.847796	-2.994373

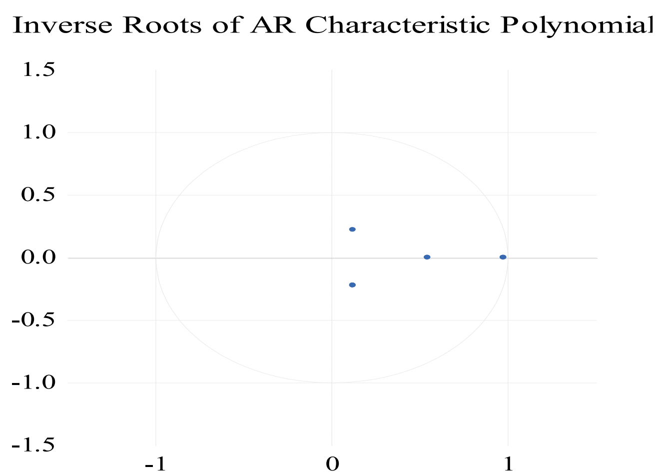
Source: Prepared by the student based on EViews-12 outputs.

Based on the results shown in the table above and according to all criteria, we conclude that the lag order yielding the lowest values for this criterion is the first order. Therefore, (K + d_{\text{max}} = 2), noting that (d_{\text{max}}) is the highest order of integration, which in our study is I(1).

B. Estimating the VAR Model and Verifying the Quality of Its Estimation

After estimating the VAR model of order ((K + d_{\text{max}})), its stability must be verified before conducting the causality test according to the TY (Toda-Yamamoto) methodology. This is achieved through the unit circle test and the residual autocorrelation function.

Figure No. 04: Unit Circle Test



Source: Output from EViews 12 software.

From Figure 04, it is observed that all roots lie within and on the unit circle, confirming the stability of the VAR model and the absence of issues related to error correlation and heteroscedasticity.

C. TY Causality Test

Based on the Granger Causality/Block Exogeneity Wald test, the results of causality between money supply and economic growth in Algeria during the period 1990–2023 are presented in the table below.

Table 05: TYDL Causality Test

Dependent variable: LGDP

Excluded	Chi-sq	df	Prob.
LM2	2.837429	2	0.2420
All	2.837429	2	0.2420

Dependent variable: LM2

Excluded	Chi-sq	df	Prob.
LGDP	9.246479	2	0.0098
All	9.246479	2	0.0098

Source: Outputs from EViews.12

Based on the results from Table 35, we conclude the following:

- There is no causal relationship from the money supply (LM2) toward economic growth (LGDP) at a 5% significance level.
- There is a causal relationship from economic growth (LGDP) toward the money supply variable (LM2) at a 5% significance level.

Conclusion

No country can achieve economic growth and stability without a financial system capable of providing the necessary liquidity for the economy, as well as monitoring indicators that reflect economic performance. Many studies have focused on investigating the causal and influential relationship between the monetary system and economic performance.

This study aimed to uncover the causal relationship between money supply and economic growth in Algeria during the period 1990–2024 using the TYDL methodology. The results indicate a unidirectional causal relationship from economic growth (LGDP) toward the money supply variable (LM2). Therefore, LGDP is considered an independent variable, while LM2 is considered a dependent variable. The direction of causality should be followed to study both the long-term and short-term influential relationships between the two variables.

Accordingly, the study's hypothesis stating that "there is a unidirectional causal relationship from the money supply variable toward economic growth in Algeria during the period 1990–2024" is rejected.

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