Analysis of Monetary Policy Channels on Inflation Condition: Experience from Nigeria

Yusuf Hamza Umar and Zunaidah Sulong

Faculty of Economics and Management Sciences, Universiti Sultan Zainal Abidin, Gong Badak Campus, 21300 Kuala Nerus, Terengganu, Malaysia

Abstract: Despite the various monetary regimes that have been adopted by Central Bank of Nigeria over the years, inflation has still become a major threat to Nigerian economy. The monetary policy also persistently failed to meet the stipulated monetary target of the Nigerian economy due to the existence of largely non-monetized sectors and most of the people live in rural areas. The objectives of the paper are as follow: (1) to identify the channels of monetary policy on inflation condition in Nigeria; (2) to identify the dynamic co-integration relationship between monetary policies on inflation condition in Nigeria. The theoretically underpinning of this study is based on the Monetary Growth and Structural Rigidity theories. The Autoregressive Distributed Lag (ARDL) model has been used by utilizing annual data covering the period of 1973 to 2013. The empirical results indicate that in the long-run, the exchange rate channel of monetary policy is highly dominant in explaining the inflation condition in Nigeria. While in the short-run, the interest rate channel of monetary policy transmission mechanisms is highly dominant in explaining the inflation condition in Nigeria. Overall results derived from the study are also in consistent with Keynesian monetary transmission theory, which argued that monetary policy operates effectively through the traditional interest rate channel. Finally, the study recommends that exchange rate and interest rate channels of monetary policy should form the basis of two leading indicators for the future inflation targeting in Nigeria.

Key words: Autoregressive Distributed Lag (ARDL) model · Monetary policy · Structural Rigidity theories

INTRODUCTION

The monetary authorities around the world alter their monetary policy instruments in an attempt to achieve their ultimate objectives such as price stability and sustainable economic growth. Despite various monetary regimes that have been adopted by Central Bank of Nigeria (CBN) over the years, inflation has still become a major threat to Nigerian economy. The monetary policy also persistently failed to meet the stipulated monetary target of the Nigerian economy due to the existence of largely non-monetized sectors and most of the people live in rural areas. Inflation can be seen as the sustained increase in the general price level of goods and services rapidly and persistently over a period [1].

Moreover, monetary policy is defined by the Central Bank of Nigeria as combination of measures designed to regulate the money supply, interest rate in an economy, in line with the level of economic activities [2]. It is a course of action embarks upon by the monetary authority (Central Bank) to regulate the money supply and credit condition in order to achieve macroeconomic objectives. The monetary policy is concerned with the regulation of the money supply, interest rate in order to influence key macroeconomic indicators such as inflation, unemployment, in the desired direction [3].

Therefore, monetary policy can be expansionary or contractionary. Expansionary or easy monetary policy is designed to combat a recession or depression or a deflationary gap. When the consumers demand for goods and services as well as the business demand for investment goods reduced, deflationary gap occurs. The central bank embarks on an expansionary monetary policy; it increases the velocity of the money supply in circulation that eases the credit market conditions and leads to an upward shift in aggregate demand. However, the central bank buys the financial securities in the open market; it will also lower the reserve requirements of
member banks, lowers the discount rate or the rate at which the central bank rediscount the interest charges to commercial bank and encourages consumer and business credit through selective credit measures. By doing that, it will decrease the cost and availability of credit in the money market and improves the economy.

Despite the various monetary regimes that have been adopted by Central Bank of Nigeria over the years, inflation has been a major threat to Nigerian economic growth [4]. Nigeria has been experiencing high degree of volatility in inflation rates; the growth of the money supply is correlated with high inflation episode because money growth is often in excess of real economic growth. Hence, the purpose of this study is to investigate the dynamic co-integration relationship between monetary policy on inflation condition in Nigeria; and the causal direction between monetary channels and inflation condition in Nigeria. Overall, the paper is divided into five sections with this introduction serving as section 1. Section 2 presents the empirical literature review, whilst the methodology used for the study formed the contents of section 3. The empirical findings and discussion are presented in section 4. Lastly, conclusion is presented in section 5.

Empirical Literature Review: The various empirical studies reviewed here show mixed results and conclusions. In some studies, strong positive relationships are found to exist and in some the relationships are weak. Other researchers report different results. The study started with the work of Neuenkirch [5] who studied the monetary policy transmission in vector auto-regressions: A new approach using central bank communication. Where he found out that communication determines the inflation (anticipations) the same to that of actual target rate changes. It also plays a noticeable role in the transmission of monetary policy to output; monetary policy transmission should incorporate both a short term interest rate and a communication indicator. However, the monetary policy transmission mechanism changed during financial crisis as the overall impact of monetary on anticipated inflation and output remains weaker and shorter especially during this period compared to the overall sample period. Communication improves the management of expectations about future interest rates, giving its importance in the transmission process and its impacts on inflation and inflation expectations.

Prachi M. et al. [6] surveyed how effective is monetary policy transmission in low-income countries where they found out that monetary tightening (an increase in required reserves) resulted in a contraction in bank credit that was accompanied by slower growth and lower inflation, the economic stabilisation problem in developing economies indeed and enumerating the ways of revitalising the effectiveness smooth working of monetary policy in such economies. The current literature reveals that low-income countries are characterised with the inconsistency in their channels of monetary policy transmission mechanisms and frequent market failure which affect the channel of monetary transmission in low-income countries adversely. Nigeria is not in exception in the transmission process, as a low-income economy; the only channel that works in Nigeria is interest rate channel which affects the productive activities in the country.

