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Money Supply and Inflation Nexus in Nigeria, 1981-2018: Engle-Granger Approach

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Abstract:
Economic instability in Nigeria more often than not causes high inflationary pressure. Monetary and fiscal inadequacies have been blamed as the major causes of price instability in the economy. The study examines the monetary aspect of high inflation in Nigeria; in other words, the relation between money supply and inflation in Nigeria using annual series for the period, 1981 to 2018. The variables are checked for unit roots and found to be stationary at first difference. Sequel to this finding, we adopt Engle and Granger approach for the analysis of the datasets, and the results indicate a long-run relationship between moneysupply and inflation in Nigeria. In the short-run, money supply is found to exert a positive and significant impact on inflation in Nigeria. Following the establishment of long-run relation between the two variables, the ECM test conducted shows that 41 per cent of disequilibrium in the short-run is corrected annually. Granger causality outcome suggests a uni-directional causality from money supply to inflation.

Keywords: *Money supply, Engle-granger, inflation, and Nigeria*

1. Introduction

The stability of the Nigerian economy in the last few years has been questioned following the outcome of unfavourable economic indices as high exchange rate, high interest rate, low outputs, high rate of inflation, soaring unemployment rate, etc. One of the disturbing macroeconomic factors behind the poor economy is high inflation. Ensuring general price stability in the economy is usually the wish of every administration in power in Nigeria. The objective was one of the primary aims of the Structural Adjustment Programme (SAP) introduced in 1986. This is not unconnected to the price stability policy of successive monetary authorities in Nigeria, including the Central Bank of Nigeria (CBN) (Alade & Tule, 2017).

The need for minimal rate of inflation cannot be oversized especially in a developing economy like Nigeria. The incursion of the military into governance in Nigeria derailed the economic progress achieved by past civilian administrations. The economy of Nigeria experienced its worst inflationary pressure in the 1990s**.** The era of the military dictatorship of Late Gen. Sani Abacha witnessed the worst inflation in the history of Nigeria. This could not be unconnected to the sanctions imposed on Nigeria by the international community under the draconian regime, among other fiscal and monetary policy inadequacies of the military rule (Olorunfemi & Adeleke, 2013). Nigeria recorded her worst inflation in the first-three years of the regime- 1993 to 1995. The years 1993 and 1994 had very high inflation rates of 57.17 per cent and 57.03 per cent respectively, with 1995 recording the highest inflation rate in the history of Nigeria at 72.84 % (International Financial Statistics). Generally, the military periods in Nigeria were characterized by fiscal indisciplines, racketeering, excruciating corruption, public fund mismanagement, financial repressions, general economic instability, etc. Subsequent administrations had made conscious efforts to revamp the economy and bring inflation under control (to achieve single rate of inflation) using both fiscal and monetary corrective measures.

This paper focuses on one of the monetary measures the Central Bank of Nigeria (CBN) uses in stabilizing the price level- the money supply policy. Within the period under consideration, average inflation rate recorded by Nigeria is 19.35%. This rate is considerably high compared to average inflation rate of 5.20% for South Africa (an emerging market like Nigeria) for a five-year period, 2014-2018 (World Development Indicators). As a major determinant of interest rate, high inflation rate influences the direction of supply and demand for money. Central Bank of Nigeria (CBN) uses the real interest rate, which is interest rate adjusted for inflation as a monetary policy instrument to control the supply and demand for money with the aim of stabilizing the purchasing power of the Naira. Stock of money would increase if savings rate is high, holding inflation rate constant. Therefore, rising rate of inflation would whittle savings and in turn affect the

real stock of money. Investors tend to lend more money to users of funds when interest rates appreciate, hence, the real interest rate is an important variable to the monetary authorities. Therefore, high inflation rate if left unchecked may deter the monetary authority's objective of achieving overall price stability in the economy.

In view of the recent economic recession that befell Nigeria in 2016, and the slow economic recovery process, high inflation is believed to be among the primary economic woes facing the country. To this end, this study examines the link between inflation and money supply. With the study, monetary policy measures could be adopted as a remedy to the problem of high inflation in the country by the Central Bank of Nigeria (CBN), if a relationship is established between inflation and money supply.

