ISSN 1957-2968

CENTRAL BANK OF NIGERIA

A Quantitative Exploration of the Drivers of Inflation in Nigeria
Rapu, S., B. Gaiya, M. Eboreime, M. Nkang, N. Audu, P. Golit and H. Okafor

Modelling the Effect of Exchange Rate Changes on Nigeria's Non-Oil Exports: A Vector Error Correction Model (VECM)
Duke, O., N. Audu and A. Aremu

Currency Demand and Cash Policy in Nigeria: Implications for Monetary Policy
Alley, I.

INSERT

CBN

LOGO

Economic and Financial Review

Volume 54, Number 2
June 2016

Central Bank of Nigeria

Economic and Financial Review

Volume 54, Number 2, June 2016

Aims and Scope

The *Economic and Financial Review* is published four times a year in March, June, September and December by the Research Department of the Central Bank of Nigeria. The Review contains articles on research undertaken at the Bank, in particular, and Nigeria, in general, mainly on policy issues both at the macroeconomic and sectoral levels in the hope that the research would improve and enhance policy choices. Its main thrust is to promote studies and disseminate research findings, which could facilitate achievement of these objectives. Comments on or objective critiques of published articles are also featured in the review.

Correspondence

Correspondence regarding the *Economic and Financial Review* and published articles should be addressed to:

Director of Research/Editor-in-Chief
CBN Economic and Financial Review
Central Bank of Nigeria
33 Tafawa Balewa Way
Central Business District
P. M. B. 0187 Garki
Abuja
Nigeria

Email: info@cbn.gov.ng
Website: www.cbn.gov.ng

Subscription

Subscription to the Central Bank of Nigeria *Economic and Financial Review* is available without charge to individuals and institutions, including corporations, embassies, and development agencies. Articles may be reprinted, reproduced, published, abstracted, and distributed in their entirety on condition that the author and the source—Central Bank of Nigeria Economic and Financial Review—are duly credited.

Disclaimer

Any opinions expressed in the *Economic and Financial Review* are those of the individual authors and should not be interpreted to represent the views or policies of the Central Bank of Nigeria.

Notes to Contributors

Information on manuscript submission is provided on the last and inside back cover of the Review.

Contents

A Quantitative Exploration of the Drivers of Inflation in Nigeria

Rapu, S., B. Gaiya, M. Eboreime, M. Nkang, N. Audu, P. Golit and H. Okafor*

Abstract

The gradual but steady rise in inflation from 7.7 per cent in February 2014 to 9.2 per cent as at end-July 2015 necessitated a re-examination of the drivers of inflation and the extent to which they contribute to headline inflation in Nigeria. This paper, therefore, uses the Fully Modified Ordinary Least Squares regression technique with quarterly data spanning 2000:1 to 2015:1 for the investigation. The results show that in the long-run, money supply, exchange rate, imports, and oil price dynamics are the main drivers of inflation in the economy. Specifically, a 1.0 per cent increase in the money supply exerts about 0.29 per cent increase in inflation rate. Similarly, a 1.0 per cent depreciation in naira exerts about 1.09 per cent increase in inflation, while 1.0 per cent increase in oil price induces about 0.20 per cent rise in inflation in Nigeria. Furthermore, the short-run estimates also support the evidence from the long-run result, indicating that the gap between the current short-run disequilibrium and long-run equilibrium inflation decreases each quarter by 27 per cent. Among others, the paper recommends that the CBN should further consolidate the current restrictive monetary policy stance in order to curtail inflationary pressure and stablise the exchange rate.

Keywords: Inflation, Money Supply, Oil Prices, Monetary Policy, Central Bank of Nigeria

JEL Classification: *E31, E52, E58*

I. Introduction

A monetary authority has the primary goal of achieving price stability, that is, low and steady inflation, characterised by a low level of uncertainty. This goal often conflicts with other objectives such as low unemployment, as amply illustrated by the Phillips curve. High inflation is detrimental to an economy for a good number of reasons: it distorts prices, depletes savings, discourages investment, fuels capital flight, hinders growth, makes economic planning difficult and possibly lead to social and political upheavals.

For these reasons, keeping inflation under control, vis-à-vis the other key rates (interest and exchange rates), has been one of the most daunting tasks of central banks. This is more so in developing countries which are experiencing fiscal imbalances due to dwindling commodity prices that account for large proportions of government revenues. This result to inadequate fiscal buffers and its attendant consequences, such as currency depreciation, depleting external reserves and tight monetary policy stance.

Available statistics indicate that between January 2013 to May 2015, Nigeria has managed to keep headline inflation at single-digit with an all period high of 9.5 per cent in February 2013 and a low of 7.7 per cent in February, 2014. However, as at end-July, 2015, inflationary pressures have heightened substantially, and headline inflation rate is near double-digit, at 9.2 per cent from 9.0 per cent in May. Food and core inflation rates on the other hand, have also risen to 10.1 and 8.8 per cent from 9.8 and 8.3 per cent, respectively, in the month of May.

According to the NBS (2015), the rise in the headline index emanates from the increase in most Classification of Individual Consumption by Purpose (COICOP) Divisions, which contributed much to the increase in the index. Same factor accounted for the increase in

* *The authors are staff of the Research Department, Central Bank of Nigeria. The views expressed in this paper are those of the authors and do not necessarily reflect the opinions of the Central Bank of Nigeria.*

the food and core inflation sub-indices. However, the depreciation of the exchange rate, occasioned by the plunge in oil prices in the international market in 2015, depleting external reserves and increased capital outflows had aggravated the pressures, through imported inflation and cost-push factors. Thus, keeping inflation at these levels for that long period, given the economic fundamentals of Nigeria, has been at a cost to the monetary authority, in terms of liquidity management and defending the value of the naira, using the external reserves.