Uluc Aysun et al. [7] identified the balance sheet and the lending channels of monetary transmission: a loan-level analysis. They found out that the balance sheet channel of monetary policy transmission is the main and effective channel which monetary policy shocks are transmitted to the economy and that the lending channel play a significant role not in this regard. However, the monetary policy tightening, leads to the lending spreads to the customers which are more sensitive to borrower leverage for the monetary policy measures and that this channel of monetary policy transmission mechanism is considered as very significant in influencing the economic activities. There exists a positive relationship between lender liquidity and lending spread of monetary policy tightening. Monetary transmission operates through balance sheet channel and that the positive coefficient suggests that a monetary tightening has a larger positive impact on the lending spreads of banks that have a higher liquidity ratio. If monetary policy is effective, which is measured broadly using balance sheet channel in addition to the more common lending channel measures; monetary policy that operates through the broad credit channel is still effective.

The current literature reveals that Monetary policy affects the level of bank lending to borrower balance sheets, since there is a weak balance sheet position of borrower, which consequently increases the lending spread on a bank loan more under tight than under loose monetary policy. In Nigerian context, the credit channel of monetary policy transmission mechanism is very weak due to the increase in the rate of interest rate; the level of investment is not favourable due to the depressed atmosphere for investment due to increase in interest rate. Matteo C. et al. [8] examined a new look at the credit channel of monetary policy using the trusting the bankers
approach. They found out that credit channel amplifies a monetary policy shocks on GDP and prices through the balance sheets of households, firm and banks. For corporate loans, amplification is highest through the bank lending and the borrower's balance sheet channel; for household demand is the strongest channel. The current literature reveals that the credit channel of monetary policy is the most prominent channel of transmission, unlike in Nigeria where the interest rate channel of monetary policy is the dominant channel to reduce the inflationary trends of the economy. The response of the interest rate is very small in magnitude and statistically insignificant in every case.

Moreover, Bhattacharya [9] examined the inflation dynamics and monetary policy transmission in Vietnam using Vector autoregressive (VAR) model and found out that lagged GDP growth and lagged movements of the nominal effective exchange rate, had an important impact on headline inflation in Vietnam, unlike in other emerging Asian countries in the region. This means that Vietnam has high rate of inflation caused by slower movements of nominal exchange rate and GDP growth compared to Asian countries because prices of important commodities such as rice, cement, urea fertiliser and steel for construction were liberalised to a great extent 2002-2004. Moreover, these periods also witnessed growing use of open market operations as well as liberalisation of interest rates on dong deposits and on dong and foreign currency lending. Simon et al. [10] employed the structural vector autoregression (SVAR) in order to separate monetary and structural causes of inflation in Ghana; they found out that structural factors explain more of the inflation dynamics in Ghana than the monetary factors.

While the structural shocks take a longer time to decay, monetary shocks dissipate quickly over a shorter period. Similarly, Georgios G. [11] quantified the importance of financial structure, labour market rigidities and industrial mix for the monetary transmission mechanism in Germany using vector-autoregressive (VAR) models and a non-standard panel VAR model match. He found out that the impulse responses vary across countries in an unrestricted way. However, the panel VAR models, as well as the impulse responses vary across countries but, only differed based on the financial structure of the countries, labour market rigidities and industrial mix. Nevertheless, short run asymmetries in the output responses of output happened mainly because of cross-country barriers in industrial mix, in the medium run difference in financial structure and labour market rigidities are of paramount. Cross country barriers asymmetry in the monetary policy transmission mechanisms tend to appear very negligible to prices.

The current literature reveals that a tentative decomposition of the results shows that in the short run cross-country asymmetries in the output responses arises mainly because of the barriers in the industry mix and also in the medium run differences in financial structure and labour market rigidities gain more importance in the economy. The transmission of monetary policy to real activities first work through the interest rate channel and then gets amplified through credit channel effects and other frictions such as labour market rigidities. Credit channel of monetary policy strengthening the firms dynamics and monetary policy transmission in Vietnam to reduce the prices in the presence of adjustment costs such as those caused by labour market rigidities. In Nigerian context, the reverse is the case regarding the monetary policy transmission channels, where interest rate plays a pivotal role in the transmission process unlike in German economy.

Adeoye et al. [12] examined the monetary policy frame work and pass through in Nigeria where they use vector autoregressive framework to capture the two-way relationship between shocks and other variables used and their related lags. The result shows that there is a close relationship between the bank credit and aggregate demand which suggests stronger monetary transmission system via-credit channels and investment multiplier in Nigeria. The current literature emphasised the credit channel of monetary policy transmission as the most viable way of yielding a great impact on aggregate demand neglecting other channels such as interest rate, exchange rate and assets price channel. 74 Jeon and Ji [13] examined the role of foreign banks in monetary policy transmission: evidence from Asia during the crisis of 2008-2009. The study found out that when there is an increase in the foreign bank patronisation, which will weaken the effectiveness and smooth running of the monetary policy transmission mechanism in the host emerging Asian economies during crisis periods mentioned above.