The rest of the paper is structured thus: section 2 contains brief literature review, and section 3 presents methodology and data. Section 4 shows the empirical results, while section 5 contains the conclusions and policy implications.

2. Brief Literature Review

Quantity of money is of two types: the nominal quantity of money and the real quantity of money. The nominal quantity of money is expressed in terms of the units used to capture money, for instance the US dollar, naira, pound sterling, etc. However, the real quantity is defined in terms of the quantity of goods and services that a given sum of money will buy. For instance, the sum of N10,000 is expressed as real quantity of money if it bought 20 units of X commodity in the year 2018, but can only buy 15 units of X commodity in 2020. The real quantity of money matters more for economic stability.

2.1. Quantity Theory of Money (QTM)

The link shared between money supply and inflation is believed to have started with quantity theory of money. The theory is expressed in the quantity equation, one of the transaction versions originated by Newcomb (1885) and made popular by Fisher (1911). The quantity equation is expressed, thus:

$MV=PQ$

where M is specified amount of money, and V is the velocity of money, implying the number of times transactions have taken place with a given sum of money. MV is described as the transfer of money. On the other hand, P is the unit price per quantity, and Q represents aggregate quantities bought at a time. Therefore, PT represents the transfer of goods and services, or financial instruments in an interval of time. MV can also be viewed as payments made in a given interval of time for the transfer of goods and services, or securities. Monetary economists as Milton Friedman, Anna Schwartz, among other scholars are of the view that the general price level shares a direct relationship with money supply. They assert that an exogenous change in the stock of money occasioned by the monetary authority would cause the nominal price level to adjust in the long-run, but not the real general price level. Bennett & Edward (2011) describe this notion as hypothetical as monetary policies in reality are not engineered to push for exogenous change in the quantity of money supply.

Tang & Lean (2007) analysed the relation between money supply (M1) and inflation in Malaysia. The regression result indicates that money supply has a negative and significant impact on inflation. The findings of the study do not support the monetary theory of equation of exchange, and also do not correspond with the findings of Waingade (2011) and Koyuncu (2014). Ditimi et al. (2018) assessed the effect of money supply on inflation in Nigeria for the period 1970 to 2016. They found that money supply has non-significant impact on inflation both in the long-term and and short-term. The result of the Granger causality test indicates no causality between money supply and inflation. Uddin et al. (2019) examined the causality relation between inflation and money supply in Bangladesh using M1 and M2 as indicators of money supply, while CPI serves as proxy for inflation rate. The paper adopted cointegration test and Error Correction Model (ECM) for the empirical investigations. The outcomes of the study indicate a long-run relation between money supply and inflation, and the speed of adjustment between M2 and CPI to long-run equilibrium was found to be 40 per cent each month. The study also finds a bi-directional relationship between inflation and money supply in Bangladesh. Olorunfemi & Adeleke (2013) used time-series covering the period, 1970-2008 to investigate the impact of money supply on inflation in Nigeria. The paper which adopted Vector Auto-Regression (VAR) model found a positive relationship between money supply and inflation in Nigeria. The study's results correspond with that of Egwaikhide (1994). Waingade (2011) tested the link between money supply and price level over a long-run period in India and found a positive link between growth in the cash supply and price level. The study's findings indicated that money supply and inflation did not increase proportionally, which implies that the growth in money supply has more often than not surpassed the increase in inflation rate. The gap between the two is attributable to the growth in real national income. Ajisafe (1996) analyzed the cause of inflation in Nigeria from monetary factors. The study suggested that money supply, real gross domestic product, previous level of inflation and exchange rate cause inflation in Nigeria. Yousfat (2015) examined the causality between money growth and inflation in the Gulf Co-operational Council (GCC) region. He used cointegration and causality tests on data covering the period, 1970 to 2013. The paper finds a positive long-run relation between money supply and inflation. The research concludes that price stability and minimum rate of inflation can be achieved if money supply is contracted. Koyuncu (2014) used the time-series approach to investigate the impact of the budget deficit and money supply on inflation in Turkey for the period spanning 1987-2013. The study's shows a uni-directional relationship between the variables, that is inflation granger causes money supply in Turkey.