Consequently, in order to tame the observed inflationary pressures, and perform the core mandate of ensuring monetary and price stability, the Central Bank of Nigeria implemented several measures to mitigate inflationary pressures in the country. The Bank's tight monetary stance reflects part of the measures to moderate inflationary pressures and stabilise exchange rate. In this regard, the Bank had, in November 2014, further tightened its monetary policy stance by raising the MPR from 12 to 13 per cent and, in May 2015, harmonised both public and private sector cash reserve ratio (CRR), which stood at 75 and 20 per cent, respectively, to 31 per cent.

furthermore, the retail Dutch Auction System (rDAS) foreign exchange window was closed in February 2015, followed by a devaluation of the naira to curb speculative attacks on the currency and this curtailed the continued use of reserves by the Bank to defend its value. Additional measures were taken by the Bank to ensure exchange rate stability which included the inclusion of some imported goods and services on the list of items not valid for foreign exchange from the Nigerian foreign exchange market in June 2015; restriction of importation of foreign exchange by banks without the Bank's approval in order to prevent money laundering; among others.

Although the actions of the Bank have been carried out with the belief that inflationary pressures would be doused, evidence from data since the last quarter of 2014 seems to suggest otherwise. Thus, the research questions are: what are the drivers of inflation in Nigeria? Have the main drivers changed over time given the findings of Asogu (1991); Moser (1995); Fakiyesi (1996); Masha (2000); Adenekan and Nwanna (2004) amongst others? What strategies can the CBN pursue in order to mitigate the current inflationary pressures in Nigeria? The objective of this paper, therefore, is to provide answers to these questions by empirically examining the drivers of inflation in Nigeria and recommending appropriate strategies for mitigating the current inflationary pressures in the economy.

The paper is organised in five sections. Following the introduction is Section 2, which covers the stylised facts on inflation in Nigeria, Section 3 is concerned with the literature review, while Section 4 describes the methodology, empirical analysis and discussion. Finally, Section 5 presents the conclusion and way forward.

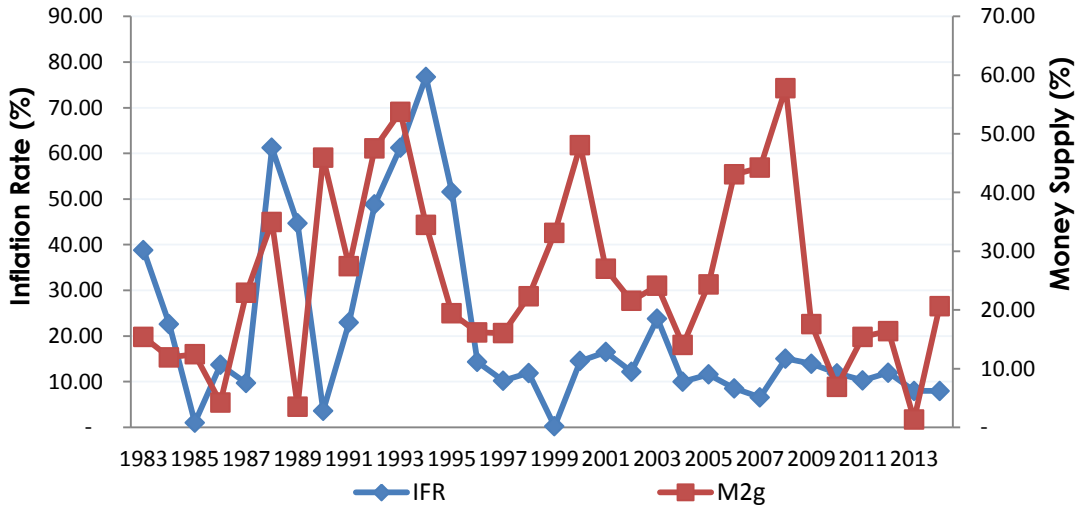
II. Inflation in Nigeria – Stylised Facts

This section utilises both the quarterly and annual data to analyse inflation trends in Nigeria from the 1970s. Where historical data for most of the relevant variables are unavailable on a quarterly basis (specifically before the 1990s), the analysis was based on annual data. Trends in Nigeria's rate of inflation indicate that the country has experienced episodes of high, moderate and low inflation. Four major episodes of high inflation, exceeding 30 per cent have been identified in the literature since the mid-1970s. The high inflation rates that epitomised the 1976 period were attributed to the growth in monetary aggregates, which

triggered inflation rates in excess of the corresponding targets. Figure 1a demonstrates the relationship between the growth in money supply and the rate of inflation in Nigeria over the years, with periods of high monetary growth largely associated with periods of high inflation rate, and vice versa.

Masha (2001) ascribed the high rates of inflation noticed during the mid-1970s to structural characteristics of the economy, which preceded the growth in money supply. These included supply shocks, arising from such factors as famine, currency devaluation and changes in terms of trade. The drought that swept through the Northern Nigeria devastated agricultural production, leading to high cost of food items, a significant component in the computation of the consumer price index (CPI). Another important factor was the monetisation of revenue from oil export, which pushed the rate of inflation to over 38 per cent in 1983, thereby giving credence to the monetarist argument that inflation is essentially a monetary phenomenon. This was also at a time when the country was under pressure from foreign creditors to devalue its currency as a precondition for debt negotiations. The growing inflation expectations fuelled inflationary pressures with prices adjusting in tandem with the parallel exchange rate.

Figure 1a: Relationship between Growth in Money Supply (M9%) and Inflation Rate (INF%)

