

## The Determinants of Inflation in Nigeria from 1970-2014

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**Abstract:** The aim of this paper is to examine the long-run relationships between exchange rate, broad money supply, gross domestic product, interest rate, financial instability, oil price and inflation. The study employed an Autoregressive Distributed Lag (ARDL) technique using annual time series data for 45 years period, from years 1970 to 2014. The findings derived from this study clearly confirmed the existence of a long run relationship between the variables tested. Besides that, the findings also showed the existence of a positive long-run relationship between the exchange rate, broad money supply, oil price and inflation; but negatively related to financial instability, interest rate, gross domestic product and broad money supply nominal effective exchange rate irritation term. Conclusively, throughout the overall findings, it is recommended for monetary authority in Nigeria to pursue price stability either through monetary policy or exchange rate target since shocks in both money supply and exchange rate influence variation in inflation. Besides that, diversification strategy and export-based economy are also recommended for Nigerian economy as this will lead to increase in output and productivity, as well as to overcome the trade balance of the nation.

**Key words:** Autoregressive distributed lag • Financial instability • Inflation

### INTRODUCTION

The inflationary procedure has remains a disputable point in both hypothesis and observational discoveries. It is for the most part questionable that regardless of whether inflationary pace is a decent or awful for the economies. It brings up an issue before the strategy creators that how to accomplish the twin objective of low swelling and low unemployment. It has been watched that high swelling diminishes reserve funds and occupy speculation into theoretical channels. The nations are concerned that high expansion will swell the objective of accomplishing high financial development. This is clarified by surely understood Phillips bend supporting the conceivable exchange off amongst swelling and unemployment [1]. The bend sets up that there is no exchange off between the inflation and unemployment over the long haul however there are a conceivable trade off amongst inflation and unemployment in the short-run [2].

All through the previous two decades, the goals of Nigerian monetary policy were to achieve the external balance and price stability. As documented by Batini [3], the CBN monetary policy circular no. 33, year 2002, stating that one of the CBN's real targets is the "sustenance of price and external stability." However, still the goal remained unchanged over years. As the Nigerian economy is an import oriented economy, this necessitates the need to continuously investigate the precise linkages between exchange rate and consumer prices. Further, there is also a need to address the possible effect of exchange rate policy as well as money supply on inflation in Nigeria. This is because the exchange rate and money supply are variables that can be influenced by monetary policy instruments, so that they can serve as monetary policy intermediate targets. Besides, the inflation is also considered as one of the ultimate targets of monetary policy instruments. Therefore, the aim of this paper is to investigate the causal relationship between determinants the nominal effective exchange rate, broad money supply,

gross domestic product, interest rate, financial instability, oil price and inflation. The remaining section of this paper is presents as follow: Section two presents the empirical literature review while the methodology employed for the study formed the contents of section three. Findings and discussion are presented in section four and finally, conclusion and recommendations are presented in section five.

**Empirical Literature Review:** A survey of the many works on exchange rate reveals that it is dominated by issues relating exchange rate and prices (import prices, producer prices, CPI, agricultural and industrial prices). Similarly, VAR or VECM methodology dominates such literature. Empirically analysing the interaction between floating exchange rates, money and prices with a VAR model for a sample of countries, Iyaji [4] investigated the effectiveness of monetary policy in controlling the inflationary pressure in Nigeria by using OLS method. The literature examined the real effective exchange rate, broad money supply and minimum rediscount rate and discovered that monetary policy innovations based on controlling money supply has modest effects on prices and output with a fast and speedy adjustment. While minimum exchange rate as well as real effective exchange rate have neutral and fleeting effects on output. The study suggested that inflationary growth rate can be checked by embarking on the monetary policy, based on moderating the level of money in circulation within the Nigerian economy. Langnan and Shoufeng [5], observed the transmission of foreign exchange reserves on price level in China from 1993 to 2008 by using non- parametric model. The results report that an increase in foreign exchange reserves caused a rising in money stock in circulation, which in turn lead to an increase in the price level, hence inflation. Therefore based on the VAR model of consumer price index and money supply the price level was fully respond to shocks in money supply in only two months. But the literature has short comings because the clear shocks will not be captured in only two months. The research forgot to acknowledge the role of exchange rate variation, he only consider the foreign reserve in the analysis.

Jalil *et al.* [6] tested the fiscal theory of price level for Pakistan using Autoregressive Distributive Lag (ARDL) techniques for the period of 1972–2012. The found that fiscal deficit is a major determinant of the price level along with other variables like government sector borrowing, private borrowing and interest rates. In Bangladesh

Muktadir-Al-Mukit *et al.* [7] investigates the relationship between inflation and import using a sample period of 2000 to 2011. They applied Johansen cointegration techniques and found that import is statistically positively related to inflation. The Granger causality test shows a unidirectional causality running from inflation to import.

Maku and Adelowokan [8], observed the dynamic of inflation in Nigeria by using vector autoregressive model and reveals that money supply, real output growth rate, fiscal deficit and interest rate exert contributed to an increase in the inflationary dynamic pressure in Nigeria. But money supply and real output growth contributed higher than the interest rate and fiscal deficit. However, the researchers did not include exchange rate variation which is also important cause of inflation in Nigeria, due to the fact that Nigerian economy is an import oriented economy. Okoro [9], using error correction model, examined the relationship among money supply, interest rate, inflation rate, exchange rate and gross domestic product in Nigeria. The study findings suggested that the greater the coefficient in the parameter, the higher the speed of adjustment of the model from short run to a long run, which means that there was an existence of long run relationship between monetary policy and economic growth in Nigeria. Therefore, the result shows that exchange rate and money supply were positively correlated to GDP in long run. But the study did not consider or give emphasis on the relationship between the price level and other variables under the study. This is because both economic growth and price stability are integral part of economic development in Nigeria.