3. Methodology and Data

3.1. Methodology

It is accepted by monetarists that money supply drives inflation. In view of this, we adopt the two-step approach of Engle-Granger to investigate whether long-run relation exists between inflation and money supply in Nigeria, and determine the short-run impact of money supply on inflation in Nigeria. This study is modeled after the work of Kalu et al. (2016). Co-integration is possible if the variables of interest are integrated of order one. There is need for unit-root pre-testing to ascertain the stationarity of the time-series. Hence, a unit root test is estimated using the Augmented Dickey-Fuller (ADF) test from Dickey & Fuller (1979). We, therefore specify the ADF test procedure as follows:

$$\Delta yt = \alpha + \beta t + \alpha 1 yt - 1 + \sum + b1\Delta yt - 1 + \varepsilon t \quad (1)$$

where: α is the constant, β is the coefficient on a time trend, and εt is the error term. The null hypothesis for the ADF is that there is unit root in the time-series, implying that $\alpha 1 = 1$. For this hypothesis to hold, the calculated absolute value of the coefficient of α1 must be less than the ADF critical value, otherwise reject the null. However, the alternate hypothesis is that yt has no unit roots, which means that $\alpha 1 < 1$. This is accepted if absolute ADF critical value is less than the absolute computed value (or if ADF t-statistic is more negative than the critical value), otherwise yt contains unit root.

Having determined that the variables M2 and INF are stationary at first difference, we carry-out a residual-based unit root test to estimate whether cointegration exists between the two series. The test is estimated below:

$$\Delta \mu t = \alpha 1 \mu t - 1 + \varepsilon t \quad (2)$$

Here, Δμt are the first differenced residuals, α1 represents the slope of the line parameter, and εt is the stochastic variable. $\mu t - 1$ stands for the estimated lagged residuals. The residuals from equ.(1) should be stationary for the series INF and M2 to be cointegrated. There is no cointegration, if the residuals are not integrated of order zero. Therefore, a long-run relation subsists between the series if the null hypothesis of a unit root is rejected (Engle & Granger, 1987).

Based on the estimation results derived from the cointegration test (which indicate cointegration between the two variables), we proceed to Error Correction Model (ECM). The ECM shows the speed of adjustment to long-run equilibrium after a shock. With the assumption that the Error Correction approach tests for both short-run and long-run relationships among variables, we therefore model the ECM as follows:

$$\Delta INF = \alpha o + \alpha 1 \Delta InM2 + \alpha 2 \mu t - 1 + \varepsilon(t\text{-}1) \quad (3)$$

where α1 is the coefficient of money supply. It measures the short-term impact of money supply on Inflation. α2 represents the coefficient of a lagged value by one period of the error term, while εt is the stochastic error term. We expect the coefficient α2, which should range between 0 and 1, to be negative and significant at 5% level of significance for long-run equilibrium to be restored after an external shock. Speed of adjustment reduces as α2 tends to 0 implying that 1 signifies full adjustment. However, a positive coefficient (α2) indicates non-existence of convergence to equilibrium after exogenous shock.

We further estimated causality for the two time-series using Pair wise Granger Causality test. The test investigates whether past changes in variable R contribute to present changes in another variable S. If this is the case, then R granger causes S, otherwise there is no causality between R and S.

3.2. Data

In this study, we adopt annual time-series that cover the period, 1981 to 2018. The series utilized were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, 2018 and International Financial Statistics (IFS). Broad money (M2) is used to measure money supply, while consumer price index (CPI) is adopted as a measurement of inflation. Broad money is defined as currency in circulation plus demand deposits and time deposits. Inflation rate is defined as the percentage change in consumer price level over a given period.