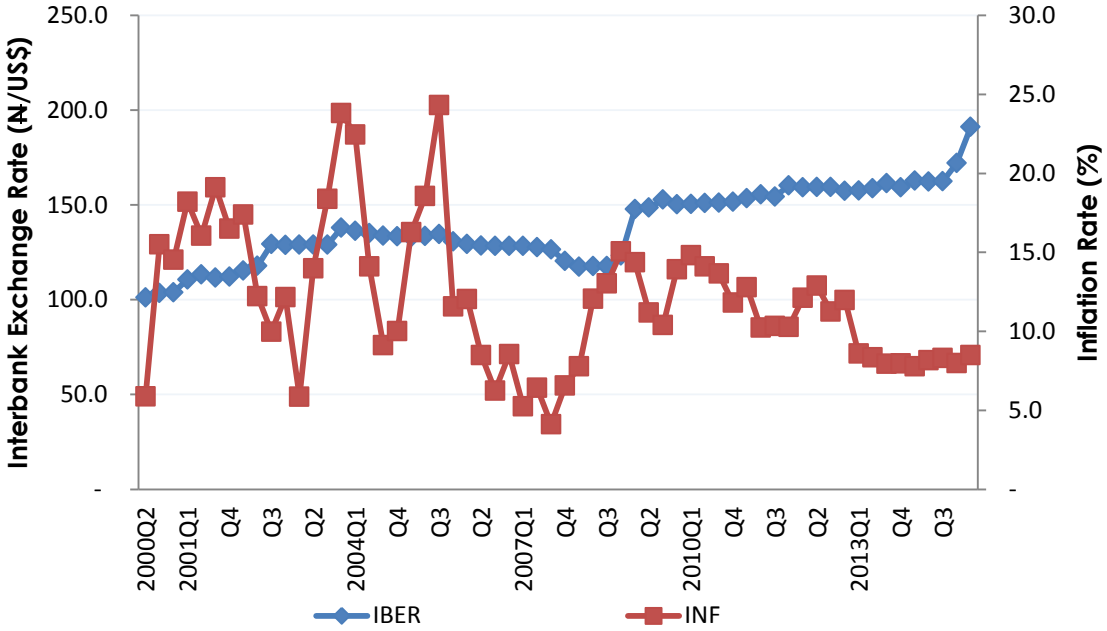


Another episode of high inflation was in the late 1980s (from late-1987 to 1989). The high inflation episode in this period was traceable to the impact of wage increases that trailed the implementation of the Structural Adjustment Programme (SAP) in mid-1986. This triggered cost-push inflation, with structural bottleneck which characterised the economy and the ensuing growth in monetary aggregates, sustaining it to long-lasting increases. The high inflation rates of the late 1980s had also been linked to the worsening terms of external trade, which the country experienced during the period. This caused inflation rate to rise to about 61 per cent in 1988, from around 10 per cent in 1987.

The late 1980s high inflation episode was also attributed to the fiscal expansion that accompanied the 1988 budget. The central bank financing of the budget amounted to an injection of high-powered money, the inflationary effect of which was aggravated further by the monetisation of huge forex inflows accruing from the high oil prices that followed the Persian Gulf War. Furthermore, the debt-equity swaps that followed the debt conversion programme, implemented during the period, led to the repurchasing of external debt with fresh domestic currency, thereby worsening inflationary pressures. The

Central Bank of Nigeria had to take drastic measures in mid-1989 through a barrage of policies designed towards monetary contraction, thereby bringing inflation to its lowest level in 1990 over a half-decade.

Figure 1b: Relationship between Inflation Rate (INF {%}) and Interbank Exchange Rate (IBER{N/US$})



The last episode of high inflation ranged from 1993 to 1995. The rate of inflation that was building up in late 1992 reached an unprecedented level of 76.8 per cent in 1994 and further climaxed to an all-time high of 76.8 per cent in 1994. Banking system financing of budget deficits and massive build-up of monetary aggregates comparable to the inflationary episode of the 1980s, coincided with the last episode of high inflation. Like in the last episode, banking system liquidity and growth of domestic credit to the private sector precipitated the growth of money supply to 53.8 per cent in 1993. Other factors included the heightened agitations for higher wages, necessitated by the decline in purchasing power, resulting from the sustained increase in inflationary pressures. The rising wages culminated in cost-push inflation, as producers adjusted prices in response to the changing cost structures. Relative to the periods of high inflation discussed above, the rate of inflation moderated to 23.8 per cent in 2003. It declined substantially from 14.3 per cent in 1996 to about 8 per cent at end-2014. Since end-2013, inflation rate has remained within the single digit threshold.

Two major episodes of low inflation are easily identifiable from Figure 1b. The first regime of low inflation was recorded from 2006 to 2008, with an all-time low of 4.1 per cent in the third quarter of 2007. This coincided with the period of 2008/2009 Global financial melt-down, which was accompanied by severe cash crunch linked to significant reductions in global liquidity and growing demand for fiscal stimulus. The proactive use of monetary instruments led to sustained macroeconomic stability and renewed confidence in the financial system, which combined to sustain low rates of inflation. The second episode of low inflation stretched from the first quarter of 2013 to July, 2015, remaining at the single digit mark. The harmonisation of monetary and fiscal policies, coupled with the proactive use of monetary instruments have delivered and sustained the present low inflation. However, the current crisis in the international oil market is posing significant threats to

monetary stability, in view of the exchange rate pass-through of the cost of imported input to domestic prices.

Figures 2a and 2b demonstrate the relationship between the growth in imports and inflation rate in Nigeria with both variables moving in the same direction for most parts of the periods. The pressure in the foreign exchange market has led to considerable depletion of the country's external reserves, with dire consequences for the central bank's ability to defend the international value of the domestic currency. The devaluation of the currency to ease pressure on the naira exchange value has contributed to higher inflation with the rate of inflation, estimated at 9.2 per cent at end-July 2015.

Figure 2a: Relationship between Growth in Imports (%) and Inflation Rate (INF{%})