Bozkurt, [10] examined money, growth and, inflation relationship in Turkey over the period of 1999Q2-2012Q2. They used co-integration test. Their results indicated that money supply and velocity of money is a main determinant of inflation in the long run. On the other hand, 1 percent declines in income directly reduce inflation by 1%. Similarly, Turhan *et al.* [11], examined the dynamic relationship between exchange rate and oil prices in G20 member countries by using the consistent dynamic conditional correlation (CDCC) model. The empirical result shows the negative relationship between exchange rate and oil prices in some member countries. Moreover, the study reveals that in 2003 there was a shift of correlations to a significant negative point because of the intervention of United State of America into Iraq and global financial crisis. However, the variation in the exchange rate has led to inflationary pressure in all the member countries.

However, Hassan, [12] examined the relationship between money growth and inflation in Nigeria over the period of 1970-2012. They employed Johansen co-integration approach, Vector Error Correction Model (VECM) and Granger Causality Analysis. They showed that in the long run money supply growth has significant and positive relationship with inflation while the insignificant relationship with inflation in the short run. Furthermore, the causality test results revealed a unidirectional causal relationship is running from money supply growth to inflation. However, import and interest rates have significant and positive relationship with inflation but Gross Domestic Product and exchange rates have a significant and negative relationship with inflation in the long run. Also, Stephen [13], studied the exchange rate volatility, devaluation and price level dynamic in Nigeria using the OLS method, from 1970 to 2009. The study however analyzed if any correlation exist between exchange rate instability, the distortion in the general price level and depreciation in Nigeria. (OLS) was utilized for the study. This explanatory system is suitable in light of the fact that it is productive in term of yield and sufficiency of measurements created. The findings shows that inflation rate and money supply were stationary at level at 5% level of significance while and exchange rate were stationary at first difference. The work found that exchange rate volatility has negative impact on the price level in Nigeria.

On the other hand, Hossain [14] has explored the relationship between money, output and prices in some Muslim majority countries. The empirical result acquired by the Engle-Granger, Johansen and ARDL bound test shows the presence of the causal relations among money, prices and output. In India, Mohanty and John [15] examined the determinants of inflation from Q1:1996-97 to Q3:2013-14. Their variables were Gross domestic product deflator, output gap, domestic crude oil prices, overnight weighted average call money rate and fiscal deficit. They applied structural vector autoregressive (SVAR) model. Their analysis indicated that the fiscal deficit appeared as one of the main determinant of inflation in 2011-12.

Adom *et al.* [16] investigate the internal and external factors in determining inflation in Ghana from 1960-2012. Their variables were food supply, international transfer inflation and inter-continental transfer of inflation through changes in crude oil prices and policy regime changes. They applied fully modified-ordinary least square techniques. The findings indicated the existence of co-integration relationship among the variables. And also,

money supply has significant positive effects of inflation in Ghana. However, Alexander *et al.* [17] analysed the main determinant of inflation in Nigeria using annual time series data from 1986-2011. The variables used were import, real gross domestic product, fiscal deficit, money supply GDP of Agriculture, exchange rate and lending rate. They used Granger Causality test and Vector Autoregressive (VAR) model. Their result indicated that exchange rate, money supply fiscal deficit, money supply, import and lending rate have negative relationship with inflation in the short run, but positive relationship in the long run. In the sense of Granger causality, all the variables have bidirectional causal relationship with inflation but causality run from lending rate to inflation.

Moreover, Awang and Imran [18] examine the factors affecting food price inflation in Pakistan using time series data for the period of 1980-2013. Their variables were money supply, exchange rate, fuel prices, foreign aid, per capita and fertilizer prices. They applied Error correction model (ECM). Their analysis showed that per capita, money supply fuel prices, fertilizer prices and foreign aid have significant positive impact on inflation while exchange rate has negative significant effects. Therefore, Barugahara [19] examined the effects of political instability on inflation in 49 African countries. This study employed GARCH (1, 1) model. The findings indicated that political instability has significant positive impact on inflation volatility in the 49 African countries. In addition, Chakraborty and Varma [20] studied the fiscal theories of price determination (where inflation targeting is emphasised) and the monetarist axioms in India using the autoregressive distributive lag (ARDL) model. They empirically tested the determinants of inflation based on Wholesale Price Index (WPI) and the Consumer Price Index (CPI) for the financially deregulated period. The results revealed that the supply-side variables are indeed significant and have a considerable effect on inflation.

Gerlach *et al.* [21] examined the determination of inflation between 1926 and 2012 in Ireland. They found that the changes in unemployment and the NAIRU are a significant determinant of inflation both in the full sample and in the subsamples covering the periods before and after the Sterling parity association. In addition, Lim and Sek [22] investigated the determinants of inflation in high inflation group countries and low inflation group countries using time series data from 1970-2011. They employed Autoregressive Distributive Lags (ARDL) techniques and they found that in low group countries GDP growth and import have positive and negative

effects on inflation respectively, while money supply and expenditure have insignificant positive and negative effects respectively. In the high inflation group countries they also found that money supply and expenditure have positive and negative significant effects on inflation while GDP growth and import showed no effects. Similarly, Mohanty and John [23] identified the determinants of inflation in India using quarterly data from Q1: 1996–1997 to Q3: 2013–2014. They applied a multivariate econometric framework. The crude oil prices, output gap, fiscal policy and monetary policy were identified determinants of inflation. They found that dynamics inflation in India had changed over time with various determinants showing significant time variation in the recent years, mostly after the global financial crisis.

