

## INVESTIGATING THE THE EFFECT OF BROAD MONEY SUPPLY ON ECONOMIC GROWTH IN ALGERIA: FRESH INSIGHTS FROM AUGMENTED LINEAR & NONLINEAR ARDL (1970-2021)

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**Received: 03/2024**

**Published:03/2024**

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### **ABSTRACT :**

This study investigates the asymmetric Effect of Broad Money Supply Shocks on Economic Growth in Algeria using time-series data from 1970 to 2021. The study has employed a novel extension of ARDL which is Augmented ARDL & Augmented NARDL. The result reveals that adjustments in broad money supply influence Algeria's economic growth asymmetrically in both short & long run. As a consequence, positive (negative) money supply shocks boost (decrease) the economic growth rates. These findings strongly imply that money is not neutral, and this could be regarded as a realization goal of monetary policy. While, even though the efforts made by policymakers to stimulate high levels of economic growth, the aim of improvement is also modest compared with other developing countries.

**Keywords:** Money supply; Economic Growth; Augmented ARDL & NARDL, Algeria

**Jel Classification Code:** C22, E51, E58, O40.

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### **INTRODUCTION :**

Monetary policy has been often seen as the key driver of economic activities in both developed and developing countries. it is a fundamental instruments for the attainment of macroeconomic stability, It often considers it as prerequisite to achieving sustainable economic growth and development (Chinedu, Magaji & Musa, 2021). However, its application differs from one country to another, according to the variables of each country, as the view of developing countries on monetary policy varies from that of developed countries in terms of objectives. Developed countries believe that the

primary goal of monetary policy is to achieve monetary stability and economic growth. Unlike developing countries, which believe that the primary goal of monetary policy is beyond that, as through it is possible to achieve economic growth and monetary stability, reduce unemployment levels, and maintain the stability of exchange rates in local currencies. In fact, to achieve this objective, monetary policy tools are used such as the interest rate, the money supply, the liquidity ratios, among others.

The issue of money supply is also considered one of the most important economic topics, which has attracted the attention of many thinkers at the theoretical and applied levels, due to the prominent and effective role played by the money supply in achieving economic stability, as it affects many macroeconomic variables such as gross domestic product and inflation. In recent decades, attention has been directed to the sectoral or regional effects of monetary policy shocks (distributive effects of policy), as many recent studies on this subject show that the problematic sectors of the economy respond differently to monetary shocks (asymmetric effects), which reflect the asymmetry in financial conditions. For economic units, which are related to the role played by financial intermediaries, led by the banking system, and the extent of banks' contribution to financing the economy. Therefore, this point obliges the central bank to be aware of the resulting consequences of its measures on sectors and their growth, so that they are not an obstacle. On the path of development that most countries seek to achieve in the long term, especially developing countries.

The paper is structured into five sections: The first section presents a Money Supply and economic growth in Algeria. The second section is devoted to exposing Empirical Literature Review (all countries, Algeria). The third section elaborates on the study Data and Methodology. the fourth section presents the results of the study, and the last section was devoted to the conclusion.

### **Money Supply and economic growth in Algeria**

This section presents trends in the main aggregates of the monetary sphere and growth in the Algerian economy over the period 2017-2022.

### **Money Supply in Algeria**

After two years of sustained growth of 8.4% (2017) and 11.1% (2018), the M2 money supply (which corresponds to M1 + passbook deposits and short-term loans) contracted by -0.8% in 2019, from 16,636.7 billion dinars at the end of 2018 to 16,510.7 billion dinars at the end of 2019. This slight decrease in monetary availabilities resulted from the sharp fall in sight deposits at banks (including the Bank of Algeria), which fell by -19.0%, compared with increases of 5.7% in time deposits and 10.4% in currency in circulation. However, the sharp fall in demand deposits at banks (including the BA) was entirely due to the decline in demand deposits at the national hydrocarbons company, whose deposits fell by 71.3% over the same period. Excluding deposits from the hydrocarbons sector, M2 money supply expanded by 3.0% in 2019.

After declining by 0.78% in 2019, broad money supply M2 increased by 7.47% in 2020 (against the backdrop of an unprecedented health crisis), rising from 16,506.63 billion dinars at the end of 2019 to 17,740.01 billion dinars at the end of 2020.

During 2021, the COVID-19 pandemic continued to hamper economic activity, although this improved relatively overall following the decontamination measures. Money supply in the M2 sense grew by 13.75% in 2021 compared with a lower growth of 6.99% in 2020, rising from 17,659.64 billion dinars at the end of 2020 to 20,087.53 billion dinars at the end of 2021. This significant growth is mainly due to the rise in the M1 aggregate (which corresponds to the sum of currency in

circulation and sight deposits), which increased by 14.52% in 2021 compared with a growth rate of 8.44% in 2020, rising from 11,901.82 billion dinars at the end of 2020 to 13,630.36 billion dinars at the end of 2021. Similarly, quasi-money recorded growth of around 12.15% at the end of 2021, when it reached 6,457.17 billion dinars compared with 5,757.82 billion dinars at the end of 2020. Excluding the deposits of the national hydrocarbons company, the M2 money supply increased by 9.35% in 2021 compared with 8.90% in 2020, rising from 16,546.612 billion dinars in 2020 to 18,095.300 billion dinars in 2021. The following figure shows changes in the money supply:

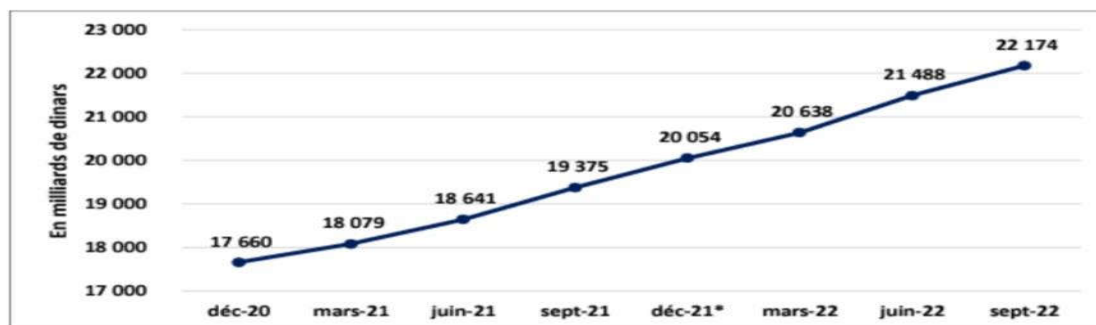
**Figure 1: Money supply trends**



**Source :** Bank of Algeria, Rapport annuel 2021 évolution économique et monétaire, Décembre 2022

At the end of September 2022, the M2 money supply increased by 10.58% compared with its level in December 2021, reaching 22,174.3 billion dinars compared with 20,053.5 billion dinars at the end of 2021, following the combined effect of a 12.71% increase in M1 money and a 6.08% increase in quasi money. Excluding the hydrocarbons sector, the money supply rose by 6.62% compared with its level at the end of December 2021, against the backdrop of an increase in the deposits of the national hydrocarbons company, which rose from 1,046.5 billion dinars at the end of 2021 to 1,908.4 billion dinars at the end of September 2022. Year-on-year, the money supply, excluding the deposits of the national hydrocarbons company, increased by 8.18%. The following figure shows the evolution of M2 :

**Figure 2: Evolution of M2**



Source : Bank of Algeria, Tendances monétaires et financières, Janvier 2023

## 2.2 Economic growth in Algeria

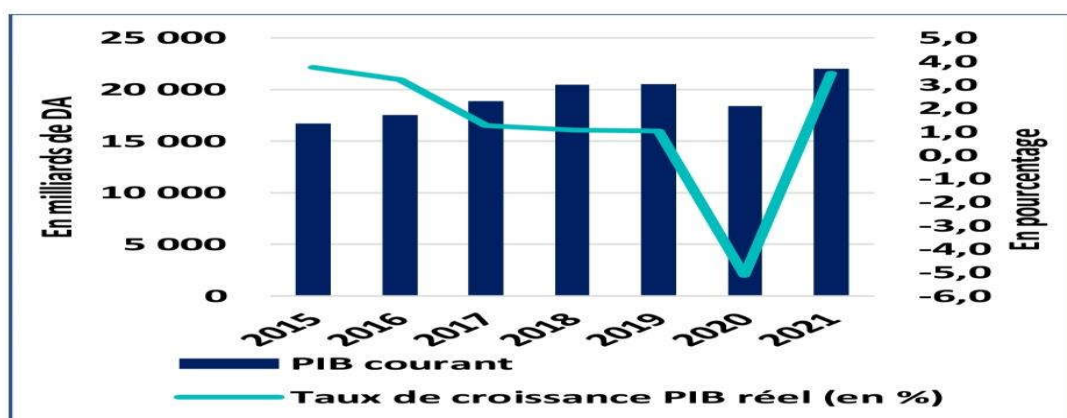
The rate of growth of national economic activity, as measured by real gross domestic product (GDP), has fallen steadily since 2014, partly as a result of successive declines in activity in the hydrocarbon sector (with the exception of 2015 and 2016). The GDP growth rate has fallen from 3.8% in 2014 to 1.2% in 2018 and 0.8% in 2019.

In 2020, the Covid-19 pandemic worsened Algeria's economic outlook. The year-on-year decline in Gross Domestic Product (GDP) began in the first quarter of 2020 (-3.7%1 ), before accelerating sharply in the second quarter (-10.4%), mainly as a result of the containment measures put in place to stem the spread of the virus. However, activity in some sectors began to pick up in the third and fourth quarters, particularly in industry, construction and non-market services, as the containment measures were gradually lifted.

And after the unprecedented 6% fall in real output in 2020, economic activity has rebounded sharply in 2021, driven by the improvement in the pandemic situation. Gross domestic product (GDP) at current value in 2021 will thus exceed its pre-crisis level, reaching 22,021.5 billion dinars, representing growth of 19.8%, in an inflationary context where the GDP deflator has reached 15.7%, bringing real GDP growth to 3.5%, before accelerating to 4.7% in 2022.

The following figure shows GDP growth and development over the period 2015-2021:

**Figure 3: GDP growth and development**



Source : Bank of Algeria, Rapport annuel 2021 évolution économique et monétaire, Décembre 2022

## 1. Empirical Literature Review

**Aigheyisi, O. S., & Edore, J. E. (2019)** assessed the asymmetric impacts of broad money growth on economic growth in Nigeria using the Shin-Greenwood-Yin nonlinear autoregressive distributed lag (NARDL) approach to cointegrating and error correction modeling and based on annual time series data spanning the period from 1981-2016. The results revealed an asymmetric relationship between the short-term variables, as a positive change in broad money growth positively and significantly affects economic growth, while a negative change has a negative, but larger effect and more significant on growth. The study also showed no significant influence of a positive change in broad money growth on long-term economic growth. A negative change in broad money growth positively and significantly influenced long-term economic growth. The study also proves that economic growth was positively responsive to government financial consumption expenditure growth on the short- and long-term, while it was negatively affected by inflation in both time horizons. Based on the empirical evidence, it is recommended that monetary expansion can be used as a panacea for short-term growth deficits, but for long-term growth, broad money growth should be kept under control monetary authority using appropriate policy instruments. It is also necessary to control inflation and constantly increase government final consumption expenditure, but this should be done with caution to ensure that it contributes significantly to raising the level of economic activities, especially through national companies operating in the country's private sector.

**Goshit, Gédéon G., and al. (2022)** analyzed the asymmetric effects of monetary policy shocks on output growth in Nigeria using the recently developed Lee and Strazicich unit root test with structural breaks, Nonlinear ARDL, and the Hatemi-J causality tests on quarterly data from 1981Q1 to 2018Q4. The study founded that the impact of monetary policy shocks on output growth in Nigeria was asymmetric on the long and short run. The results of the long-run indicated that both positive and negative monetary policy rate shocks was a positive, elastic, and statistically significant influence on output growth. While in the short-run, the changes on negative monetary policy dominated the positive monetary policy shocks. Therefore, it was recommended that to ensure output growth using the interest rate channel and money supply tool, the CBN through Monetary authority (Monetary Policy Committee) and other relevant units should consider lowering the MPR and increasing the supply of money in the economy.