However, the reliance of parent banks on the wholesale funding market, the country that has the foreign banks and entry modes under which the effectiveness of monetary policy transmission is decreased enormously due to the increase in the presence of foreign banks in the emerging Asian banking sectors. The current literature reveals that the presence of foreign banks destabilise the Asian economy, despite the
The current literature reveals that monetary policy growth influences the demand for housing in an economy; the implications of monetary policy are non-trivial. For informally employed households, monetary growth and the demand for housing are positively related as long as the housing finance markets are developed well enough. In Nigerian context, there is inverse relationship between demand for housing and the rate of monetary growth because of institutional weakness to facilitate the raising demand for housing due to pervasive nature of corruption and indiscipline. Similarly, W. Maureen et al. [16] examined the effectiveness of monetary policy in Kenya: using evidence from macroeconomic model. They found out that changes occur in the policy rate which is very effective in affecting the short term interest rates and the long term lending rates respond, but marginally. Moreover, when there is change in the CBR, it has a significant effect on the inflationary trend while a change in CRR has a relatively larger impact on aggregate demand but not as much as CBR. When promoting the effectiveness of the CBR and strengthening of the interest rate channel, there is probability of anchoring inflation expectations and boosting the effectiveness of monetary policy transmission mechanism in Kenya. Policy rate has a strong effect on the short term rates, that is the interbank and the TBR.

On the other hand, the lending rate appears to respond marginally, in general comparing the average effect of the policy shock on domestic interest rates during the first year, it is clear that the effect is highest at the short end of the market as would be expected. Ibrahim F. et al. [17] analysed the effects of monetary policy on the REIT returns: evidence from the United Kingdom. They found out that monetary policy environment is supposed to affect, on one hand, the REIT returns and, expansionary monetary policy has an impact only in the case of boom market. However, an increase in the inflation rate decreases the probability of remaining in the bust regime. Monetary policy transmission mechanism showed that house prices to have important effects on aggregate demand and the REIT markets are not efficient. Jain-Chandra [18] examined the effectiveness of the monetary policy transmission mechanism under capital inflows: evidence from Asia using a dynamic factor model and a structural vector auto regression model. They found out that long term interest rates in Asia are indeed predominantly through short term interest rates.
However, the monetary transmission mechanism, though effective, is somewhat weaker in Asia during the periods of surges in capital inflows. The large capital inflows will weaken the link between changes in the policy rates and bank lending rates; the monetary policy transmission mechanism from short term rate of interest rate and the long term are high, both in the short term and in the long term. Likewise, the pass through coefficients even under large capital inflows is very strong. The current literature reveals that the policy interest rate is the powerful macroeconomic instrument in macroeconomic stabilisation in Asia. Similarly, in Nigerian context, policy interest rate remains the most powerful instrument in the process of monetary policy transmission mechanism process. Despite the fact that Nigerian economy is structurally unbalanced with heavy reliance on crude oil, which serve as the main and powerful source of foreign exchange earnings and there exist a deplorable state of infrastructural facilities which will affect the channels of monetary policy transmission mechanisms to be very weak.

Mahdi [19] examined the transmission of US monetary policy into the Canadian economy: A structural co-integration analysis using Canada and US and he found out that interest rate- path-through is the prominent tool by which US monetary policy shocks are transmitted into the Canadian economy. However, the responses of the US macroeconomic indicators to the same degree of shock: after the era of US contractionary monetary policy shock, output falls very quickly and indicates a U-Shaped response, inflation decreases but with the delay, short term interest rate increases tremendously and then gradually declines and long-term interest rate increases for one year and then gradually declines. The impulse response functions are sensitive to the lag structure. The current literature reveals that there is strong linkage between US economy and the Canadian and the latter depends on the former for economic, political and social factors. Similarly, in Nigeria, our economy is vulnerable to the vagaries of external shocks due to the import orientation syndrome. Still Canadian economy is among the developing category, the same with Nigerian counterparts.

Hasin and Abdul Majid [20] examined the economic role of the Islamic banks in the monetary policy transmission mechanism in Malaysia using autoregressive distributed lag (ARDL), the study revealed that the Islamic financing channel for monetary policy transmission ensues in Malaysia. Islamic financing is unequally distributed to different economic sectors in response to monetary policy volatility. However, the findings also revealed that Islamic banking as operating in dual banking system is not spared from the interest rate and monetary conditions of the country. This show that the behaviour of Islamic banking which cannot run away from the interest rate, while its operation run away from the interest rates. The current literature reveals that monetary policy transmission mechanism work effectively through different channels of monetary policy, such as interest rate, exchange rate, credit and assets price channel.

Methodology: This section deals with the theoretical framework of the study, where focus has been made on the two schools of thoughts which discussed deeply the causes of inflation. Therefore, the study used them as the basis for the theoretical underpinning of the research. However, the research hypothesis of the study has been enumerated. The data are sourced from the World Bank development indicators. Autoregressive distributed lag (ARDL) has been used to analyse the data. The reasons why the study uses ARDL are: ARDL is used to capture small observation data. I.e. if your data is 30 years and above, it is the suitable framework to be used [21]. ARDL can also be used to capture the long run and short run simultaneously, unlike other models. When variables I (0) and I (1) are mixed, ARDL is the suitable framework to be used [21].

Theoretical Framework: The basic theoretical framework is the monetarist’s theory of inflation.

Monetarists’ Theory: The monetarists contend that money is the principal cause of demand pull inflation. They contend that inflation is always a monetary phenomenon. They used a simple quantity theory of money as follows:

\[ MV = PQ \]

where; 
M stands for money supply, V stands for the velocity of money, P stands for the price level and Q stands for the level of real output.