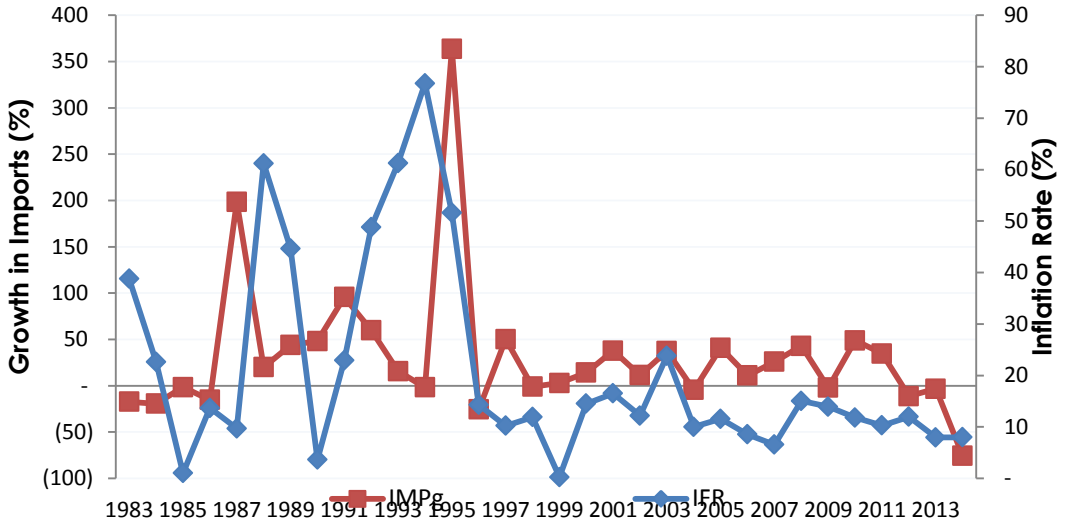
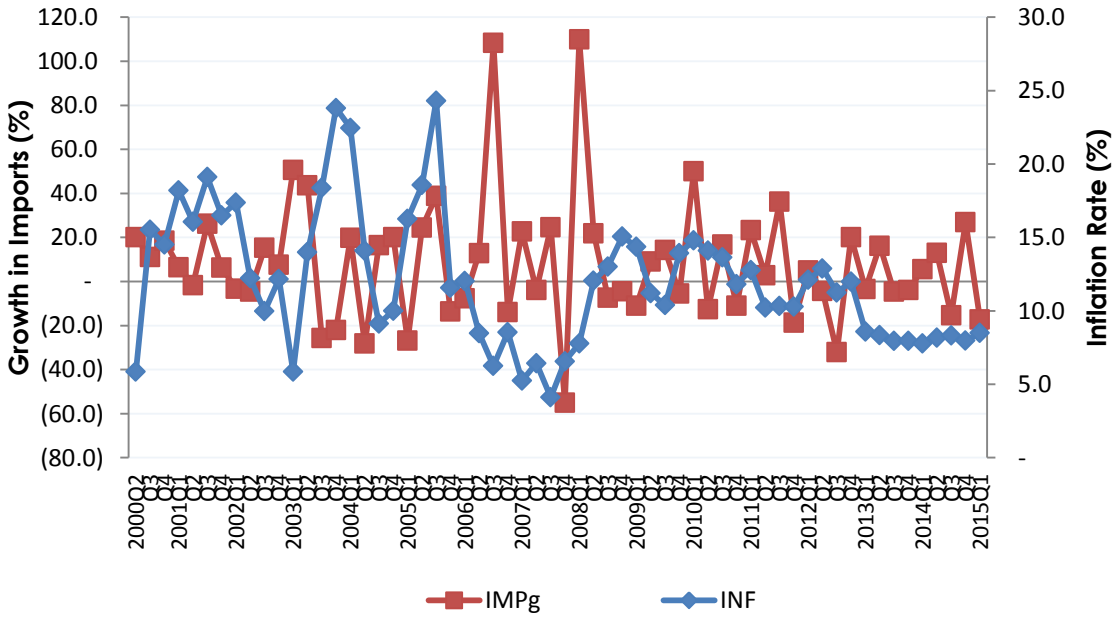


Figure 2b: Relationship between Growth in Imports (%) and Inflation Rate (%)



In sum, the review of inflation episodes has shown that the incidences of high inflation in Nigeria have originated from both demand and supply-sides. The variations in monetary

aggregates accounted for the demand-side factors, while some structural impediments like unfavourable climate and import-dependent production structure, accounted for the supply-side factors.

III. Literature Review

III.1 A Theoretical Review of Inflation

The notion that inflation correlates to excessive growth in money supply dates back to the sixteenth century. However, it was only in the early part of the twentieth century that Fischer formulated the well known quantity equation of money, which was basically a part of the overall framework of the classical theory (Nikitin 1995). The classical theory postulates that when the quantity of money in circulation rises, the value of a unit of money in real terms or the reciprocal of the general price level declines, which translates to a rise in the general price level (Ireland, 2014).

Fischer, in 1911, provided a concise equation to capture the classical theory of inflation as follows:

$$MV = PT \qquad (1)$$

Where M is the money stock, V is the velocity of money, which refers to the number of times a given stock of money is turned over each year in financing economic transactions; P is the price level; and T is transactions. The level of transactions is directly related to money supply. Since T is difficult to measure, national output Y is substituted into the equation as stated:

$$MV = PY \qquad (2)$$

This defines the quantity theory of money. If V and Y are assumed to be fixed, any monetary injection is transmitted into a rise in the price level (Dornbusch, Fischer and Richard 2008). As Nikitin (1995) observed, the quantity theory of money was flawed on several grounds, which inter alia, includes the constancy assumptions of V and Y, as well as the strict proportionality condition between M and P. The failure of neo-classical economics (which encompasses the quantity theory) to provide any solution to the great depression of 1930s led to the rise of the Keynesian economics.

Keynes rejected the notion of an unfailing self-regulatory economic system enshrined in the neoclassical doctrine, which proved to be grossly disappointing during the great depression. The suggested that an increase in government spending or demand would pave the way out of depression, and this is the fundamental idea underlying the emergence of the demand theory of inflation. Thus, the theory of demand-pull inflation draws from the fact that when there is a positive output gap, at full employment, an inflationary gap will rise. The notion of demand-pull inflation is predicated on the Keynesian IS-LM framework, where demand for output determines supply up to the full employment level. The framework assumes an exogenous price level and a significant amount of unemployed labour and underutilised capacity in the economy. In this scenario, firms' short- run average cost will remain unchanged as more output is produced in response to increasing demand. The price level will not change over this range where output is perfectly elastic (Levacic and Rebmann 1982). Keynesianism led to the idea that low inflation is often necessary to (and it is in harmony with) the normal growth process. According to Hodes and Synder (1981), the demand-pull theory, however, failed to

explain why inflation persists during recessions, and that deficiency led to the development of cost-push theories that emerged in the late 1950s.