	INF	M2
Mean	19.35079	5153.387
Median	12.71500	753.7050
Maximum	72.84000	25079.72
Minimum	5.390000	14.47000
Std. Dev.	17.24408	7536.495
Skewness	1.742064	1.337830
Kurtosis	4.839194	3.431295

Table 1: Descriptive Statistics

The descriptive statistics reveals the silent unique features of a series. Table 1 shows the mean of the time-series INF for the period 1981-2018 as 19.35%. The maximum and minimum inflation rates within the period under consideration are 72.84% and 5.72% respectively. The mean value of M2 for the same period is N5,153.387 billion, with maximum and minimum values of N25,079.72 billion and N14.4700 billion respectively. As a measure of dispersion, the standard deviation for INF is 17.24%, a non-volatile rate when compared to the mean. The two variables, INF and M2 are positively skewed with the values 1.74 and 1.33 respectively. The Kurtosis for both INF and M2 are 4.84 and 3.43, hence, the two series are leptokurtic.

4. Empirical Results

This section contains the empirical results of the various tests conducted to examine the nexus between inflation and money supply, and the interpretations of the results. They include the outcome of unit root tests, estimation results from long-run and short-run regressions tests, error correction test results, among other things.

4.1. Estimating Unit Roots

In order to ascertain the stationarity properties of the data used, ADF Unit Root Test as advised by Augmented Dickey Fuller (1981) is deployed. The findings of the unit root test conducted show that the two variables are not stationary. INF becomes integrated of order 1, and M2 is stationary at first difference with its natural logarithm. The two series must be I(1) for a cointegration test to be tested (Engel and Granger, 1987). From Table 2, the computed value of INF -5.587115 is less than the critical values at 1%, 5% and 10% significance level, an indication of stationarity at first difference. In like manner, InM2 is integrated of order 1 at 1%, 5% and 10% threshold values respectively with the t-stat being less than the critical values.

Variables	Critical values			ADF t-stat
	10%	5%	1%	
INF	-2.611531	-2.945842	-3.626784	-5.587115
InM2	-2.611531	-2.945842	-3.626784	-3.662953

Table 2: Unit Root Test Results (ADF)
Note: the variables, INF and InM2 are not stationary at level. However, they become stationary at order 1. INF is stationary at both 1% and 5% significance level respectively, while InM2 is integrated of order 1 at 5% and 10% threshold value respectively.

4.2. Estimation of the Long-Run Relationship

Engle-Granger cointegration test results are estimated in Tables 3. As shown in Table 3, the outcome of the residual based unit root test conducted using Augmented Dickey Fuller (ADF) shows the t-statistic -3.132841 is less than the critical value of -2.943427 at 5% level of significance. With this, we reject the null hypothesis of no cointegration. In other words, the estimation results clearly suggest a long-run relation between money supply and inflation in Nigeria. The unit root test findings on the residuals shows that the residual term is stationary at level, a strong evidence of existence of cointegration between the two variables. This outcome corresponds with the finding of Uddin et al. (2019) that found long-run relation between money supply and inflation in Bangladesh, a developing country like Nigeria.

Variables	Critical values			t-stat
	10%	5%	1%	
Residuals	-2.610263	-2.943427	-3.621023	-3.132841*

Table 3: Residual Based Unit Root Test Result
*Note: * indicates significance at 5% level.*

4.3. Error Correction Mechanism (ECM) and Short-run Regression

The results of the ECM are a depiction of the model in equ. 3. The estimated outcome in Table 4 shows both short-run and long run relationships. ΔInM2 has a p-value of 0.014, which is significant at 5% threshold value. It implies that in the short-term, variations in stock of money have a positive and significant impact on inflation in Nigeria. This confirms the monetarists' view that inflation is determined by the quantity of money supply available to the economy. The Nigeria's case tends to adhere to the theoretical underpinning of the monetarists. The findings also indicate a long-run link between the two variables. The adjustment coefficient, -0.41 as presented in Table 4 is rightly signed and significant, the p-value 0.03< 0.05. It suggests that a long-run convergence to equilibrium is attained between the two variables after exogenous shock. In other words, 41 % of the deviation from equilibrium is corrected annually. It also follows that the ECM estimates are proof of long-run relationship as shown by the residuals of equ. 2.