Murshed and Nakibullah [24] explored the relationship between price level and inflation in GCC countries for the period of 1975–2011. They used the following variables: World oil price index, real gross domestic product, money supply and nominal effective exchange rate. Their result showed that in both long run and short run exchange rate pass-through elasticities to the consumer price level of GCC countries. In Ghana, Ofori *et al.* [25] investigates the relationship between inflation and import using Autoregressive Distributive Lag (ARDL) techniques. They used a sample period of 1960 to 2012. Their analysis found that import and government expenditure were statistically insignificant negative and positive relation with inflation in the short run but statistically significant negative and positive relations in the long run respectively.

Orji *et al.* [26] examined the unemployment and inflation nexus in Nigeria. They applied a distributed lag technique with data covering the period 1970–2011. Their variables were consumer's price index (a measure of inflation rate), unemployment rate, budget deficit, the growth rate of money supply, interest rate, the lag of current interest rate and real gross domestic product. Their analysis revealed that unemployment is a significant determinant of inflation and that there is a positive association between inflation and the unemployment rate in Nigeria. Equally, Ola, A. E [27] investigated the determinants of inflation in Sri Lanka and Nigeria from 1963 to 2013. Their variables were money supply, interest rate, exchange rate and import. He employed Error correction model (ECM) and Multiple regression techniques. His findings showed that money supply, interest rate, exchange rate and import are positively related to inflation in both countries. Consequently,

Pingfeng [28] examined the determinant of inflation in Sierra Leon using annual time series data for the period of 1990 to 2013. He used Augmented Dickey Fuller test, Johansen Cointegration test and Error correction Model (ECM). Their result showed that GDP and money supply have significant positive impacts on inflation while interest rate has a significant negative effect in the short run. No significant effects of imports of goods and services and exchange rate. In the long run GDP and money supply contribute positively, but interest rate and exchange rate contribute negatively. Sami and Sassi [29] analyzed the nexus between corruption and inflation using a sample of 100 developed and developing countries representing five regions which are Americas, Europe, Middle East and North Africa, Sub-Saharan Africa and Asia Pacific for the period of 2000–2012. They employed some model estimations and two indicators of corruption. Their findings revealed a significant and positive relationship between all country corruption measures and inflation.

Utama *et al.* [30] elaborated the impact of changes in BI Rate (interest rates of the central bank), PUAB (money market interest rates) and provincial money supply to regional inflation in the framework Hybrid New Keynesian Phillips Curve (HNKPC). They employed Generalized Method of Moments (GMM) techniques on panel data of 32 provinces from 2005–III to 2014–IV. They classified the data into four groups, which are Jawa-Bali (W1), Sumatera (W2), Kalimantan-Sulawesi (W3) and Papua-Maluku-Nusa Tenggara (W4). Their findings showed that provincial monetary aggregate influence inflation significantly only in Sumatera while BI Rate affects inflation in Sumatera and Kalimantan-Sulawesi. Furthermore, they also showed that PUAB is significantly affecting inflation in almost all Indonesian regions, except Kalimantan-Sulawesi. Van zyl [31] investigated the determinant of South African inflation-linked bond returns using time series annual data of 2000–2013. He applied Augmented Dickey Fuller test, correlation analysis and co-integration test. The result showed no co-integration relationship between interest rate and inflation; inflation linked bond return and inflation. It is also found that trend in inflation is the real causes of inflation-linked bond performance.

Alam and Alam, [32] investigated the determinants of inflation in India using time series for the period of 1989–90 to 2012–2013. They applied co-integration method and revealed that depreciation of the rupee, money supply and supply bottleneck are the main determinants of inflation in the long run. However, in the short run the results

indicated that supply bottlenecks and domestic factor MSlead the other factors as a degree of the cause for persistent increase of inflation in India. Furthermore, Deniz *et al.* [33] examined how inflation rates of inflation focusing on (IT) and non-inflation focusing on (non-IT) developing and modern economies are influenced with the determinants as real effective exchange rate, money growth, budget balance, real wages, output gap and GDP growth dynamic static panel data over the period of 2002-2012. Deteriorating the determinants of inflation rate empowers to examine the presence of a few transmission systems for developing and modern economies.

Jongwanich, Wongcharoen and Park, [34] investigated and compared the causes of consumer and producer prices inflation using ten Asian emerging economies. They applied Variance Decomposition (VC) and Impulse Response (IR) over the period of 2000 to 2015. They also examined the global food prices, exchange rate and global oil prices to consumer and producer prices. The found that cost-push variables, for example, food prices and oil are more critical in clarifying producer price inflation than consumer price inflation in the 10 Asian emerging economies. Then again, demand-pull factors, consumer prices still clarify a great part of the inflation. At last, they revealed that the global food prices, global oil prices and exchange rate have a tendency to be higher at producer prices than consumer prices in Asia.

In Pakistan, Jaffri *et al.* [35] investigated the influence of demographic variation on inflation over the spinning of 1988 to 2014. They employed Autoregressive Distributive Lags techniques and showed that middle age working population and population growth have negative and positive effect on inflation respectively. Also, Hassan *et al.* [36] studied the relationship between indirect taxes per capita; export per capita, crude oil prices, exchange rate, external debt per capita and inflation for the period of 1976 to 2011 in Pakistan. They applied Autoregressive Distributive Lags and found the existence of long run co-integration among the variables. Moreover, the crude oil prices, exchange rate, indirect taxes and export have significant positive influence on inflation; however, external debt has insignificant negative impact on inflation.