Cost push theories attempt to explain inflation from the supply side perspective in terms of increases in production costs, for instance, wage hikes through the exercise of trade union power, rise in input/material costs, negative supply gap and market structure (Totoncchi 2011). However, Batten (1981) criticised the cost-push hypothesis and concluded that it was a myth. First, Batten averred that despite the intuitive appeal of the cost-push argument, neither economic theory nor empirical evidence indicated that labour and businesses could cause continually rising prices. The first premise of Batten's argument was that if labour unions succeeded in getting wage hikes, given that money stock remains unchanged, there would be no additional money for them to hold to meet up with increase in demand for larger real money balances. Consequently, workers must decrease their demand for goods and services, which would lead to decline in aggregate demand and a fall in the general price level to that prevailing before the wage increase. Batten based his second argument on the proposition that if a firm, with market power, such as a monopolist, raised price arbitrarily, the quantity of output sold must fall since the firm faced a downward sloping demand curve. The implication was that continuous increase in price would translate into smaller and smaller profit and this would ensure that a monopolist would have no incentive to raise price continuously.

Another major approach that was used to explain inflation in 1950s, and which became a centre-piece of macroeconomic management throughout 1960s in advanced capitalist economies, is the Phillips curve (PC). The empirical findings between the rate of inflation and the rate of unemployment provide clear evidence of a negative relation or trade-off, involving the two macroeconomic variables. Therefore, with an expected inflation of zero, lower unemployment leads to higher nominal wage and higher price level, and vice versa. In this case, the short- and long-run trade-off between inflation and unemployment coincides, indicating that the PC is non-vertical (Karanassou, Sala and Snower, 2006).

However, in the 1970s, the increase in non-labour costs (especially the two oil price shocks), coupled with positive inflation expectations and the attendant problem of stagflation, resulted in the abandonment of Keynesianism, as well as the traditional PC whose interpretation of inflation was rooted in the Keynesian framework.

Consequently, in the 1970s and 1980s, there was a resurgence of neoclassical economic theory in the form of monetarism – a school of thought that is predicated on the quantity theory of money. Monetarists refuted the Keynesian prescription of government interventions in economic affairs, including the notion and practice of deficit spending (Nikitin 1995). Monetarism is hinged on laissez faire, belief that the economy is always near or close to full employment (thus negative output gap is small or negligible) and that changes in the quantity of money in circulation will only affect the price level in the equation of exchange in the long-run. This idea of the long-run neutrality of money accounts for the observation by Friedman that inflation is always and everywhere a monetary phenomenon – an assertion that implies that any growth in money supply finds its way one-for-one into an increase in the inflation rate in the long-run. One of the notable policy prescriptions of monetarists is that the control of money supply should not be left to the discretion of monetary authorities, but that a set of rules should be followed by these institutions. Nevertheless, in the short run, money growth will impact nominal output (Blanchard 2009). Furthermore, monetarists place a large premium on inflationary

expectations, which brought about the expectation-augmented PC (Karanassou, Sala and Snower 2006).

Although, monetarism held sway in the US and in some other countries in the 1970s and 1980s, majority of developing countries continued to follow the path of Keynesian prescriptions. In Latin America, new original theories based on their experience developed – the structural theories of inflation (Nikitin 1995).

The structural (sectoral) demand-shift theory, for instance, is predicated on the perspective that inflation is not just a cost-push or aggregate demand phenomenon; rather, aggregate demand may remain constant but there could be sectoral adjustment or shift in the demand composition of various industries – some industries may enjoy a boom in demand and concurrently, others could experience a downturn. But an important point to note is that prices generally rise in response to higher demand and they are downward sticky when demand declines. Therefore, the net effect of rapidly rising prices in certain sector in high demand and near static price movements in other sectors with falling demand is inflation. Also, the bottle-neck inflation hypothesis is based on empirical evidence gleaned from studying several episodes of inflation. The findings indicated that inflation was not simply due to wage-price spiral, but that there were certain capital good industries whose products enjoyed high demand and transmitted inflationary pressures to other sectors of the economy. These industries are known as bottle-neck industries. An increase in the demand of the products of these industries generates a rise in wages and prices, which is subsequently transmitted to the rest of the economy through purchases made by other firms. This type of inflation occurs despite the existence of widespread excess production capacity in the economy (Dewett and Chand 2001).

According to Wachter (1979), Latin American structuralists believe that the money stock responds to inflation rather than initiating it (see Neil 2004 for the case of South Africa). The causative factors of inflation are considered not to be linked to monetary and fiscal policies but to the weak and underdeveloped social and economic structure of Latin American countries.

The New Keynesian Phillips curve (NKPC) was derived by Roberts in 1995 (cited in Wikipedia). Following Sill (2011), the NKPC can be represented as the deviation of inflation from its expected long-run value *(π_t),* which is modelled as a function of expected value today of the deviation of inflation tomorrow from its expected long-run value and the deviation of marginal costs from its long run expected value:

$$\pi_t = \beta E_t[\pi_t + 1] + kmc + \varepsilon_t \qquad (3)$$

The residual represents stochastic circumstances that warrant mark-up in firms' prices. The key assumptions of the model are that firms have some market power to set prices (imperfect competition) and that firms do not adjust prices frequently (nominal rigidity). These assumptions make it possible for monetary policy to influence the real economy through positive interest rates. The import of these assumptions for inflation is that firms set their prices by taking into consideration the expected future behaviour of marginal costs (over the horizon in which set prices are expected to remain constant). Thus, expected firms' marginal costs are a key driver of inflation in NKPC whereas in the traditional PC, the inflation driver is the unemployment rate.

III.2 Review of Related Empirical Literature

The body of empirical evidence on the drivers and/or determinants of inflation and inflation expectations are vast. Thus, the scope of the empirical review covers studies on Nigeria and other countries.

Asogu (1991) investigated the nature and causes of inflation in Nigeria, using annual time-series data from the period 1960 and 1989, incorporating monetary, structural, demand-pull, cost-push and external factors. He hypothesised that the rate of inflation was jointly and severally determined by money supply lagged one period, real domestic output, credit to the economy, government expenditure, import price index, industrial production index, food price index, and the naira/US dollar exchange rate. Using the OLS regression technique, several combinations of the explanatory variables (in first differences and in logs respectively) were solved. Results indicated that real output, current money supply, domestic food prices and exchange rate were the major determinants of inflationary pressures. The study thus emphasised the need for fiscal discipline, via a reduction in the fiscal deficit financing, intensifying measures that would enhance domestic output and productivity, as well as a more pragmatic exchange rate policy to stem capital flight, in order to curtail inflationary pressures.