Suppose V and Q remain constant, the price level (P) changes proportionately with the supply of money (M). With flexible wages, the economy was assumed to be at
full employment where the productive resources are employed. The factors of production change but very slow over time. Moreover, the money that will be spent did not affect the level of productivity, the amount of money that will be used will double the price level of goods and services. When the price increase by this proportion, individuals and business firms can have enough money which they can spend and this will lead to the rise in prices. Inflation emanates at the same proportion in which the money supply increases [22]. Based on this preposition, the aggregate supply is presumed to be fixed.

However, the economy is assumed to operate at full employment. Ideally, when the money supply increases, it creates more demands of commodities, as a result the supply of goods and services cannot be increased due to the fact that economy operates at full employment of resources. This leads to rise in prices, but it is a continuous and prolonged rise in the money supply that will lead to true inflation. According to Friedman, inflation is always and everywhere a monetary phenomenon which emanates when there is tremendous increase in money supply than in output. He opined that variations in the quantity of money in circulation work in order to cause changes in nominal income. Inflation everywhere is assumed to be as a result of an increased in the demand for goods and services, i.e., when people try to spend their cash balances. The demand for money is assumed to be fairly stable; this excess spending is as a result of an increase in the nominal quantity of money supplied to the economy. Therefore, inflation is considered as always a monetary phenomenon.

Moreover, Freidman argued that if an increase in money supply will go first into output or prices. Initially, there is monetary expansion; the nominal income of the people tends to increases. Its immediate chain reaction is to increase the demand of goods and services; this will definitely increase the demand for labour by employers of factors of production. Workers will settle for higher wages, Input costs and prices will rise. Profit margins will be drastically reduced and the prices of products will increase. In the beginning people are reluctant; do not anticipate the prices of goods and services to continue increasing. They regard the price increase as temporary and anticipate prices to fall later on. However, they tend to increase their money holdings and the price increase is less than the proportionate increase in nominal money supply. Gradually, people will try to readjust their money holdings, Prices then will increase more than proportionate increase in the velocity of money supply.

The exact rate at which prices increase for a given percentage of increase in the money supply depends on such factors as past price behaviour, current changes in the structure of labour, product markets and fiscal policy. Thus, according to Friedman, the monetary policy expansion works through output before inflation starts. Based on the above preposition, it can be seen that velocity of money supply (M) has direct relationship with price level; in Nigeria the reverse is the case, there are simultaneous existence of unemployment, inflation and deteriorating terms of trade.

These problems make the implementation of monetary policy ineffective. However, inflation occurs due to the increase in the cost of production which reflects in the price of goods and services, frequent increase in the price of fuel, growth in money politics, rise in population etc. Sometimes, Nigeria faces two macroeconomic problems simultaneously; that is Inflation and unemployment (stagflation).

**Structural Theory of Inflation:** The structural school of thought of South America stresses the structural rigidities as the principal cause of inflation in developing countries. When the economy develops, rigidities tend to occur which will lead to structural inflation. Initially, there are increases in non-agricultural incomes accompanied by high growth rate of population that tend to increase the demand for goods [22]. The structural factors are managerial, technological, infrastructural deficiency and climate change. Based on this literature, we can see that institutional weaknesses are the important cause of inflation such as managerial, technological, infrastructural deficiency and climate change. The increase in the population growth and rising urban incomes would tend to increase through a process of chain reaction mechanism, first and foremost the prices of agricultural goods, second the general price level and third the wages paid to the labour.

When the demand for agricultural goods increase, their domestic supply remained inelastic, the prices of agricultural goods will subsequently increase. The quantity of these goods and services do not increase if their price increases because their production is inelastic as a result of defective system of land tenure and other problems. However, lack of irrigation, finance, storage and
marketing facilities and bad harvests affects it adversely. To safeguard the continues increase in the prices of agricultural products especially food based products, that can be imported in large quantities due to the problem of exchange rate volatilities, the prices of imported products are relatively higher than their domestic prices. This tends to raise the price level upward in the economy, when there is increase in the price of food items, wage earners demands for the increase in their wage rates in order to compensate for the fall in their real incomes. But wages are directly proportionate to the cost of living index, they are, therefore increase.

Whenever the cost of living index rises above an agreed point, it will further increase the demand for goods and a further rise in their prices. But in Nigeria infrastructural deficiency is the major cause of inflation such as prevalence of power supply failure, frequent increase in the price of fuel, rise in population which is not accompanied by increase in the available resources and poor commitments of government to agricultural policies. Therefore, structural rigidity theory of inflation will be applicable to Nigerian inflationary trend and should be used as the basis for theoretical framework.

Model Specification:

\[ CPI = F (M2, EXR, LR) \]  

where CPI = consumer price index, M2 = Money supply, EXR = exchange rate.

The above equation can be transformed to natural logarithm in order to allow for log-linear specification for empirical analysis. It can be written below as:

\[ \ln CPI_t = \alpha_0 + \alpha_1 \ln M2_t + \alpha_2 \ln EXR_t + \alpha_3 \ln LR_t + \mu_t \]  

where \( \ln CPI_t \) is the natural log of consumer price index, \( \ln M2_t \) is natural log of money supply, \( \ln EXR_t \) is natural log of exchange rate, \( \ln LR_t \) is natural log of Lending rate and it is residual term assumed to be white noise. The reason why the study converts the variables into natural logarithm stems from the fact that the large values of the variables under the study are reduced into small ones.