Recently, Alemu and YilkalWassie, [37] investigated the impact money supply on inflation in Ethiopia using time series data from 1994/95 to 2014/15. They employed Johansen cointegration analysis and confirmed the existence of a relationship between the variables. Moreover, the results of Granger causality test revealed

unidirectional causal relationship from money supply to inflation, budget deficit to the money supply. Hence, no causal relationships exist between inflation and budget deficit. In Nigerian context, Iheonu *et al.* [38] applied autoregressive distributive lag (ARDL) and analyze the influence of money supply, GDP per capita, interest rate and exchange rate during 1980 to 2014. Their results showed that co-integration relationship exists between the variables. This analysis suggested that fiscal strategies ought to be equipped towards the control of interest rate and money supply in the short run in other to direct Inflation and furthermore, the Nigerian economy can stand to shift any of human capital improvement or innovative headway to lift efficiency without bringing on inflation as GDP per capita demonstrated insignificant in the short run.

Rashid *et al.* [39] investigated the co-integration relationship between inflation, exchange rate and foreign direct investment in Malaysia. They applied Ordinary Least Square Method covering the periods of 1992 to 2012. The results indicated that the variables have a long run relationship. Moreover, Yien *et al.* [2] examined the determinant of inflation in Malaysia during 1960 to 2014. They employed Granger causality test analysis and Johansen co-integration test techniques. Their results confirmed the existence of co-integration relationship between domestic debt, exchange rate, external debts and inflation. Also, the result of Granger causality revealed one-way causality running from exchange rate to inflation, domestic debt to exchange, it also the two-way causal relationship between external debts and exchange rate.

Therefore, the empirical literature reviewed in this study show blended results and conclusions. In a few literatures, solid positive associations are establish to exist among inflation and the chose factors under study and some the associations are feeble. Different studies account distinctive outcomes. This blend of discoveries and conclusions radiates from contrasts in approach, factors utilized and the time of study. There is in likewise uniqueness of study zone that basically influences the unpredictability of inflation rate. The stunning success of the current study, consequently, will be on these four fronts. It will cross over any barrier made by a portion of the investigated consider by utilizing distinctive approach and study range. This is on the grounds that where the region of study is comparable, the approach and factors utilized difference. Once more, the utilization of 1970-2014 review periods is an incredible change in the literature. Lastly, the creation of the index of financial instability and

developing a new model broad money supply nominal effective exchange rate interaction terms will prove to be a major pace in the literature of volatility of inflation in Nigeria.

### Methodology

**Data:** The study utilizes annual time series data over the period from 1970–2014 in order to examine the determinants of inflation in Nigeria. This period is adopted to capture the impact of structural shocks, such as the period of high inflation during the late 1970s, first oil crisis in 1973, global economic recession in the early 1980s, Structural Adjustment Programme (SAP) in 1986, Dual Deregulation policy 1994, global financial crisis in 2007, current problem of insecurity, as well as the current oil crisis Nominal effective Exchange rate, Broad money supply, Gross Domestic Product (GDP), Oil prices, financial instability and interest rate are the independent variables while inflation is used as the dependent variables. The data used for this research are sourced from World Bank Development Database Indicator (2015), the United Nations Statistical Division (2015) and DataStream (2015). The research analysed the data using time series techniques. This consists of unit root tests, co-integration tests, Granger causality test. The study estimated the Cointegration using Autoregressive Distributive Lag (ARDL) developed by Pesaran & Pesaran [40] to estimate the Long run and Short run coefficients. The ARDL technique indeed was recognized to have additional advantages of yielding consistent estimates of the short run and the long-run coefficients [41].

**Unit Root Test:** Standard vector autoregressive techniques necessitate that the underlying stochastic procedures are stationary (that is, invariant concerning time). On the off chance that they are not stationary, the F-measurements on which the significance of the regression assessments is based will be one-sided. A standard system used to test for stationarity is an augmented Dickey-Fuller test [42] and Phillips-Perron test [43]. In light of these tests, the study assessed the model in first distinction frame over the whole sample frame. Indicators are expressed in logs, so that first differences indicated the rate of changes. This form is especially helpful on the grounds that the indicators in the evaluated show straightforwardly measure the inflation rate. The test is led by including the slacked estimations of the dependent variables  $\Delta Z_t$  as given in equation (1) below:

$$\Delta Z_t = \alpha + \beta t + \theta Z_{t-1} + \sum_{i=1}^k \alpha_i \Delta Z_{t-i} + \varepsilon_t \quad (1)$$

where:  $t$  is a pure white noise error term and  $\Delta Z_{t-1} = (Z_{t-1} - Z_{t-2})$ ,  $\Delta Z_{t-2} = (Z_{t-2} - Z_{t-3})$  and so on and  $t$  is the time or trend variable while  $k$  is the lag length and  $Z$  in this study represents the independent variables. Therefore,  $H_0 : \theta = 0$ ; this indicated that there is unit-root, while,  $H_1 : \theta < 0$ ; which indicated, the time series is stationary.