The study of **Razia, A., & Omarya, M. (2022)** investigated the impact of the Broad Money Supply (M2) on Economic Growth per Capita in Palestine from 2000 to 2020 using autoregressive

distributed lag model (ARDL), the cointegration approach and the error correction model in order to determine the effect of four macroeconomic variables, namely, gross domestic product (GDP) per capita, broad money supply (M2), gross fixed capital formation (GFCF), and inflation rate (INF) on gross domestic product (GDP) per capita. The findings illustrated that the money supply, the total capital formation, and the inflation rate have a positive impact on the economic growth in the short run. However, none of these variables affected the economic growth in the long term. The authors indicated that it is necessary to know how the Palestinian monetary system deals with three currencies within the economy of an occupying power. Therefore, it would be desirable that future researchers consider using this methodology on the other variables of the study.

Similarly, **Joshi, UL (2022)**, examined the impact of monetary policy on economic growth in Nepal during the period 1965-2020 using Johansen's co-integration test after confirming that all variables have been integrated in I(1) order, then the vector error correction model to determine the speed of adjustment towards long-term equilibrium. The estimated results suggested that the coefficient of VECM was negative and significant that showed long run relationship between monetary policy and GDP Growth. Thus, Granger Causality results showed two-way causality between money supply and GDP Growth. Furthermore, The result supported the impact of monetary policy on economic growth of the country. Finally, it is recommended that monetary authorities and policymakers should focus on sound monetary policy for the country's economic growth.

**Musa, I., Magaji, S. et Salisu, A. (2022)** measured the effect of monetary policy on economic growth in Nigeria using SVAR analysis to assess the impacts of monetary policy following the framework of Inflation Targeting (IT) on economic growth in Nigeria using quarterly time series data from 1986Q1 to 2017Q4. The results obtained suggest that monetary policy has a positive impact on economic growth. The monetary policy rate (MPR) positively affects growth. However, its influence is minimal, representing only a maximum of 3%. The researchers also found that the broad money supply (M2) was positively shocked, but representing only a maximum of 7 percent. However, Inflation Targeting (IT) framework is a good monetary policy tool but this is not sufficient. Other complementary instruments are needed.

**Ikram BENAZZA (2022)** employed the autoregressive distributed lag (ARDL)-bounds testing cointegration and error correction model to examine the impact of M2 on GDP in Algeria using time-series data from 1980 to 2017. The model was specified with six macroeconomics variables, namely, Gross Domestic Product (GDP), Broad money supply (M2), Discount rate (DR), Inflation rate (INF), real exchange rate (reer), government expenditure(gov). The study finded that there is statistically significant positive relationship between money supply and economic growth both in the short and long run. Where the central bank in Algeria should maintain consistency and follow “the Taylor rule” to allow money supply to increase at a steady rate keeping pace with the economic growth.

Authors	Region/ Country	Time	Methods	Findings
Tolulope, A.O (2017)	Nigeria	1986-2015	NARDL model	The findings suggested that both positive and negative shocks of money supply positively affected output in the long run in the country, but only the positive shocks were statistically significant.

<b>Hazwan Hain (2019)</b>	The ASEAN economies	1995-2017	dynamic panel estimator	The study found that financial institutions was positive and significant towards economic growth, while financial markets was insignificant. Equally important, institutional quality plays a significant and positive role in economic growth. More interestingly, the study found that institutional development was complementary to financial institutions and markets.
<b>Mathew, A.O (2021)</b>	Nigeria	1971-2018	Ordinary Least Square (OLS)	Long-run relationship exists among the variables and that some explanatory variables (Monetary policy rate, Interest rate, Investment to productive sector) presents a positive but non significant effect on economic growth whereas real exchange rate has a negative impact on economic growth in Nigeria. However, monetary supply, which is another explanatory variable has a positive significant influence on economic growth.
<b>Shafiu, Kamal &amp; Shuai bu (2021)</b>	Nigeria	1989-2019	Generalized Method of Moment (GMM) and Autoregressive Distributed Lack Model (ARDL)	The finding provided that money supply is was an important variable explaining economic growth in Nigeria but foreign external policy affected economic growth negatively. However, income was the most important variable that explains monetary demand in Nigeria.
<b>Mwange, A. (2022)</b>	Zambia	2001Q1-2021Q2	The Johansen cointegration approach, Error Correction Model (ECM), and Granger causality test	The results showed that economic growth proxied by Gross Domestic Product (GDP) in Zambia is negatively affected by lending rates, inflation, and an increase in private sector credit, while exchange rate and deposit rates were found to have a positive impact on the other hand. These results confirmed the presence of exchange rate and credit channels of monetary policy transmission in Zambia.
<b>Ahmed, S. H., &amp; Abtan, A. K. (2022)</b>	Bahrain	1995-2020	the expanded Dicke-Fuller test	The results indicated an inverse relationship between the long-term real interest rate with GDP, and a direct relationship between each of the short-term real interest rate with GDP. The total, and a direct relationship between the broad

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money supply, and the rate of inflation, with the gross domestic product.

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## 2. Data and Methodology

In our study, we will use annual data from 1970 to 2021 of the Real GDP growth which is the dependent variable in function of some of independent monetary variables, which are:  $INF_t$  by taking consumer price index (2010=100) as an indicator of inflation,  $FD_t$  financial development using domestic credit to private sector as a proxy variable, and  $BM_t$  broad money supply of M2 is chosen as a tool for monetary policy. Data sources are mostly from the World Bank's (WB) database, and from the World Development Indicators (WDI).

Cointegration tests such as Engle and Granger (1987), Johansen and Juselius (1990), have a tendency for unreliability in small sample sizes. Thus, bounds testing approach is widely used to investigate developing countries issues because of data lack. Pesaran et al., (2001) proposed the autoregressive distributed lag ARDL model to check if the studied variables have a long-run relationship despite the order of integration of the variables is different  $I(0)$  or  $I(1)$  except  $I(2)$ . In this paper we employ a novel extension of ARDL approach which is Augmented Autoregressive Distributed Lagged (AARDL) bounds test for cointegration developing by McNown et al. (2018) based on the following specifications:

$$\Delta RGDP_t = \alpha_0 + \rho RGDP_{t-1} + \lambda INF_{t-1} + \delta FD_{t-1} + \vartheta BM_{t-1} + \sum_{j=1}^p \gamma_j \Delta RGDP_{t-j} + \sum_{j=0}^q \mu_j \Delta INF_{t-j} + \sum_{j=0}^q \varphi_j \Delta FD_{t-j} + \sum_{j=0}^q \tau_j \Delta BM_{t-j} + \varepsilon_t$$

Where  $\Delta$  is the first difference operator and it provides the short run estimation, in addition  $\rho, \lambda, \delta, \vartheta$  are the coefficients of long run estimation and  $\varepsilon_t$  is a white-noise disturbance error term.