Moser (1995) assessed the main determinants of inflation in Nigeria using annual time-series data from 1960 to 1993 within the co-integration and error-correction modelling framework. The variables used were nominal broad money, the naira/U.S. dollar exchange rate, expected nominal foreign interest rates adjusted for the expected change in the exchange rate, expected inflation and foreign prices, real income and rainfall. Results showed that in the long-run, money supply, income, and the exchange rate significantly explained the price level. Similarly, in the short-run, money growth, income, expected inflation, the exchange rate and agro-climatic conditions, all significantly predicted current inflation. The author concluded that monetary expansion, driven mainly by expansionary fiscal policies, explained to a large degree, the inflationary process in Nigeria.

Fakiyesi (1996) investigated the major determinants of inflation in Nigeria, using annual data from 1960 to 1994 and ordinary least squares (OLS) econometric method to analyse the data. The independent variables used were growth in broad money supply lagged one period, official naira/US dollar exchange rate, growth in real income, the level of rainfall, and the anticipated level of inflation. The empirical results showed that lagged growth in broad money supply and the exchange rate, significantly impacted inflation in Nigeria during the period under consideration. Of note is the fact that a 1 per cent growth in the exchange rate led to a more than proportionate rise in inflation. Growth in real income and rainfall were weakly significant in explaining inflation during the period. The paper concluded that continuous devaluation of the naira increased domestic prices and thus the need to limit the expansion of monetary growth and fiscal discipline.

Masha (2000) sought to provide new perspectives on inflation in Nigeria with particular emphasis on the impact of parallel market exchange rate on prices, using annual data spanning 1971 to 1995 and the two-stage least squares (2SLS) single equation instrumental variables method for estimation. Two models were estimated. Model 1 incorporated official exchange rate, parallel exchange rate, foreign prices, and lagged price level, while model 2 included stock of money and income level in addition to the variables mentioned in model 1. Results of the study showed that the parallel market exchange rate was significant in explaining inflation. However, although the official exchange rate carried the expected sign, it was not significant at conventional levels. In addition,

inflation expectations, changes in the stock of money and output also significantly explained changes in inflation during the period under study. The study concluded that, in addition to conventional determinants of price level change, the cost-push effect of the parallel market exchange rate on production was significant for price level change in Nigeria, and thus had important implications for prices, productivity and export competitiveness.

Adenekan and Nwanna (2004) investigated inflation dynamics in Nigeria, with the objective of exploring the ultimate sources of inflation in Nigeria. Using the co-integration and error-correction modelling framework, the authors analysed annual time-series data on consumer price index, money supply and exchange rate from 1959 to 2002. The findings showed that changes in the price level in the immediate past period was a major driver of inflation rate, suggesting a possibility of a self-generating inflationary process. However, money supply exerted a fairly significant influence on inflation, while the impact of exchange rate was not significant in the short-run. They concluded that the monetary authority should ensure monetary control in order to mitigate the problems of inflation and exchange rate depreciation.

Olubusoye and Oyaromade (2008) studied the main sources of fluctuations in inflation in Nigeria, based on annual data spanning 1970 and 2003, using an error correction model. The variables used included expected inflation, fiscal deficit/GDP ratio, gross domestic product, interest rate, money supply, oil prices, average rainfall, and real exchange rate. The empirical results showed that lagged CPI, expected inflation, petroleum prices and real exchange rate influenced the inflationary process in Nigeria significantly. However, the level of output and lagged money supply were not significant in explaining inflationary trends during the period. The study concluded that efforts geared toward stabilising the domestic price level would continuously be disrupted by volatility in the international price of crude oil; thus, the need for diversification of the economy.

Hossain (1989) examplified a monetary model to assess inflation in Bangladesh based on the hypothesis that inflation in Bangladesh was a monetary phenomenon. The study used OLS and Instrumental variables technique to analyse quarterly time-series data from 1972:2 to 1985:4. Results showed that changes in the prices of traded goods in the international market, real permanent income, real money stock, one period-lagged rate of inflation, and changes in the terms of trade between traded and non-traded goods were found to be the major determinants of inflation in Bangladesh.

Siregar and Rajaguru (2005) examined the sources of Inflation in Indonesia during the Post-1997 Financial Crisis, using annual time-series data. The variables utilised in the model were money supply, nominal domestic interest rates, expected depreciation, foreign interest rates and output and the findings showed that a significant rise in the expected depreciation of rupiah and a loose management of base money, particularly during the early stage of the 1997 financial crisis, had strong influence on inflation. In addition, they found that the adoption of a more flexible exchange rate regime in August 1997 made the rupiah more volatile and inflationary. However, there was limited evidence on the roles of monetary variables in explaining the inflation rate during the pre-1997 period. Thus, they concluded that the success of the country to manage its inflation during the pre-crisis period was due largely to its ability to keep the money supply growing at an acceptable rate of around 25 per cent.

Khan and Schimmelpfennig (2006) investigated the factors that explain and forecast inflation in Pakistan, using money supply and credit to the private sector. The study

employed monthly time-series data, spanning January 1998 to June 2005 and relied on the vector error-correction model for analysis of the data. Their results showed that monetary factors determined inflation in Pakistan, and that they were good leading indicators for future inflation. Furthermore, broad money growth and private sector credit growth were the key variables that explain inflation developments, with a lag of around 12 months. Finally, it was found that a long-run relationship existed between inflation and private sector credit. Thus, the study concluded that the monetary authority in Pakistan should implement monetary policy, with a view to meeting its inflation target around 12 months from the day the inflation target was announced.

Dua and Guar (2009) used quarterly data from 1990 to 2005 to investigate the determination of inflation in the framework of an open economy forward-looking, as well as conventional backward-looking, Phillips curve for eight Asian countries, using the instrumental variables estimation technique. Their findings revealed that the output gap was significant in explaining the inflation rate in almost all the countries investigated.

AfDB (2012) applied multivariate analysis to annual data from 1961 to 2010 to unpack the factors behind the high inflation rates in Ethiopia, Kenya, Tanzania, and Uganda. In Ethiopia and Uganda, they found that the main driver of short-run inflation was a surge in the money supply accounting for 40 and 33 per cent respectively. In Kenya and Tanzania, oil prices seemed to drive inflation, accounting for 20 to 26 per cent, respectively. They found that the differences in inflationary effects were due to differences in the intensity of monetary policies.