**Autoregressive Distributed Lag Model (ARDL):** The study apply Autoregressive Distributed Lag (ARDL) approach known as the bound test developed by Pesaran & Shin [44] and extended by [45]. As beside the conventional Johansen cointegration technique that uses a system of the equation to estimate the long run relationship. The application of Autoregressive Distributive Lag helps to prevent problems related with determining short time series [46]. The method can test for cointegration between the variables irrespective of whether the underlying variables are  $I(0)$ ,  $I(1)$ , or fractionally integrated. Nevertheless the method has a limitation when it comes to integration of order two  $I(2)$ . Additionally, the long and short-run parameters of the model are estimated concurrently. Consequently, the inability to test hypotheses on estimated coefficients in the long-run associated with Engle-Granger method is avoided. Hence, the Autoregressive Distributive Lag Model in this study is specified as follows:

$$LNINF = f(LNEXR_t, LNM2_t, LNGDP_t, LNINT_t, LNFI_t, LNOP_t) \quad (2)$$

where  $INF_t$  is the Inflation,  $NEER_t$  is the Nominal Effective Exchange Rate,  $M2_t$  is the Broad Money Supply,  $GDP_t$  is Gross Domestic Credit,  $INT_t$  is the Interest rate,  $FI_t$  is the Financial Instability,  $OP_t$  is the Oil Price.

According to Central Bank of Nigeria [47] Money supply and exchange rate are the variables that can be prejudiced by the monetary policy instruments and serve as intermediate targets of the monetary policy and the inflation is considered as one of the ultimate targets of monetary policy. In this view, this study developed a new model broad money supply and nominal effective exchange rate interaction terms to answer the objective three. The model is as follows:

$$LNINF = f(LNEXR_t, LNM2_t, LNGDP_t, LNINT_t, LNFI_t, LNOP_t, LN(M2EXR)_t) \quad (3)$$

The model can be restated as:

Without Interaction Term;

$$\begin{aligned}\Delta LNINF_t = & \alpha_0 + \sum_{i=1}^n \alpha_1 \Delta LNINF_{t-1} + \sum_{i=1}^n \alpha_2 \Delta LNEXR_{t-1} + \sum_{i=1}^n \alpha_3 \Delta LNM2_{t-1} + \\ & \sum_{i=1}^n \alpha_4 \Delta LINGDP_{t-1} + \sum_{i=1}^n \alpha_5 \Delta LNINR_{t-1} + \sum_{i=1}^n \alpha_6 \Delta LNFI_{t-1} + \sum_{i=1}^n \alpha_7 \Delta LNOP_{t-1} \\ & \pi_1 LNINF_{t-1} + \pi_2 LNEXR_{t-1} + \pi_3 LNM2_{t-1} + \pi_4 LINGDP_{t-1} + \\ & \pi_5 LNINR_{t-1} + \pi_6 LNFI_{t-1} + \pi_7 LNOP_{t-1} + \mu\end{aligned}$$

With Interaction Term;

$$\begin{aligned}\Delta LNINF_t = & \alpha_0 + \sum_{i=1}^n \alpha_1 \Delta LNINF_{t-1} + \sum_{i=1}^n \alpha_2 \Delta LNEXR_{t-1} + \sum_{i=1}^n \alpha_3 \Delta LNM2_{t-1} + \\ & \sum_{i=1}^n \alpha_4 \Delta LINGDP_{t-1} + \sum_{i=1}^n \alpha_5 \Delta LNINR_{t-1} + \sum_{i=1}^n \alpha_6 \Delta LNFI_{t-1} + \sum_{i=1}^n \alpha_7 \Delta LNOP_{t-1} + \\ & \sum_{i=1}^n \alpha_8 \Delta LN(M2 + EXR)_{t-1} + \pi_1 LNINF_{t-1} + \pi_2 LNEXR_{t-1} + \pi_3 LNM2_{t-1} + \pi_4 LINGDP_{t-1} + \\ & \pi_5 LNINR_{t-1} + \pi_6 LNFI_{t-1} + \pi_7 LNOP_{t-1} + \pi_8 LN(M2 + EXR)_{t-1} + \mu\end{aligned}$$

where:  $\Delta$  is the first-difference operator and *lnexr*, *lnm2*, *lingdpp*, *lnint*, *lnfi* and *lnop* are the dependent variables selected in the study. The constants is  $\alpha_0$  the coefficients on the trends are  $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7, \alpha_8$ .  $\pi_1, \pi_2, \pi_3, \pi_4, \pi_5, \pi_6, \pi_7$  and represent the lagged dependent and independent variables respectively,  $\mu$  is error term and the  $n$  represents the maximum lag length that is decided by the lag selection. There are two procedures for testing the cointegration relationship between inflation and the dependent variables. The first procedure is to estimate eq. (3) by ordinary least squares (OLS) procedure. Secondly, the existence of cointegration is traced by restricting all estimated coefficients of lagged level variables equal to zero.

The  $H_0$  indicates the non-existence of a long-term relation as  $\delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$  against  $H_1 = \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq \delta_7 \neq \delta_8 \neq 0$  implies that cointegration exist among the variables. Two bounds of critical values are computed by Pesaran *et al.* [45] for decision rule. If the ascertained F-statistics is not as much as the lower and upper basic bound esteem, then we accept the  $H_0$  and presume that there is no cointegration between the variables under review. In any case, if the computed F-statistics is more prominent than the lower and upper basic bound esteem, than we reject the  $H_0$  and infer that there exists cointegration between

the variables under review. In any case, if the figured F-statistics fall inside upper and lower basic bound qualities, then we reason that the outcome is inclusive.

The consequent method is to assess the short-run and long-run conditions by utilizing the ECM. To guarantee the joining of the long-run equilibrium, the sign for the coefficient of the lagged error correction term (ECMt-1) must be negative and statistically significant. Additionally, to run the diagnostic tests [40].