The specific application of Augmented ARDL medialization amounts to : on one side, the assumption of an  $I(1)$  endogenous variable is not necessary, therefore we can accept  $RGDP_t$  if it is stationary at zero order  $I(0)$ . On the other side, if we have degenerate cases, McNown et al. (2018) suggest a test to eliminate the  $I(1)$  assumption for the dependent variable. Therefore, in order to precede the Augmented ARDL approach and to establish the presence of cointegration, three separate tests need to be examined:

First, the overall  $F$  test for the joint significance of lagged level variables (LLV), as recommended by Pesaran et al. (2001). The null hypothesis of no cointegration cannot be rejected if the  $F$ -statistic is below than the lower bound value. While, the null hypothesis can be rejected when the  $F$ -statistic is greater than the upper bound value that proves the existence of long run relationship among variables. Although, if the  $F$ -statistic falls between the upper and lower bound value, the result is not conclusive. As a consequence, the null hypothesis of LLV is presented as follow:

$$H_{0A}: \rho = \lambda = \delta = \vartheta = 0$$

Second, according to Pesaran et al., (2001) the  $t$ -test on the lagged level of the dependent variable (LLDV) is applied, to avoid the possibility of degenerate lagged dependent variable case. This test is



beneficial because the overall  $F$  test for joint significance of lagged variables may induce from the lagged level independent variables (LLIV) or the lagged level of the dependent variable (LLDV), therefore, statistical significance is established if the calculated value of the t-statistic exceed the upper bound critical value in absolute value Kriskkumar, K., Naseem, N. A. M., & Azman-Saini, W. N. W. (2022). The null hypothesis of LLDV is presented as follow:

$$H_{0B}: \rho = 0$$

Third, McNown et al. (2018) added a new test which is an  $F$ -test on the lagged levels of the independent variables (LLID), this test is necessary because it eliminates the hypothesis that the exogenous variable is integrated of order one and to rule out degenerate lagged independent variable case, this assumption was not taken into consideration in the standard ARDL (Pesaran et al., 2001). The examination of this test is the same to the first one (overall  $F$ -test), we compare the calculated  $F$ -statistic with the upper (lower) bound value. Thus, if the three tests are significant so the cointegration relationship among variables exists. The null hypothesis of LLIV is presented as follow:

$$H_{0C}: \lambda = \delta = \partial = 0$$

A novel approach has been developed to establish a benchmark at zero in order to identify both positive and negative shocks, allowing for the separate identification of the positive and negative effects of independent variables on the dependent variable Ayad, H., et al. (2023). Hence, the objective of this study is to examine the asymmetric impact of broad money supply by decomposing this variable into positive and negatives partial sums as follow:

$$BM_t^+ = \sum_{j=1}^t \Delta BM_j^+ = \sum_{j=1}^t \max(\Delta BM_j, 0)$$

$$BM_t^- = \sum_{j=1}^t \Delta BM_j^- = \sum_{j=1}^t \min(\Delta BM_j, 0)$$

By integrating these shocks ( $BM_t^+$  &  $BM_t^-$ ) in the previous ECM error correction equation we obtain the Augmented Nonlinear ARDL model following to Shin et al. (2014):

$$\begin{aligned} \Delta RGDP_t = & \alpha_0 + \rho RGDP_{t-1} + \lambda INF_{t-1} + \delta FD_{t-1} + \partial_1 BM_{t-1}^+ + \partial_2 BM_{t-1}^- \\ & + \sum_{j=1}^p \gamma_j \Delta RGDP_{t-j} + \sum_{j=0}^q \mu_j \Delta INF_{t-j} + \sum_{j=0}^q \varphi_j \Delta FD_{t-j} + \sum_{j=0}^q \tau_{1j} \Delta BM_{t-j}^+ \\ & + \sum_{j=0}^q \tau_{2j} \Delta BM_{t-j}^- + \varepsilon_t \end{aligned}$$

As the NARDL model above is extended from an ARDL approach so the three long run relationship tests suggested under the augmented ARDL model will also be applied to the NARDL.

The nonlinear version is characterized by the existence of short and long term asymmetry tests contrary to the linear version which assumes that the effects of the independent variables are symmetric overtime. A Wald test is applied to verify the asymmetric impact and the null hypotheses in both short and long term are respectively as follow:

$$H_0: \sum_{j=1}^q \pi_j^+ = \sum_{j=1}^q \pi_j^-$$

$$H_0: -\partial_1/\rho = -\partial_2/\rho$$

As a result, if we accept  $H_0$  then symmetric effects exist otherwise we confirm that  $BM_t$  shocks affect the dependent variable  $RGDP_t$  differently.

#### 4. Results and Discussions

##### 4.1. Unit root tests

Firstly, we have to check the stability of our variables, by applying Augmented Dicky Fuller (ADF) (1979) and Phillips Perron (PP) (1988) unit root tests, the aim is to examine the null hypothesis which states that there is a unit root in the time series studied, meaning that this variable is not stationary. The results are shown in Table 1 & 2 as below:

**Table 1.** ADF test results

Variables	Series at level			Series in first difference			Degree of integration
	I	II	III	I	II	III	
$RGDP_t$	- 2.298033 **	-8.787***	- 9.479 372** *	- 12.88107 ***	- 12.562 17***	- 12.26466* **	<b>I(0)</b>
$INF_t$	- 1.434282	-2.247069	- 2.385 374	- 6.673913 ***	- 6.6031 26***	- 6.554291* **	<b>I(1)</b>
$FD_t$	- 0.977017	-1.396196	- 1.841 866	- 5.350409 ***	- 5.2970 00***	- 5.240432* **	<b>I(1)</b>
$BM_t$	- 0.949038	- 5.436746* **	- 6.223 674** *	- 6.751578 ***	- 6.6851 46***	- 6.636030* **	<b>I(1) or I(0)</b>

\*, \*\* & \*\*\* indicate significance at 10%, 5% et 1% levels, respectively.