Unit Root Test: Macroeconomic time series data are considered to be characterized by stochastic trend which can be removed by differencing. Thus, the study will use or adopt Augmented Dickey-Fuller (ADF) (1979) and Phillips Perron (PP) techniques to test and verify the unit root property of the series and stationery of the model. If the unit root tests find that a series contain one unit root, the right way of transforming the data is by differencing the variables prior to their inclusion in the regression model, but this incurs a loss of important long-run information. Unit root is the formal way to test the stationarity of a series. Nelson and Plosser [23] opined that almost all time series macroeconomic data typically have a unit root. Hence, by taking first differences the null hypothesis of non-stationary of series is rejected for most of the variables. Unit root tests are essential in investigating the stationarity of a time series because non-stationary series invalidates many empirical researches results and hence requires special treatment. Granger and Newbolt [24] have found by simulation that the F-statistic calculated from the regression involving the non-stationary time-series data does not follow the Standard distribution.

Alternatively, if the variables are co-integrated, that is, if a long-run relationship exists among the set of variables that share similar non-stationary properties, regression involving the levels of the variables can proceed without generating spurious results.

Bound Test: To examine the existence of long-run relationship among variables, the study adopts bound testing approach and Autoregressive distributed lag (ARDL) model for co-integration test. However, Pesaran et al. [25] argued that F- bounds on the critical values for the asymptotic distribution of the F-statistic, for different situations (e.g., different numbers of variables, (A + 1), give lower and upper bounds on the critical values. In each case, the lower bound is based on the assumption that all of the variables are I (0) and the upper bound is based on the assumption that all of the variables are I (1). In fact, the truth may be somewhere in between these two polar extremes. If the F-statistics exceed their respective upper critical values at any lag-length, it implies that there exists the long-run relationship among variables and vice-versa [26, 27].

Long Run and Short Run: The Error Correction Model was introduced by Sergan [28] and later perfected by Engle and Granger [29]. It is used to correct disequilibrium and testing for long and short run causality among co-integrated variables. Basically, ECT has four advantages.
First, it is a comfortable way of measuring the correction from disequilibrium in the previous time period, hence allowing for a meaningful economic interpretation. Secondly, in the presence of co-integration, the first difference specification of the ECT helps to eliminate the trends from variables thereby removing the problem of spurious regression. Third, the ECM can very easily be adapted in a general-to-specific econometric modeling process. This is actually the most parsimonious ECT which gives the best fit to the data. Fourth, the disequilibrium error term is a stationary variable given co-integration. An important implication of this is that there exists some adjustment process which minimises errors in a long-run relationship.

ARDL model deals with single co-integration and is introduced originally by Pesaran and Shin [21] and further extended by Pesaran et al. [25]. Therefore the model is:

\[
\Delta \text{ln}c_{i,t} = \alpha_{i} + \sum_{j=1}^{n} \theta_{j}\Delta \text{ln}c_{i,t-j} + \sum_{k=1}^{m} \beta_{k}\Delta \text{ln}y_{i,t-k} + \sum_{l=0}^{p} \gamma_{l}\text{ln}x_{i,t-l} + \text{error terms}
\]

where: \(\Delta\) is the first-difference operator and the constant is the coefficients on the trends are \(\beta_{j}\), \(\beta_{k}\), \(\beta_{l}\), and \(\beta_{m}\). The \(\theta_{j}\), \(\theta_{k}\), \(\theta_{l}\) and \(\theta_{m}\) represent the lagged dependent and independent variables respectively, \(\epsilon_{i}\) is error terms and the \(n\) represents the maximum lag length that is decided by the lag selection.

RESULT AND DISCUSSION

Unit Root Test for Stationarity: Unit root is the formal way to test the stationarity of a series. Nelson and Plosser [23] opined that almost all time series macroeconomic data typically have a unit root. Hence, by taking first differences the null hypothesis of non-stationarity of series is rejected for most of the variables. Thus the significance of the test is overstated and a spurious result is obtained. The presence of a stochastic trend is determined by testing the presence of unit roots in time series data. In order to determine whether the macro economic variables are stationary or otherwise, unit root tests are conducted if non-stationary at levels, we then go ahead to determine the order of integration. The econometric model assumes non-stationary of the series, it is necessary to test whether the series are stationary or not. Time series data exhibit non-stationarity of data, hence, there is need for making them to be stationary.

The result of the Augmented Dickey-Fuller and Phillips Perron unit root test presents in Table 1, shows that the variables employed in this research are not all stationary at levels; only lnM2 is stationary in both Augmented dickey-fuller and Phillips perron unit root test. However, in both intercept and intercept and trend only lnM2 is stationary at levels or I (0). Therefore, the conventional null hypothesis or econometric theory that said time series data are not stationary is rejected here. Unit root tests are essential in investigating the stationarity of a time series data because non-stationary series invalidates many empirical research results and hence requires special treatment [24]. The unit root result derived above is in line with the Girma [30].

The result of the Augmented Dickey-Fuller and Phillips Perron unit root test presents in Table 2 shows that the variables employed in this research are all stationary at first difference. The variables must be stationery at first difference as far as ARDL is concerned [31]. Both in ADF and PP the variables are stationery at first order, which justifies that the study will use ARDL [31]. Because non-stationary series invalidates many empirical research results and hence requires special treatment. The unit root results are in line with the findings of Duasa [32] and Ozofere [33].