## RESULT AND DISCUSSION

The paper findings discussed the empirical outcomes of the impact of nominal effective exchange rate, broad money supply and trade on inflation in Nigeria from 1970 to 2014. The discussions are presented in phases, starting with the descriptive statistics, correlation analysis, the analysis of the empirical result of unit root tests using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). The co-integration tests use Autoregressive Distributive Lag Bound testing method that was established by Pesaran *et al.* [48]. The estimates of the Short-run and Long-run coefficients are observed through the Autoregressive Distributive Lag (ARDL). The last phase is the determination of causality between the nominal effective exchange rate, broad money supply, gross

Table 3: Unit root test on level

Result for Unit Root Test on Levels				
Variables	ADFPPhillips Perron (PP)			
	Constant	Constant and Trend	Constant	Constant and Trend
LNINF	-3.752*	3.741*	-3.538**	-3.486***
LNEXR	-0.672	-1.481	-0.467	-1.571
LN2M	-3.957*	-3.923**	-4.059*	-4.021*
LNGDP	0.464	-0.676	0.464	-0.733
LNINR	-1.433	-1.072	-1.462	-1.231
LNFI	-4841*	-4.781*	-4.742*	-4.678*
LNOP	-0.523	-1.702	-0.550	-1.793
Critical Value for ADF and PP				
ADF-3.368 (1%) -2.981 (5%)			-2.625 (10%)	
PP-3.606 (1%) -2.937 (5%)			-2.607 (10%)	

Note: \*, \*\* and \*\*\* imply 10% and 5% and 1% levels of significant respectively

Table 4: Unit root test on first difference

Result for Unit Root Test on First Difference				
Variables	ADF		Phillips Perron (PP)	
	Constant	Constant and Trend	Constant	Constant and Trend
LNINF	-7.156*	-7.157*	-15.473*	-16.607*
LNEXR	-3.699*	-3.646**	-3.716*	-3.652*
LN2M	-8.406*	-8.371*	-10.768*	-12.356*
LNGDP	-6.277*	-6.263*	-6.296*	-6.266*
LNINR	-6.276*	-6.354*	-6.293*	-6.355*
LNFI	-8.857*	-8.748*	-20.859*	-20.111*
LNOP	-6.511*	-6.439*	-6.510*	-6.438*

Note: \*, \*\* and \*\*\* imply 10% and 5% and 1% levels of significant respectively

domestic product, interest rate, financial instability, oil price and inflation through autoregressive distributive Lag Granger causality popularly known as Wald Test.

**Unit Root Test:** Table 3 shows the result of ADF and Phillips-Perron unit root test on level for both constant and constant and trend. The test revealed that all the variables (LNEXR, LNGDP, LNINR and LNOP) except LNINF, LNM2 and LNFI were non-stationary at level that is, I (0).

While Table 4 represents the ADF and Phillips-Perron unit root test on first difference [I (1)]. It showed that all the variables under the study LNINF, LNEXR, LNM2, LNGDP, LNINR, LNFI and LNOP were stationary at I (1). And the F\* is greater than the critical value at 1%, 5% and 10% level of significance. Thus, the variables are stationary and integrated of same order, i.e., I (1). Since the variables are set to be stationary at first difference, it is possible to carry out the further analysis base on ARDL approach as discussed in the previous section.

**Lag Selection:** The lag selection is the second step for using ARDL model according to Pesaran *et al.* [45]. General the lag are choose based on Akaike information criterion, Schwarz information criterion and Hannan-Quinn information criterion the Table 5 below showed the lag selection system.

**F-Bound Test to Co-integration:** Table 6 showed the co-integration F-bound test for co-integration and the calculated F-statistics (6.221) exceeds the critical upper and lower bounds values at 1%, 5% and 10% level of significance as indicated above. This confirms that there is existence of co-integral relationship between inflation, nominal effective exchange rate, broad money supply and trade in Nigeria. And the null hypothesis which says that there is no significant cointegration relationship between inflation, nominal effective exchange rate, broad money supply, gross domestic product, interest rate, oil prices, financial instability and broad money supply nominal effective exchange rate interaction term in

Table 5: Lag Selection

Lag	LogL	SMLR	FPE	AIC	SCIC	HQIC
0	-298.0113	-	0.0004	14.9274	15.2617	15.0491
1	-50.1676	386.8780	5.67e-08	5.9594	8.9686*	7.0552
2	37.2308	102.3200*	2.61e-08	4.8180	10.5021	6.8878
3	131.3088	73.4267	1.91e-08*	3.3508*	11.7097	6.3946*

Note: \*indicates lag order selected by the criterion

SMLR: Sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SCIC: Schwarz information criterion

HQIC: Hannan-Quinn information criterion

Based on the table 4.5 above the study is going to use Schwarz information Criterion (which is lag 1) on the grounds that it performs better than others (Narayan, 2004; Pesaran *et al.* 2001).

Table 6: Co-integration Bound Test Analysis

Variables	LNGDP DEF		
Optimum-lags	(1,0,1,1,0,0,1,1)		
F-Bound	6.221*		
Critical values	1%	5%	10%
Upper bound	3.90	3.21	2.89
Lower bound	2.73	2.17	1.92
Diagnostic test:			
R2	0.638		
Adj-R2	0.493		
Durbin-Watson	1.813		
F-Statistics	4.402		

Note: \*, \*\* and \*\*\* show the significance at the 1%, 5% and 10% levels.