I, II, III present the equation: without constant, including constant & with constant and trend, respectively.

**Table 2.** Phillips-Perron (PP) test results

Variables	Series at level			Series in first difference			Degree of integration
	I	II	III	I	II	III	
$RGDP_t$	- 6.567341* **	- 8.589422* **	- 9.183646* **	- 25.9788** *	- 25.41264* **	-24. 1597***	<b>I(0)</b>
$INF_t$	-1.444797	-2.341364	-2.461221	-6. 6632***	- 6.608008* **	- 6.550067* **	<b>I(1)</b>
$FD_t$	-0.846505	-1.413756	-1.993760	- 5.367214* **	- 5.31114** *	- 5.255080* **	<b>I(1)</b>
$BM_t$	- 2.036744* *	- 5.487380* **	- 6.220834* **	- 25.70893* **	- 24.54643* **	- 29.96058* **	<b>I(0)</b>

\*, \*\* & \*\*\* indicate significance at 10%, 5% et 1% levels, respectively.

I, II, III present the equation: without constant, including constant & with constant and trend, respectively.

According to ADF & PP tests, half of variables are integrated of order one I(1), except, and the rest are stationary at level, besides, ADF unit root test indicated that the broad money supply  $BM_t$  is possible to stabilize at level I(0) or in their first difference I(1), this result appears inconclusive, but PP test confirms that this variable is stationary I(0).

The following Table 3, shows the results of Zivot-Andrews unit root test with one structural break :

**Table 3.** Zivot-Andrews unit root test results

Variables	At level			At first difference			Degree of integration
	K	t-statistics	Break point	k	t-statistics	Break point	
<b>Intercept</b>							
$RGDP_t$	0	10.8177 ***	1986	4	-6.432***	1994	<b>I(0)</b>

$INF_t$	0	-4.539	1997	0	-7.381***	1993	<b>I(1)</b>
$FD_t$	3	-7.679***	1992	0	-5.93***	1989	<b>I(0)</b>
$BM_t$	0	-6.546***	1997	4	-5.662***	1990	<b>I(0)</b>
<b>Intercept + Trend</b>							
$RGDP_t$	0	-11.194***	1995	4	-6.415***	1995	<b>I(0)</b>
$INF_t$	0	-4.591	1997	0	-7.347***	1996	<b>I(1)</b>
$FD_t$	3	-7.230**	1992	0	-6.725***	1994	<b>I(0)</b>
$BM_t$	0	-7.099***	2001	4	-5.632***	1990	<b>I(0)</b>

\*, \*\* & \*\*\* indicate significance at 10%, 5% et 1% levels, respectively. K is the optimal lag period used in the root tests of the Z-A unit (1992) (defined by Schwartz criterion). The critical values for the model with intercept are respectively: -5.34 (1%), -4.93 (5%), -4.58 (10%), and for the second model with trend and intercept, respectively: -5.57 (1%), -5.08 (5%), -4.82. (10%).

The results of Zivot-Andrews unit root test are more accurate, where all variables are stationary in their level, except  $INF_t$  which is stationary at first difference. Therefore, the dependent variable  $RGDP_t$  is I(0) type of series that allows us to proceed Augmented ARDL, in addition, the variables are not I(2) series, thus, we can apply ARDL approach to check for cointegration.

## 4.2. Augmented ARDL & NARDL Estimation

### 4.2.1. Cointegration tests

After confirming that there is no variable which is integrated of order 2, we move to the second step of modelisation that reveals the existence of cointegration relationship, according to McNown et al. (2018) we examine the three hypotheses: first,  $F$ -statistic is calculated to test the lagged level of all variables (LLV), then,  $t$ -statistic tests the lagged level of the dependent variable (LLDV) and the last one  $F$ -statistic (exogenous) allows to examine the significance of lagged level for independent variables (LLIV). The results are shown in Table 4 & 5:

**Table 4.** Cointegration AARDL test

Critical Levels	Upper Bounds	Lower Bounds		
1%	3.10	2.01	44.19***	<b>F statistic overall</b>
5%	3.63	2.45		
10%	4.84	3.42		

1%	-3.00	-1.62	-13.08***	<b>t statistic endogenous</b>
5%	-3.33	-1.95		
10%	-3.97	-2.58		
1%	3.69	2.09	27.96***	<b>F statistic exogenous</b>
5%	4.41	2.61		
10%	5.93	3.75		

\*, \*\* and \*\*\* indicate the significant at 10%, 5% and 1% level of significance, respectively

**Table 5.** Cointegration NAARDL test

Critical Levels	Upper Bounds	Lower Bounds		
1%	3.01	1.90	11.95***	<b>F statistic overall</b>
5%	3.48	2.26		
10%	4.44	3.07		
1%	-3.26	-1.62	-6.97***	<b>t statistic endogenous</b>
5%	-3.6	-1.95		
10%	-4.23	-2.58		
1%	3.46	1.95	8.15***	<b>F statistic exogenous</b>
5%	4.01	2.39		
10%	5.35	3.37		

\*, \*\* and \*\*\* indicate the significant at 10%, 5% and 1% level of significance, respectively

From the results of bounds testing for both models augmented linear ARDL & augmented nonlinear ARDL, we reject the null hypothesis of “No long-run relationship between variables” at 1% of significance level, consequently, we accept the alternative hypothesis that confirms cointegration between negative and positive changes, as well as other variables.

#### 4.2.2. Augmented ARDL results

Table 6 presents the findings of Augmented ARDL which is a recent approach developed by McNown et al. (2018) characterized by avoiding degenerate cases due to the examination of a new assumption lagged level of the independent variables contrary to the standard ARDL introduced by

Pesaran et al. (2001) that supposes two hypotheses concerned the set of all variables and only the dependent variable.

The results show that the error correction term ( $CointEq_{t-1}$ ) is statistically significant at the 1% level, with a negative sign it is equal to -1.073, indicating that dampened fluctuations in the equilibrium path, in this case the error correction process changes around the long-run value in a dampening manner instead than monotonically converging to the equilibrium path straight, the convergence to the equilibrium happens fast once this process is over (Narayan 2005).