Lag Selection: The selection of lag length is based on statistical information criteria. The Schwarz information criterion and Hannan-Quinn information criterion are prone to selection of lag 1, while the Akaike information criterion, Final prediction error and sequential modified LR test statistic suggest lag length of 2, at low lag lengths; however, the errors are serially correlated.

Table 3 presents the selection of lag length research criteria which is based on Schwarz information criterion. The study chooses lag 1, the reason why the study chooses SIC criterion is that the SIC formula, appears to be superficially very simple; its derivation is well founded on information theory. SIC performs better than others [33]. SIC can also be used when hypothesis is valid for
## Table 1: Results of Unit Root Test on Levels

<table>
<thead>
<tr>
<th>Variables</th>
<th>Augmented Dickey fuller</th>
<th>Phillips Perron</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Intercept and Trend</td>
</tr>
<tr>
<td>lnCPI</td>
<td>-1.261</td>
<td>-1.603</td>
</tr>
<tr>
<td>lnEXR</td>
<td>-0.522</td>
<td>-1.395</td>
</tr>
<tr>
<td>lnLR</td>
<td>-1.581</td>
<td>-1.088</td>
</tr>
</tbody>
</table>

Note: The asterisks ***, ** and *, imply 1% and 5% and 10% levels of significance, respectively.

## Table 2: Results of Unit Root Test on First Differences

<table>
<thead>
<tr>
<th>Variables</th>
<th>Augmented Dickey fuller</th>
<th>Phillips Perron</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Intercept</td>
<td>Intercept and Trend</td>
</tr>
<tr>
<td>lnCPI</td>
<td>-3.170**</td>
<td>-3.278*</td>
</tr>
<tr>
<td>lnEXR</td>
<td>-5.166***</td>
<td>-5.106***</td>
</tr>
<tr>
<td>lnLR</td>
<td>-5.980***</td>
<td>-6.124***</td>
</tr>
<tr>
<td>lnM2</td>
<td>-5.129***</td>
<td>-5.128***</td>
</tr>
</tbody>
</table>

Note: The asterisks ***, ** and *, imply 1% and 5% and 10% levels of significance, respectively.

## Table 3: Lag Selection Criterion

<table>
<thead>
<tr>
<th>Lag Length</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SIC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-107.696</td>
<td>NA</td>
<td>0.004</td>
<td>5.879</td>
<td>6.051</td>
<td>5.940</td>
</tr>
<tr>
<td>1</td>
<td>71.962</td>
<td>312.038</td>
<td>7.67e-07</td>
<td>-2.735</td>
<td>-1.873*</td>
<td>-2.428*</td>
</tr>
<tr>
<td>2</td>
<td>91.687</td>
<td>30.106*</td>
<td>6.50e-07*</td>
<td>-2.931*</td>
<td>-1.379</td>
<td>-2.379</td>
</tr>
<tr>
<td>3</td>
<td>105.187</td>
<td>17.766</td>
<td>8.02e-07</td>
<td>-2.799</td>
<td>-0.558</td>
<td>-2.002</td>
</tr>
</tbody>
</table>

Note: The asterisk * indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SIC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The asterisks ***, ** and *, imply 1% and 5% and 10% levels of significance.

Both nested and non-nested models, when comparing models with different error distribution and also to avoid multiple testing issues. Therefore SIC is the most accurate criterion for all realistic sample sizes. However, at lower lag the errors are minimized [34]. The choice of SIC criterion is also in consonance with the work of Khan et al. [35].

The ARDL F-Bound Test: Pesaran et al. [25] argued that F-bound on the critical values for the asymptotic distribution of the F-bound, for different situations (e.g., different numbers of variables, (A + 1), give lower and upper bounds on the critical values. In each case, the lower bound is based on the assumption that all of the variables are I (0) and the upper bound is based on the assumption that all of the variables are I (1). However, in order to examine the existence of long-run relationship among variables, the study adopts bound testing approach and ARDL model for co-integration test. If the F-bound exceeds their respective upper critical values I (1) at any lag-length, it implies that there exists the long-run relationship among variables and vice-versa [26, 27].

Table 4 shows the computed F-bound for lnCPI as dependent variable stands as 4.412; it exceeds the upper boundary at 1%, level of significance. The computed F-bound is very significant at 1% level of significance. It means that there exists a long run relationship between lnCPI, lnEXR, lnM2 and lnLR in Nigeria. The F-bound null hypothesis which said that there are no relationships between inflation, exchange rate, Money supply and lending rate, is conclusively rejected at 1% level of significance. The optimum lag is (1, 1, 1, 0), the diagnostic test shows that there is no serial correlation, no heteroschedasticity, which means the co-integration relationship, exists among variables and the model is good for the study. The results of the above F-bound test are in line with the Joseph and Fosu [36, 37].
Table 4: F-Bound Test Table

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>InCPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum Lag</td>
<td>(1, 1, 1, 0)</td>
</tr>
<tr>
<td>F-Statistics</td>
<td>4.412***</td>
</tr>
<tr>
<td>Critical Values</td>
<td>1%</td>
</tr>
<tr>
<td>Upper Bound</td>
<td>4.37</td>
</tr>
<tr>
<td>Lower Bound</td>
<td>3.29</td>
</tr>
<tr>
<td>x2 SERIAL</td>
<td>0.291[0.593]</td>
</tr>
<tr>
<td>x2 NORMAL</td>
<td>3.7793[0.151]</td>
</tr>
<tr>
<td>x2 ARCH</td>
<td>1.8179[0.186]</td>
</tr>
</tbody>
</table>

Note: The asterisk ***, ** and * imply 1% and 5% and 10% levels of significance respectively.