From all the reviews in Nigeria, only Olubusoye and Oyaromade (2008) included oil price as one of the determinants of inflation in their analysis. As a key variable that affects domestic prices in Nigeria, its exclusion in an analysis of this sort may not sufficiently explain inflation dynamics in the country. Thus this study fills this gap by not only including oil price in the analysis but also extending the period of analysis, in Olubusoye and Oyaromade (2008) from 2003 to 2015. This is done with the view that both the structure of the economy and policy environment would have changed substantially. Hence the dynamics of inflation would have also changed. Thus, requiring a more current investigation.

III.3 Country Experiences in Taming Inflation

In this sub-section, we present the experiences of some countries that had experienced high inflation and the measures they took to tame inflation.

Canada

Due to expansionary monetary and fiscal policies in the early 1970s in Canada, money supply expanded rapidly and she had an inflationary gap, which was created as real GDP grew faster than its potential level. By 1981, inflation hit 12.5 per cent. By this time, rapid inflation seemed firmly entrenched, and a major controversy arose over how to reduce it. The Bank of Canada adopted a highly restrictive monetary policy regime of high interest rates, as the prime rate was raised to 22.5 per cent. The high interest rates, in addition to the recession - which moderated wages and price increase caused inflation rate to fall from a peak of over 12 per cent to about 4 per cent, by early 1984.

Annual inflation did not rise above 6 per cent between 1983 and 1991. Since 1991, the inflation-targeting monetary policy adopted by the Bank of Canada had kept inflation

below 3 per cent. Thus, a restrictive monetary policy and the adoption of inflation-targeting regime had helped to keep inflation at low and stable levels in Canada, after the episodes of high and rising inflation.

Brazil

By the mid- 1980s, the progressive dis-organisation of the Brazilian economy had reached a point that inflation rates were in the range of 10 to 20 per cent a month, while real output was showing an oscillating pattern around zero rates of growth. A stabilisation plan was conceived to stem high inflation. Several plans were pursued, beginning with the Cruzado Plan of 1986, up to the Orthodox Monetary Policy (Garcia et al., 2014).

In 1993, the Real Plan, which was implemented in three steps, helped addressed the inflationary problem. The step involved balancing the budget. The next step was to convert most contracts to "units of real value", (URV) that served only as a unit of account, not a means of exchange or store of value, in order to "de-index" the economy. Prior to July 1994, In the three months, goods in shops were priced in the old, depreciating Cruzeiro, which was linked roughly one-to-one to the dollar. The URV's apparent stability, therefore, quelled Brazilians' anxiety over the risen future price. Finally, the Real (the new Brazilian currency) replaced the URV and the Cruzeiro on July 1, 1994. Consequently, the rate at which prices increased dropped dramatically from July 1994 onward.

Brazil adopted inflation targeting (IT) in the aftermath of the devaluation and floating of the real in 1999. The early years of IT in Brazil were marked by 3 waves of currency depreciation: The Real depreciated by 48.9 per cent in 1995; 18.5 per cent in 2001; and 53.2 per cent in 2002. Inflation expectations played an important role in the IT regime. Regular surveys of market expectations were taken among 100 professional forecasters-mainly financial institutions-and a summary of consensus forecasts was published weekly. Oftentimes, however, the expectation forecasts were moderated by the Banco Central do Brasil (BCB) to prevent short term developments from conditioning medium-term outlooks. Generally, the use of monetary policy under IT and the overall improvement in macroeconomic fundamental had contributed substantially to create a more stable and predictable environment (Bevilaqua, Mesquita, Minella, 2007).

Argentina

Argentina, which is a net exporter of agricultural produce, such as beef and wheat had a long standing battle with inflation. However, due to constant domestic crisis, poor governance and fluctuating commodity prices, the economic fortunes of Argentina have dwindled. By the early 1950's, inflation rose to 40 per cent and real wages plunged as commodity prices fell. By 1976, annual inflation stood at over 600 per cent, leading to rising inequality and an explosion in foreign debts. Due to incessant policy somersault (between 1930 and 1983, presidents averaged only 2 years in office, while ministers of economic affairs were replaced nearly every year), it was difficult to stabilise the economy (Marsh and Winter, 2014).

By 1989, with swelling public payrolls and stagnant revenue, inflation reached an unprecedented 5000 per cent. Under the government of Carlos Menem in the 1990's, foreign investments were cultivated, import tariffs slashed, and state-owned enterprises (SOE) privatised. The government also came up with the BONEX conversion plan (the obligatory conversion of commercial bank time deposits into external bonds of the treasury) to halt the hyperinflationary trend. Inflation fell to single digit as a result of the introduction of a currency peg. The establishment of a currency board, which pegged the

peso to the dollar, made imports cheaper and helped curb inflation. The currency board arrangement became the hallmark of the stabilisation plan of the 1990's. However, exports were put at a comparative disadvantage. Furthermore, the pegged rate gave Argentina less flexibility with its monetary policy; thus, monetising its growing debt by printing money and fuelling inflation (Paddock, 2002). This led to the shrinking of the economy by a fifth and a sovereign debt default of over USS100 billion. By 2014, the government was forced to devalue the Peso, as high government spending on social welfare programs, printing of new money and an ailing currency fuelled inflation rate.
The key strategies used by Argentina in taming inflationary pressures over the years thus included: comprehensive liberalisation of foreign trade and capital movements; privatisation of public enterprises and the deregulation of the economy; and reduction of the bureaucratic apparatus of the public sector and the reconstruction of the tax system.

Uganda

During the 1980s and the first half of the 1990s, inflation in Uganda ranged between 2 and 3 digit figures, with an annual average of more than 100 per cent, during 1981 – 1989 (Barungi, 1997). The highest recorded annual figure was more than 200 per cent in 1986/87. The country was, at that time, characterised by a near collapse of the productive sectors and economic mismanagement that contributed greatly to the surge in inflation.