The broad money supply affects positively the economic growth at 5% level of significance on the short run and 1% on the long run. Concerning, the financial development, is not significant statically at the long run however its first and second lags are positively significant respectively at 1% and 5% on the short run. In Algeria, an increase of general price level of 1% can boost the output with 5.9%. Then, it should be mentioned that the coefficient of determination and the adjusted  $R^2$  are highly interested, meaning that the independent variables explain the variation of more than 80% of the dependent variable.

Furthermore, the diagnostic tests indicate that there is no problem of serial correlation of residuals, no auto-regressive conditionally heteroscedasticity (ARCH) behavior, the errors support the normality assumption and the estimators are stable throughout the study period.

**Table 6.** Augmented ARDL(1,0,3,2) estimation results

<b>Cointegrating Form</b>			
<b>Variables</b>	<b>Coefficient</b>	<b>Stan. Err.</b>	<b>t-statistic</b>
$\Delta FD_t$	0.048	0.052	0.911
$\Delta FD_{t-1}$	0.172***	0.051	3.366
$\Delta FD_{t-2}$	0.145**	0.056	2.560
$\Delta BM_t$	0.068**	0.030	2.224
$\Delta BM_{t-1}$	0.073**	0.029	2.492
<b><math>CointEq_{t-1}</math></b>	<b>-1.073***</b>	<b>0.077</b>	<b>-13.785</b>
<b><math>R^2</math></b>	<b>0.833</b>		
<b><math>\overline{R^2}</math> adjusted</b>	<b>0.800</b>		
<b>Long run model</b>			
$INF_t$	0.059	0.052	1.123
$FD_t$	-0.019	0.013	-1.488
$BM_t$	0.213***	0.028	7.616

Diagnostic statistic	
$\chi_{SC}^2$	0.576 (0.566)
$\chi_{NORM}^2$	5.899 (0.052)
$\chi_{HET}^2$	0.006 (0.935)
$\chi_{FF}^2$	3.07 (0.995)

\*, \*\* and \*\*\* indicate the significant at 10%, 5% and 1% level of significance, respectively.

$\chi_{SC}^2$ ,  $\chi_{NORM}^2$ ,  $\chi_{FF}^2$  and  $\chi_{HET}^2$  refer to LM test of serial correlation, normality, functional form and heteroscedasticity, respectively.

#### 4.2.3. Augmented NARDL results

Table ... shows the results of augmented non-linear ARDL estimation which provides the long and short run estimated coefficients for explanatory variables : inflation  $INF_t$ , financial development  $FD_t$  and for the different partial sums of broad money supply  $BM_t^+$  &  $BM_t^-$  as a proxy for the scale variable. Furthermore, by using a Wald test we could check the existence of asymmetric impact in both long and short runs of money supplied shocks on output:

**Table 7.** Augmented NARDL(2,0,3,2,1) estimation results

Cointegrating Form			
Variables	Coefficient	Stan. Err.	t-statistic
$\Delta RGDP_{t-1}$	0.134**	0.062	2.137
$\Delta FD_t$	0.074	0.053	0.397
$\Delta FD_{t-1}$	0.171***	0.052	3.249
$\Delta FD_{t-2}$	0.104*	0.058	1.798
$\Delta BM_t^+$	0.054	0.046	1.157
$\Delta BM_{t-1}^+$	0.112*	0.066	1.700
$\Delta BM_t^-$	0.118*	0.066	1.776
$CointEq_{t-1}$	-0.819***	0.100	-8.139
$R^2$	0.846		
$\overline{R^2}$ adjusted	0.800		

<b>Long run model</b>			
$INF_t$	0.157**	0.072	2.247
$FD_t$	-0.006	0.018	-0.376
$BM_t^+$	0.349***	0.067	5.177
$BM_t^-$	0.335***	0.065	5.128
<b>Long &amp; short run symmetric tests</b>			
$W_{LR}$	10.407***		
$W_{SR}$	3.318**		
<b>Diagnostic statistic</b>			
$\chi_{SC}^2$	2.150 (0.131)		
$\chi_{NORM}^2$	1.431 (0.488)		
$\chi_{HET}^2$	0.104 (0.747)		
$\chi_{FF}^2$	0.001 (0.969)		

\*, \*\* and \*\*\* indicate the significant at 10%, 5% and 1% level of significance, respectively.

$\chi_{SC}^2$ ,  $\chi_{NORM}^2$ ,  $\chi_{FF}^2$  and  $\chi_{HET}^2$  refer to LM test of serial correlation, normality, functional form and heteroscedasticity, respectively.

The results show that in the short run positive ( $BM_t^+$ ) and negative ( $BM_t^-$ ) changes in money supply have a positive and negative significant effect on output at a 1% level of significance (except the coefficient of  $\Delta BM_{t-1}^+$  & which is significant at 10%). Whereas, on the long run, 1% increase in broad money supply has a meaningful impact on economic growth that could raise the GDP rate level at 0.349%. While 1% decrease in broad money supply leads to a decline in economic growth rate with 0.335%. The lag effect of  $\Delta BM_t^-$  is significant at the 10% level with positive sign.

In the long run, broad money growth shocks affect economic growth rate asymmetrically (Wald statistic of long term is significant at 1%, so we reject the null hypothesis of symmetry). In addition, we deduce the same result from the Wald test for the short term  $W_{SR}$  is significant at 5% level. As a result, the effect of broad money supply shocks is asymmetric on the Algerian economic growth at the short & long run. Where the output is more responsive to an increase in broad money supply meaning that positive shocks  $BM_t^+$  can boost the GDP growth rate while the negative shock of money supply growth  $BM_t^-$  has a negative impact on Algerian economic growth. These results prove that the broad money supply in Algeria is not neutral in either the long or short term; it can create improvement and having an effective role on economic development.



Now we pass to the analysis of exogenous variables. Firstly, on the long run  $INF_t$  affects economic growth positively and it is statistically significant at 5%. Then, on the short run the coefficient of financial development is positively significant only on their two lags  $\Delta FD_{t-1}$  &  $\Delta FD_{t-2}$  at 1% & 10% respectively, while it is not significant at the long run.