Table 5: ARDL Long Run Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>T-Ratio[prob]</th>
</tr>
</thead>
<tbody>
<tr>
<td>InEXR</td>
<td>0.606</td>
<td>0.239</td>
<td>2.529[0.017]**</td>
</tr>
<tr>
<td>InM2</td>
<td>0.212</td>
<td>0.665</td>
<td>0.319[0.752]</td>
</tr>
<tr>
<td>InLR</td>
<td>1.5128</td>
<td>1.0948</td>
<td>1.382[0.177]</td>
</tr>
<tr>
<td>Dummy</td>
<td>0.389</td>
<td>1.0126</td>
<td>0.384[0.703]</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.119</td>
<td>2.544</td>
<td>-1.226[0.229]</td>
</tr>
</tbody>
</table>

Note: The asterisks ***, ** and *, imply 1% and 5% and 10% levels of significance, respectively.

**ARDL Long Run Relationship**: Table 5 presents the long run representation of ARDL, the estimated coefficients of the long-run relation show that lnM2 and lnLR do not have long run relationships with inflationary trend in Nigeria. Therefore, the lending rate (lnLR) and money supply do not reduce or increase inflation in Nigeria in the long run; the interest rate channel (lnLR) of monetary policy is not significant because it does not affect the consumer price index in Nigeria. While the exchange rate channel of monetary policy is found to be very significant in the sense that 1% increase in the exchange rate (lnEXR) causes inflation to increase by 60.6% percent in Nigeria. The dummy variable is a proxy of the transition of government from military regime to the civilian government as well as the impact of structural adjustment programme (SAP) on the monetary policy structure of the Nigerian economy. However, the dummy here is insignificant i.e. it does not show any relationship.

This is indication that exchange rate channel of monetary policy is dominant in explaining inflation condition in Nigeria. However, it will form the basis for inflation targeting in the long run. However, the Nigerian economy is bedeviled with the problem of inflation in the sense that Nigerian economy is structurally unbalanced with the heavy reliance on crude oil as the main source of foreign exchange earnings. However, due to the fact that the Nigerian economy is import oriented economy, exchange rate channel of monetary policy exerts high impact in transmission process in Nigeria. Therefore, the higher the exchange rate the higher the level of inflation in Nigeria. This result of positive relationship between exchange rate and inflation is in line with the results found by Muhammad Arshad Khan and Muhammad [38]. However, the positive relationship between exchange rate and inflation is also in consistent with the monetarists’ theory of inflation supported by Friedman. The higher the exchange rate, the higher will be the money supply and inflation also.

However, the result derives is also in line with K. Holod [39], in Bangladesh that the exchange rate channel of monetary policy gives more information about inflationary trend Bangladesh. Moreover, the result derived above is in line with Ifeakachukwu [40] who investigated the monetary transmission mechanism in Nigeria: a sectoral output analysis. He found out that the interest rate was most effective in transmitting monetary policy to agricultural and manufacturing sector, while exchange rate channel was most effective in building and Construction Company.

**ARDL Short Run Relationship**: Table 6 presents the short run representation of ARDL, the estimated coefficient in the short run. The error Correction term (ECT) estimates is -0.100(10%) is highly significant, has the correct signs (negative sign), less than one and very significant. It also implies a fairly low speed of adjustment to equilibrium after a shock of approximately 10% of disequilibria from the previous year’s shock converges back to the long-run equilibrium in the current year. Short run relationships exist among ΔlnCPI, ΔlnM2 and ΔlnLR.

2224
Table 6: ARDL Short-Run Test

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standards Error</th>
<th>T- Ratio[prob.]</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnEXR</td>
<td>-0.081</td>
<td>0.074</td>
<td>-1.093[0.282]</td>
</tr>
<tr>
<td>lnM2</td>
<td>-0.163</td>
<td>0.092</td>
<td>-1.782[0.084]*</td>
</tr>
<tr>
<td>lnLR</td>
<td>0.151</td>
<td>0.084</td>
<td>1.809[0.079]*</td>
</tr>
<tr>
<td>Dummy</td>
<td>0.039</td>
<td>0.099</td>
<td>0.391[0.698]</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.292</td>
<td>0.256</td>
<td>-1.139[0.262]</td>
</tr>
<tr>
<td>ECT-1</td>
<td>-0.100</td>
<td>0.036</td>
<td>-2.759[0.009]***</td>
</tr>
</tbody>
</table>

Diagnostic Test
- x2SERIAL: 2.938[0.097]*
- x2NORMAL: 0.278[0.870]
- x2ARCH: 1.9601[.170]
- R2: 0.471
- DW-statistic: 1.447

Note: the asterisk***, ** and *, imply 1% and 5% and 10% levels of significance respectively.

The negative or inverse relationship between money supply (ΔlnM2) and inflation (ΔlnCPI) shows that 10% decrease in money supply increases inflation by -16.8% and increase in money supply by monetary authorities reduces inflation in short run in Nigeria. This inverse relationship between ΔlnCPI and ΔlnM2 is in line with the structuralist theory of inflation who argued that inflation is not always and everywhere monetary phenomenon but also structural rigidities, infrastructural inadequacy that causes inflation.