Table 7: ARDL Long Run Co-integration Test

Dependent variable is LNINF 44 observations used for estimation from 1970 to 2014

Variable	Coefficient	SE	t-Statistic	Prob.
Constant	4.7	4.611	(1.028)	[0.312]
LNEXR	1.7*	0.551	(3.074)	[0.005]
LN2M	1.1*	0.207	(5.091)	[0.000]
LN2MEXR	-0.28*	0.068	(-4.040)	[0.000]
LNGDP	-0.35***	0.200	(-1.767)	[0.087]
LNINR	-0.09	0.577	(-0.165)	[0.869]
LNFI	-0.72***	0.406	(-1.770)	[0.086]
LNOP	0.97**	0.448	(2.155)	[0.039]

Note: \*, \*\* and \*\*\* show the significance at the 1%, 5% and 10% levels.

Nigeria is rejected at 1%, 5% and 10% level of significance. (The critical bound values used are from Pesaran table case II). The result of the estimation indicates that the explanatory variables account for about 64 percent variation in inflation in Nigeria. However, the highly significant F-statistics recommends the general significance of the model.

**Long-Run Cointegration Test:** In Table 7, the t-statistics and p-values are given in brackets and square brackets respectively. The coefficients for exchange rate (LNEXR), broad money supply (LN2M) and oil prices (LNOP) are

positive but the coefficients for the interaction effects (LN2MEXR), gross domestic product (LNGDP), financial instability (LNFI) are negative and statistically significant. The constant term and interest rate (LNINR) are Negative and statistically insignificant. The volatile of nominal effective exchange rate is ability to increase inflation in the long run. This result confirmed the increased depreciation of the value of the Nigerian currency in exchange against other foreign currencies. The sign of coefficient is positive and significant. This means that One percent increase in exchange rate (depreciation) will leads to the increases in inflation in Nigeria by 0.77. The depreciation in exchange rate makes the goods and service of Nigeria relatively expensive and this further cause to raise the exports and decrease importation. Recently the Nigerian currency has been experiencing too much devaluation which causes high inflation in the country. This finding is consistent with the previous finding of Okoro *et al.* [9], Adom *et al.* [16], Alexander *et al.* [17] and Ola, A.E [27] but inconsistent with Awang and Imran [18] and Pingfeng, L. [28].

The result also showed that broad money supply is positively related to inflation which indicated that a one percent increase in broad money supply will lead to 1.1 percent increase in inflation. This clearly showed that inflation in Nigeria is a monetary phenomenon. This result is in accordance with quantity theory of money that an increase in money supply tends to boost the inflation in the Nigerian economy.

In Nigeria, increasing the money supply causes demand pressures which will cause demand-pull infation. For instances, from the middle of 2015 to date Nigerian citizen is suffering of inflation due to non-availability of money in circulation. Therefore, in Nigeria financing government expenditure by the creation of money has becomes unavoidable [49-17]. Hence, if the volume of money supply is continue to rise will account for the long

run increase in inflation rate, since the Nigerian's inflation relates to the monetarists' theory of inflation. This finding is consistent with the previous finding of Okoro *et al.* [9], Adom *et al.* [16], Alexander, *et al.* [17] and Ola, A.E [27].

The results showed that the interaction term between broad money supply and exchange rate is negatively related to inflation which indicated that a one percent increase in interaction term will lead to 0.28 percent increase in inflation. This demonstrated that both broad money supply and exchange rate has a small inverse effect on inflation in Nigeria. This result does not comply with quantity theory of money that an increase in money supply tends to increase inflation in Nigeria. This finding also confirmed that money supply, nominal effective exchange rate and inflation are linearly interdependent in Nigeria and that monetary shocks lead to rises inflation. Shocks in nominal effective exchange rate also lead to fall in inflation. The variation in nominal exchange rate has significant impact in determining the fluctuation in inflation than the changes in money supply in Nigeria. This because Nigerian economy is import oriented economy.

Negative sign of gross domestic product (LNGDP) indicated that an inverse relationship between inflation and gross domestic product (LNGDP) that is, an increase in output leads to a decline in inflation of the economy in Nigeria. The negative sign suggested that 1 percent decrease in output in Nigeria will lead to 35 percent increase in inflation. This result is in accordance the demand full inflation. The current situation on Nigeria due to the decreases in output the prices of all goods and services rises. This result is consistent with Hassan, [12] and inconsistent with the work of Orji, *et al.* [26].

Interest rate showed insignificant negative sign. The coefficient having negative sign suggested that one percent increase in interest rate leads to 0.09 percent decrease in inflation. In Nigeria as interest rate increases, cost of production also increases and this increase is transferred to final consumers from producers and eventually inflation decreases. This result is inconsistent with the work of Saleem and Ahmad [50] and consistent with Hassan, [12] and Orji, *et al* [26].

The relationship between financial instability and inflation is found to be negative which indicated that a one percent decrease in financial instability will lead to 0.72 percent increases in inflation. This means that the prices of goods and services are increases in the long run because of continuous decreases of investment. Recently, due to the insecurity and crisis in Nigeria leads many

Table 8: Short Run ARDL Co-integration

Dependent variable is LNINF 44 observations used for estimation from 1970 to 2014				
Variable	Coefficient	SE	t-Statistic	Prob.
$\Delta$ LNEXR	1.5*	0.458	(3.252)	[0.003]
$\Delta$ (LNM2)	0.32**	0.132	(2.396)	[0.023]
$\Delta$ (LNM2EXR)	-0.15**	0.059	(-2.592)	[0.014]
$\Delta$ (LNGDP)	-0.31***	0.170	(-1.805)	[0.081]
ECM(-1)	-0.87*	0.120	(-7.204)	[0.000]
Serial Correlation	1.454[0.251]			
Heteroskedasticity	0.305[0.983]			
Normality JB	0.613[0.736]			

Note: \*, \*\* and \*\*\* show the significance at the 1%, 5% and 10% levels

business men prefer to leave their money in Bank than to invest in the real sectors and no foreign investors are coming to Nigeria. This discourages and kills both infant and large industry which will lead to shortage of goods in the country. This shortage of goods will create more demand of goods which will lead to inflation.