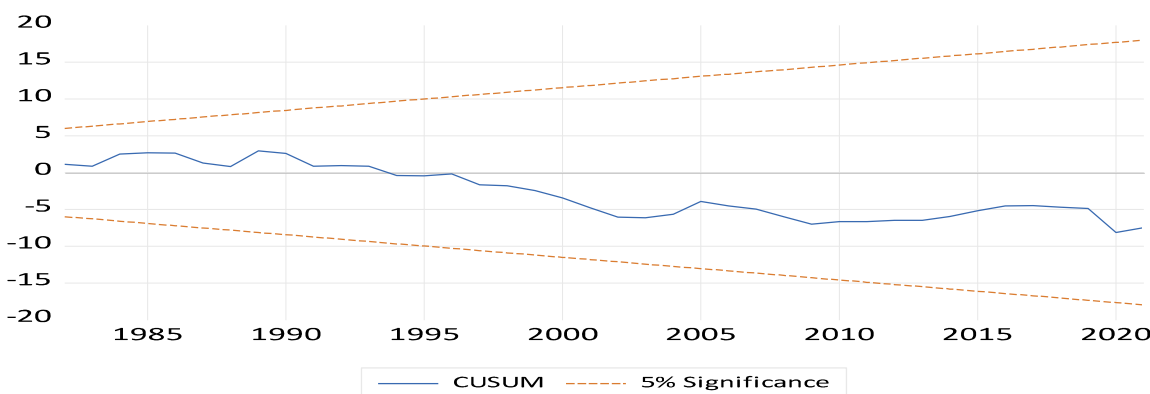
The error correction term has a negative sign. The value of this coefficient confirms the existence of cointegration relationship between the variables (there are those who call it “error cointegration term”), in addition, it suggests any short run deviation from the equilibrium situation is adjusted in the subsequent year to re-establish equilibrium in the relationship. This coefficient is highly significant (at 1%) where  $CointEq$  is equal to -0.819, it means that most of the short-run deviation from equilibrium is regulated yearly to restore equilibrium.

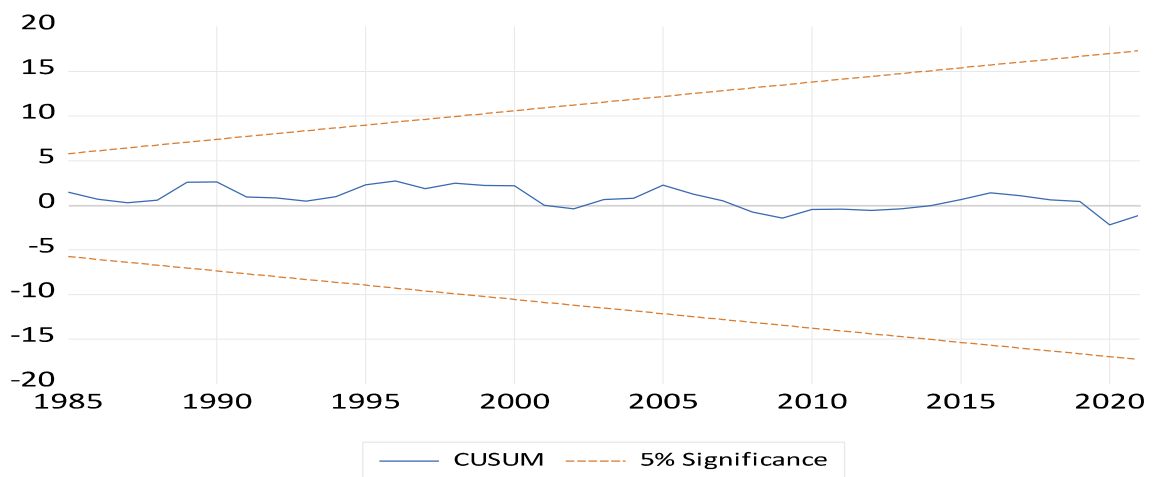
Moreover, we remark that the values of R-squared and R-adjusted are respectively equal to 0.846 & 0.800; this result means that the explanatory variables can highly explain the variations from the model; this proportion is excellent in term of representation for our target variable.

Table 7 contains some diagnostic statistics to check the serial correlation of residuals ( $x_{SC}^2$ ), the normality distribution of these residuals ( $x_{NORM}^2$ ) and their heteroscedasticity ( $x_{HET}^2$ ). To this end, the residuals are free of autocorrelation and heteroscedasticity and support the normality assumption. Moreover, the statistic of ( $x_{FF}^2$ ) is calculated from Ramsey RESET test, it indicates that the model estimated is well specified and it takes the appropriate functional.