Table 5 shows the OLS estimated results of short-run association between M2 and INF. From the Table, the p-value 0.0089< 0.05 signifies that broad money (M2) has a positive and significant impact on inflation in Nigeria. The coefficient of determination, R^2 of 0.179 shows that approximately 18% change in inflation rate is statistically explained by money supply (M2), the balance 82% is caused by other factors not captured in the model. The DW stat, a first order autocorrelation of approximately 2 is an indication of no auto-correlation. The constant, C is inversely related to INF and significant. It then means that in the short-run, inflation rate is statistically reduced by 11% when money supply is 0. In addition, inflation rate tends to be negative without the M2 as depicted by the value of C, approximately -11% in both

Tables 4 and 5. This speaks more of the significant impact broad money has on inflation in Nigeria The findings empirically support the view of the monetary economists that money supply is a major drive of inflation. The positive relation between money supply and inflation as found by this study aligns with the outcome of Waingade (2011) as regards money supply and inflation in India.

Variable	Coefficient	Std. error	t-Statistic	Prob.
C	-10.55259	3.616083	-2.918238	0.0062
ΔlnM2	51.17670*	18.86343	2.713012	0.0104
ECT(-1)	-0.414367	0.187576	-2.209065	0.0340
R-squared	0.37998			
Adjusted R-squared	0.343514			
F-statistic	10.41872			
Durbin-Watson stat	1.638379			
Prob(F-statistic)	0.000296			

Table 4: The Results of Error Correction Model
*Note: * indicates significance at 5% level.*

Variable	Coefficient	Std. error	t-Statistic	Prob.
ΔlnM2	54.38156	19.63014	2.770309	0.0089
C	-11.19685	4.588422	-2.440240	0.0199
R^2	0.179			
Adj. R^2	0.156			
F-stat	7.674			
Durbin-Watson stat	1.786962			

Table 5: Ordinary Least Square (OLS): Short-run Link between M2 and Inflation Rate

4.4. Granger Causality Test

The findings of the causality estimation as shown in Table 6 indicates a uni-directional causality between InM2 and INF. The p-value of 0.0497 < 5% level of significance suggests that InM2 granger causes INF. The result is a strong indication that broad money is one of the monetary factors that drives inflation rate in Nigeria. The finding contradicts the result of Uddin et al. (2019) that found a bi-directional relation between money supply and inflation in Bangladesh.

Null Hypothesis	Observation	F-Statistic	Prob.
INF does not Granger Cause InM2	36	1.83078	0.1772
InM2 does not Granger Cause INF	36	3.31203	0.0497*

Table 6: The Results of Granger Causality Test
** indicates H_0 rejected at 5% level of significance. And the lag length is 2.*

5. Conclusion

In view of the recent rise in inflation in Nigeria, the paper adopted recent datasets to investigate the relationship between money supply and inflation over the period, 1981 to 2018. Our findings indicate a long-run relation between money supply and inflation in Nigeria. Money supply also exerts a positive and significant impact on inflation in the short-run as confirmed by the short-run regression and the ECM results. The outcomes suggest that broad money has a strong impact on inflation in Nigeria in the short-term. This is evidenced by the negative relationship shared between the intercepts and inflation in the short-run, implying that inflation would decline by 11 per cent, if money supply is zero. Convergence to long-run equilibrium exists after exogenous shock, meaning that it will take 2 years and 5 months to attain long-run equilibrium from the year the diseqilibrium occurred. Our findings also indicate that a uni-directional causality is found from broad money to inflation. In view of our findings, we suggest that the Central Bank of Nigeria (CBN) can effectively use money supply (broad money) to control increasing inflation rate in the economy albeit short-term. Such a monetary measure would achieve the intended objectives, if the prevailing economic condition is such that requires monetary policy measures and not fiscal disciplines. Moreover, to effectively control the general price level in the economy using money stock, money in the informal sector not accessed by banks should be reached by the financial institutions through the CBN's robust monetary policies.