Likewise, there is direct relationship between lending rate lnLR and lnCPI in Nigeria in short run, in the sense that 5% increase in lnLR causes lnCPI to increase by 17%. The interest rate channel of monetary policy is very dominant in explaining inflation condition in Nigeria in short run. However, it should form the basis for inflation targeting in the short run in Nigeria. However, it depicts that the higher the lending rate, the higher the level of inflation and the lower the lending rate, the lower the inflation. This result is in line with the Keynesian theory of monetary policy transmission which argued that monetary policy operates effectively through the interest rate channel.

However, the results found are in line with the Ozofere [33]. Moreover, the nature of inflation in Nigeria is structural, in the sense that it emanates due to infrastructural inadequacy, hoarding and other forms of rigidities. However, the result found above is in line with Ifeakachukwu [40] who investigated the monetary transmission mechanism in Nigeria: a sectoral output analysis. He found out that interest rate was most effective in transmitting monetary policy to agricultural and manufacturing sector, while exchange rate channel was most effective in building and Construction Company. This result shows the evidence of the existence of short run relationships among the above mentioned variables under study. However, the diagnostic test shows that the (R2) signifies the overall goodness of fit. The value of R2 is 0.471 which means the goodness fit is high and the fact that the model is suitable for the study.

However, the diagnostic tests consist of four tests: serial correlation, normality and DW-statistic and Heteroscedasticity tests. There is serial correlation at 10% level of significant, but the serial correlation has been taken care of by DW-statistic test because the value is not significant therefore the estimated results of the study possesses the overall goodness of fit since it is free from heteroscedascity. However, the dummy here is insignificant i.e. it does not show any relationship. Therefore, the conventional null hypothesis which says no serial correlation, no heteroscedascity is accepted here. The diagnostic test is in line with Zeb et al. [41] and Khoshnevis and Khanalizadeh [42].

CUSUM is an acronym for cumulative sum of recursive residuals which is used to measure the stability of the estimated model of the study. (CUSUM) and the CUSUM of square (CUSUMSQ) are applied to assess the parameter stability [43]. However, the graphical presentation of the recursive coefficient is used to judge the stability of the coefficient. As it can be seen in Figure 1 and 2 below, the CUSUM is completely stable within the required range. It doesn’t exceed the two boundaries upward and below, which means the model is good and suitable for the study. Figure 1 and 2 below shows the stability of the model also, as the CUSUM of squares test statistics curve is within the two boundaries Switch illustrates the goodness as well as the stability of the model under study.
Therefore, the stability of the ARDL variables is tested by using the CUSUM and CUSUMsq tests which is developed by Brown et al. [44]. The graphs of Figures 1 and 2 respectively. The results show that the ARDL parameters are stable because graphs of the CUSUM and CUSUMsq (blue lines) are within the critical bounds. However, this CUSUM and CUSUMsq tests are in line with Kyophilavong et al. [45].

**CONCLUSION**

Based on the above findings, the study can conclude that in long run, the exchange rate channel of monetary policy is dominant in explaining the inflation condition in Nigeria. However, it should form the basis for the strategy to follow to reduce the inflation in Nigeria. However, in short run, the interest rate channel of monetary policy is dominant in explaining the inflation condition in Nigeria. However, it should form the basis for the strategy to follow to reduce the inflation in Nigeria. Therefore, the interest and exchange rate channels of monetary policy are the most active channels in Nigeria and they should be used as the two leading indicators in fighting inflation in Nigeria.

The results derived above are in consonance with the Keynesian monetary policy theory that says monetary policy operates effectively through the traditional Keynesian interest rate channel. It implies that a monetary tightening in the form of a shock to the Taylor rule that increases the short-term nominal interest rate would translate into an increase in the real interest rate as well when nominal prices move sluggishly due to costly or staggered price setting. The results derived above are also in line with the Ozofere [33] on monetary transmission mechanisms in Nigeria.

However, the results derive above are in line with Ifeakachukwu [40] who investigated the monetary transmission mechanism in Nigeria: a sectoral output analysis. He found out that the interest rate was most effective in transmitting monetary policy to agricultural and manufacturing sector, while exchange rate channel was most effective in building and Construction Company. However, the result is in line with Andre et al. [46] examined the monetary policy channels in Brazil through the lens of a semi-structural model using ARDL, they found out that the house hold interest rate channel of monetary policy transmission mechanism is the most effective for describing the response of output to a monetary policy shock. Based on the decomposition of inflation, the house hold interest rate as well as the exchange rate channels is the main transmission channels.

It is very pertinent to talk about the gaps discovered in the research, based on the previous researches conducted on the related topic. First of all, many previous literatures that the researchers reviewed, there are no researches on monetary transmission mechanisms and inflation targeting in Nigeria that used the Autoregressive distributed lag (ARDL). Most of the researchers used vector
autoregressive model (VAR) and structural vector autoregressive (SVAR) model in Nigeria. Secondly, this research examines the long run and short run relationships between money supply, exchange rate, lending rate and inflation trend in Nigeria simultaneously. Unlike other researches conducted so far on monetary policy transmissions where the researches paid attention to only channels of monetary policy without talking about inflation targeting frame work. Lastly, there is no any research in Nigeria that uses the variables that this research employs.

REFERENCES