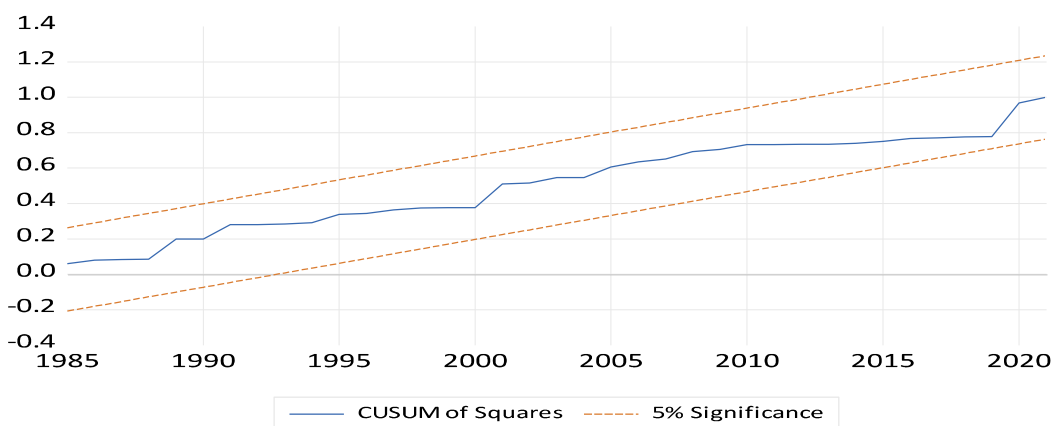
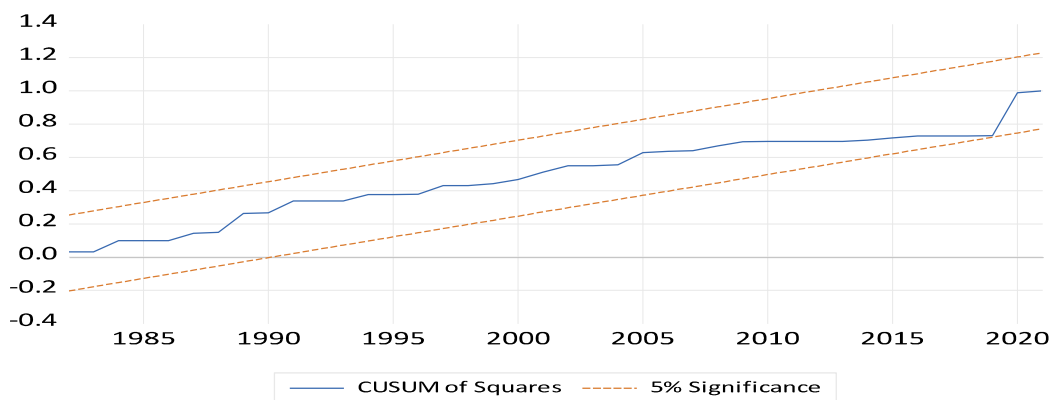
Besides, stability tests executed by using the recursive CUSUM and CUSUM of squares statistics against the breakpoints and examining the null hypothesis of parameter instability. The results are presented in Figures 4 and 5 where the lines of CUSUM and CUSUM of squares confirm the significance of trajectory at the 95% confidence bounds. As a consequence we accept the alternative hypothesis that the parameters in this regression are all stable.

**Figure 4.** The graph of the CUSUM test of AARDL & ANARDL respectively





**Figure 5.** The graph of the CUSUM of squares test for AARDL & ANARDL respectively



## 5. Analysis & Discussion results

Interesting findings have been put ahead concerning the effect of financial indicators on Algerian economic growth. First of all, we mention the positive impact of money supply increase on real GDP rate, in this context the broad monetary mass supplied can boost economic activities booming in the short run afterward it sustainable in the long run with more effectiveness so as to create high levels of economic growth rates. It is clear that money is not neutral, and this could be regarded as a realization goal of monetary policy that involves: firstly achievement of price stability which is considered one of the most important objectives of financial strategy. Second, the monetary authorities increase the money supply in the event recession to enhance the effective demand, thus increasing investment, by the way the global consumption and wages will rise. As a result it stimulates high economic growth rate; for instance, the monetary policy aims to influence by credit expansion and an elevated money supply. Therefore the origin of  $INF_t$  and  $FD_t$  effects on economic growth is basically monetary, especially when the money supply increases; in other words positive money supply shocks.

If we do a projection on the Algerian economy, we conclude that the transition from a command economy to a market economy in the 1980s allowed monetary policy to carry out certain reforms, such as money went from a neutral component to a loan instrument and based on its positive role and has become an important strategic tool in growth plans. Where the Algerian authorities have taken some regulations to strengthen the role of the money supply, such as the creation of the National Council for Supply and Money in 1986, and reconsidered the weight of Central Bank.

The effectiveness of positive shocks in broad money supply ( $BM_t^+$ ), due essentially to two reasons: the increase in the net foreign cash balances (for instance it's recorded an increase in exchange reserves until 2014), and the second reason is the approval of implementing recovery programs (ONS 2019). On the other hand, the economic growth rate was maintained a weakness positive levels despite the spending programs, so even though all efforts made by policymakers to stimulate high levels of economic growth, the aim of improvement is also modest compared with other developing countries.

This paper confirm the positive (negative) impact of broad money supply increase (decrease) on economic growth, these results are similar to **Gideon G. Goshit, Gylych Jelilov, Paul Terhemba Iorember, Bilal Celik and Onyinye Maria Davd-Wayas (2020), Alaa Razia and Mostafa Omarya (2022)** , **I. Musa, S. Magaji and A. Salisu (2022)**, and contrary to **Oziengbe Scott Aigheyisi , Julius Ovuefeyen Edore (2019)** who find a non-significant effect of positive changes in broad money growth on economic growth on the long-run for the case of Nigeria.

### Conclusion:

This paper has examined the Asymmetric Effect of Broad Money Supply Shocks on Economic Growth in Algeria using time-series data from 1970 to 2021. The study has employed a novel extension of ARDL which is Augmented ARDL & Augmented NARDL. The study results reveal that in the long run, broad money growth shocks affect economic growth rate asymmetrically. In addition, we deduce the same result from the Wald test for the short term. These results prove that the broad money supply in Algeria is not neutral in either the long or short term; it can create improvement and having an effective role on economic development.

In the light of the findings of this study, a number of recommendations and suggestions can be made, which we highlight as follows:

- It is necessary to undertake the structural reforms provided for in the legal texts relating to the process of non-traditional financing;
- Activate - as soon as possible - the monitoring committee for the non-traditional financing process provided for in Executive Decree No. 18-86, which includes the mechanism for monitoring the measures and structural reforms involved in implementing non-traditional financing ;
- Diversify sources of liquidity, so that oil does not remain the only resource, especially as its prices fluctuate;
- Applying optimal strategies for the advancement of the economy without political considerations, limiting corruption and applying the principles of governance, in addition to paying attention to the public's awareness of savings and banking culture, are all considerations that ensure that money has an effective impact on all economic and social variables

Further considerations of this study could address a broader range of questions about the role of the broad money supply in stimulating economic growth and specifically evaluate financial development policies, taking into consideration the support of other financial variables such as : real effective exchange, financial development index...etc. Moreover, since Algeria is a rentier country which is essentially based on its hydrocarbons as a source of development, in this context other variables can be added and they affect economic growth rates significantly , like: real oil prices or oil prices volatilities.

From another point, the study could examine how enhancing financial access and literacy can contribute to inclusive growth and poverty reduction objectives as well as to explore the political economy factors shaping monetary policy decision-making processes and outcomes. Analyze the interactions between monetary authorities, fiscal authorities, political leaders, central banks, financial markets, and international institutions in determining the conduct and effectiveness of monetary policy.

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