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Appendix

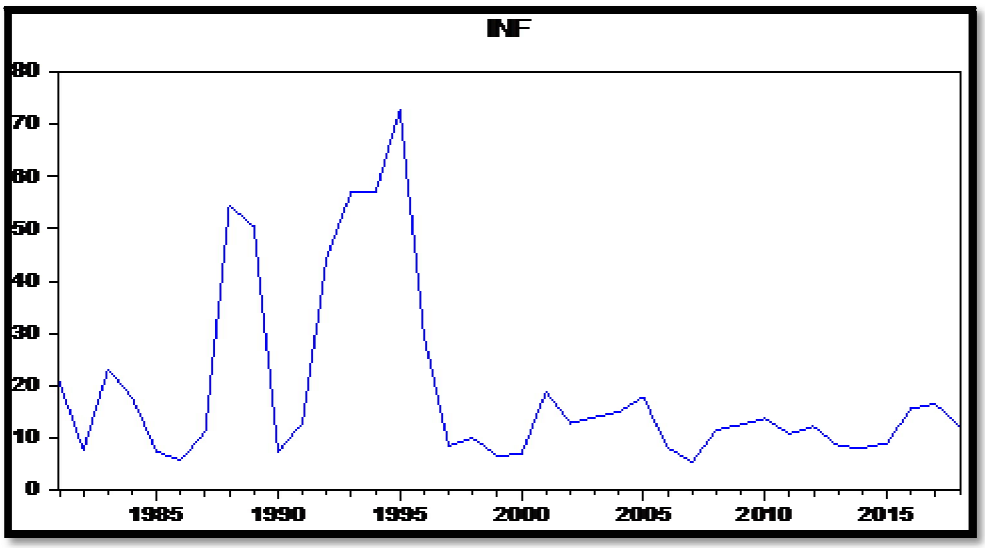

Figure 1: Level Series INF

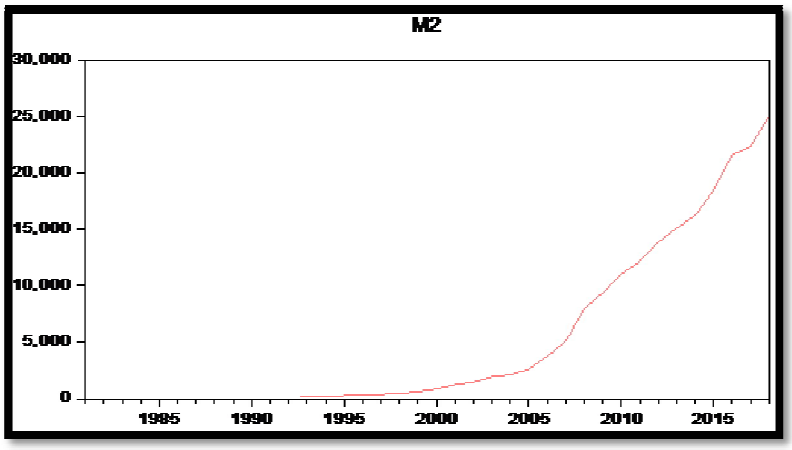

Figure 2: Level Series M2

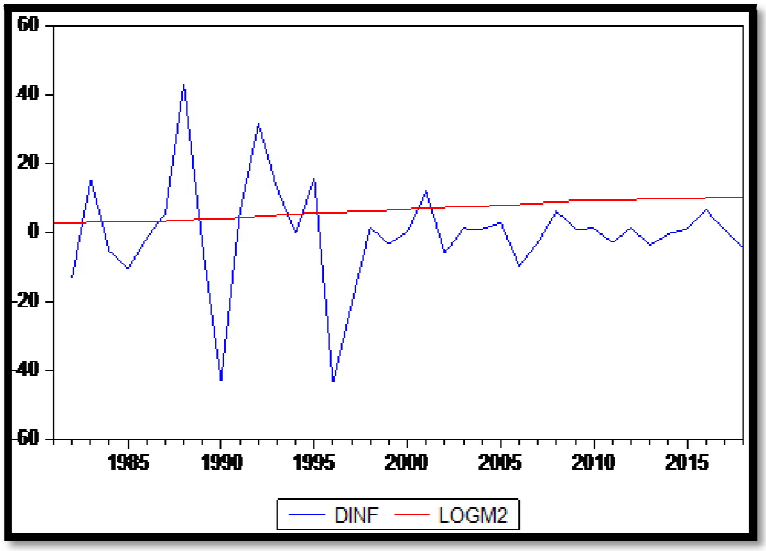

Figure 3: Diff. INF and LogM2