Oil prices (LNOP) is found to be positively related with the inflation in Nigeria. This positive sign indicated a direct relationship between Oil prices and inflation. The result suggested that one percent increase in oil prices will lead to 97 percent increase in inflation in Nigeria. Oil being the major sources of income in Nigeria has influences on almost every sectors of the economy; either it is agriculture, manufacturing or services. As the prices in Oil increases it contemporaneously affects the prices of goods and services as almost 97 percent. Recently in Nigeria the cost of goods and services is very high due to the scarcity and increase of the oil prices.

**Short-Run Co-Integration Test:** In Table 8, results revealed the short-run association among inflation, exchange rate, broad money supply and trade in Nigeria. In theory, the value ECM (-1) must be significant and negative which is exactly the case in the present study. The higher the coefficient, the more stable the short-run association. The estimated coefficient of the ECM (-1) is -0.87 (at 1% significant) signifying that in the absence of variations in the independent variables, deviation of the model from the long-run path is corrected by 87 percent per year, which is very fast. The effect is that, it will take a little time to entirely return to long-run equilibrium if there is a shock to the variables (that is nominal effective exchange rate, broad money supply, gross domestic product, interest rate, oil prices, financial instability and broad money supply nominal effective exchange rate interaction term). The result of the estimation reveals the absence of serial correlation problem, Heteroscedasticity problems and the model is normally distributed.

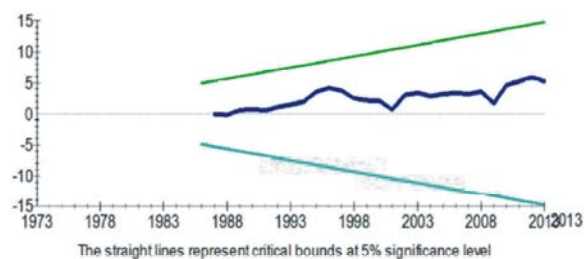


Fig. 1: Plot of Cumulative sum of Recursive Residuals

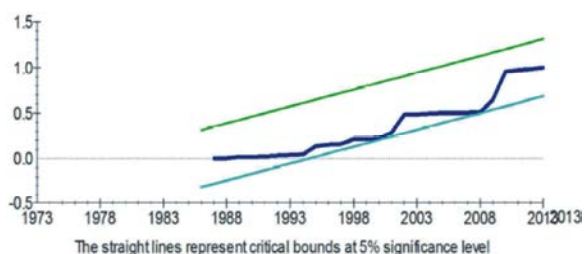


Fig. 2: Plot of Cumulative sum of Squares of Recursive Residuals

The current broad money supply and the previous broad money supply showed significant positive association with inflation in Nigeria given 0.32 percent reaction of inflation to 1 percent increase in the broad money supply. It also showed a significant positive relationship between nominal effective exchange rate and inflation in Nigeria given 1% increase in nominal effective exchange rate will lead to 1.5 percent increase in inflation. The findings revealed a negative relationship between inflation and gross domestic product. This indicated that a 1 percent increase in the gross domestic product will lead to 0.31 percent decrease inflation. Broad money supply nominal effective exchange rate interaction term also revealed a significant negative association with inflation in Nigeria given 0.15 percent reaction of inflation to 1 percent increase in broad money supply nominal effective exchange rate interaction term.

The stability of the ARDL parameters is observed by applying the CUSUM and CUSUMSQ tests established by Brown, *et al* [51]. Figures 1 and 2 showed that the plot of the statistics from the CUSUM and CUSUMSQ remains within the critical bounds at 5% significance level. This entails that all coefficients in the error correction model are stable over time. These selected models adopted in the study appear to be sufficient and strong in estimating the short-run and long-run associations between inflation and the variables selected under study in Nigeria.

## CONCLUSION

The paper analysed the short-run and long-run relationship between inflation and six macroeconomic variables, namely, nominal effective exchange rate, broad money supply, gross domestic product, interest rate, oil price and financial instability using the Autoregressive Distributive Lag (ARDL) Framework. The analysis used annual data for the period from 1970-2014 which are obtained from the United Nation Statistical bulletin, World Bank Statistical Database Indicator and DataStream. It is believed that, the selected macroeconomic variables, among others, represent the state of the economy. The data properties were analyzed to determine the stationarity of time series using the Augmented Dickey-Fuller and Philips-Perron unit root test that indicated that inflation, broad money supply and financial instability have mixed stationarity that is, they are stationary at both first difference  $I(1)$  and level  $I(0)$ , while nominal effective exchange rate, gross domestic product, interest rate and oil prices were non-stationary at level but were stationary at first difference that is  $I(1)$ .

The results of the co-integration test based on F-bound's procedure indicated the existence of co-integration between variables. Based on the findings, the study suggests that the government should give a serious attention on exchange rate stability in order to cut down the domestic prices to stable position. This is because exchange rate fluctuation is taken more portions in explaining Nigeria's inflationary phenomenon. Moreover, Policy makers should still consider monetary policy as a useful tool of achieving price stability especially in the short run due to the causality between money supply and inflation. To pursue price stability as a macroeconomic objective, either monetary policy or exchange rate target could be employed since shocks in both money supply and exchange rate influence variation in inflation. Furthermore, diversification of economy is also needed by the government. This will lead to increase in output and productivity and reduce the over dependency on imported goods, so that the economy will be export based. Hence imported inflation will be reduced.

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