To stem the tide of hyperinflation, the government adopted a national economic recovery programme, which hinged on price, trade and exchange rate liberalisation, restoration of fiscal discipline and adherence to anti-inflationary monetary policy stance, using a tight reserve money programme to buttress by a cash-budget fiscal rule. (Kuteesa, et al., 2006). As at May, 2015 headline inflation in Uganda was 4.9 per cent under the inflation-targeting lite monetary policy framework.

Lessons for Nigeria

Based on the experiences of the countries reviewed, the lessons Nigeria can draw are summarised below:

- Inflation targeting was applied by both Brazil and Canada in moderating inflationary pressure. Nigeria could consider operating a full-fledged inflation targeting regime, if the need arises. In addition, the survey of inflation expectations, used by the BCB could be emulated by the CBN. In this case, selected financial professionals, both individuals and organisations, could be surveyed on their expectations for inflation. The consensus could form the basis for policy decisions. However, just like the BCB, the CBN must be proactive in order to safeguard against expectations that are formed which are not scientific but, based on overreactions to economic phenomena;
- The combination of a restrictive monetary policy and inflation targeting in the case of Canada and Uganda is also instructive. In addition, Uganda applied a tight reserve money programme in taming inflationary pressures; and
- Fiscal discipline was also a factor in taming inflationary pressures in all the cases but especially in Argentina and Uganda, where the budget had to be balanced as a first step in stemming the tide of inflation. In the end, after successfully

overcoming episodes of high inflation, most of these countries have adopted inflation-targeting framework to keep inflation low and stable with the cooperation and compliance of the fiscal authorities.

IV. Methodology

IV.1 Data, Sources and Description

This study employed quarterly data spanning 2000:1 to 2015:1, sourced from the Central Bank of Nigeria Statistics database. The variables included consumer price index, broad money supply, gross domestic product, inter-bank exchange rate, interest rate, imports, and oil price. Specifically, consumer price index was used to capture inflationary dynamics in the economy, while inter-bank exchange rate, oil price and imports were measures of external shocks. The broad money supply and lending rate, which responded largely to changes in policy rate, were used to examine the effect of monetary variables on inflation. The data were subjected to diagnostic checks, such as the unit root and co-integration tests to ensure that the inferences drawn from the results were not misleading.

IV.2 Model Specification

This study modified the AfDB (2012) and Dua and Gaur (2009) inflation models to include other key variables[1]. It applied the Error Correction Mechanism (ECM) technique to estimate the short-run and long-run determinants of inflation in Nigeria. Thus, the model is specified as;

$$\pi_t = \alpha_0 + \beta M_t + \gamma Y_t + \phi IBr_t + \lambda \Pr_t + \psi Z_t + \delta Op_t + \varepsilon_t \qquad (4)$$

Where:

π = composite price index (inflation), M_t = growth of broad money supply, Y_t = GDP, IBr_t = inter-bank exchange rate, $\Pr_t$ = interest rate, Z_t = imports, Op_t = oil price, ε is the error term. $\alpha, \beta, \gamma, \phi, \lambda, \psi, and\ \delta$ are parameters to be estimated.

Given that adjustments in these macroeconomic variables are not instantaneous but follow random walk processes, equation 4 is transformed into an autoregressive form as;

$$\pi_t = \alpha + \sum_{i=1}^{n} \eta_i \pi_{t-1} + \sum_{i=1}^{n} \beta_i M_t + \sum_{i=1}^{n} \gamma_i Y_t + \sum_{i=1}^{n} \phi_i IBr + \sum_{i=1}^{n} \psi_i Z_t + \sum_{i=1}^{n} \lambda_i \Pr + \sum_{i=1}^{n} \delta_i Op_t + \varepsilon_t \qquad (5)$$

Where, n is the lag length. This enables us to include inflation expectations in the model. The optimal lag length in equation (5), was selected using the Schwartz information criterion (SIC) and Akaike information criterion (AIC). Since equation (4) helped to determine the long-run relationship and given the stochastic behaviour of the data, equation (5) was re-specified as an error-correction model to capture short-term

[1] Based on the new Keynesian framework, which incorporates structural, monetary, fiscal and external influences in driving inflation.

disequilibria vis-à-vis long-run equilibrium. Thus, error-correction specification of the model was given as;

$$\Delta\pi_t = \alpha_0 + \sum_{i=1}^{n}\alpha_1\pi_{t-1} + \sum_{i=0}^{n}\alpha_2 M_{t-1} + \sum_{i=0}^{n}\alpha_3 Y_{t-1} + \sum_{i=0}^{n}\alpha_4 IBr_{t-1} + \sum_{i=0}^{n}\alpha_5 Z_{t-1} + \sum_{i=0}^{n}\alpha_6 \Pr_{t-1} + \sum_{i=0}^{n}\alpha_7 Op_{t-1}$$

+…

$$+\alpha_8[\pi_t - \beta M_t - \gamma Y_t - \phi IBr_t - \psi Z_t - \lambda \Pr_t - \delta Op_t]_{t-1} + \varepsilon_t \qquad (6)$$

Equation (6) is the error-correction model (ECM), which incorporated the short-run and the long-run behaviour of inflation in Nigeria. The term, in bracket, represented the error-correction adjustment mechanism, which showed the speed of adjustment. The parameters $(\alpha_1 - \alpha_7)$ in log-difference of the variables captured the short-run responses. Since a log transformation of the all variables was carried out, the estimates were interpreted as elasticities.

IV.3 Estimation Procedures

Given the stochastic behaviour of most time-series, the data were subjected to diagnostic checks, such as unit root and co-integration tests. Thus, the behaviour of the series, following the diagnostic checks, justified the choice of the model and estimation technique for analysis. Since all the series were order one, I(1), this paper employed the ECM-based ordinary least square technique to estimate the main drivers of inflation in Nigeria. The choice of this technique is to help in tracking the short and long-term drivers of inflation in Nigeria.

V. Empirical Analysis and Discussion of Findings

The results of the unit root tests revealed that the variables were stationary at first difference. This suggested that the variables were integrated of order (1) (see Appendix Table 1). Next, the Johansen co-integration test indicated that a long-run relationship existed among the variables. Specifically, the result showed that there were four co-integrating equations based on the Eigenvalue and Trace statistic, suggesting the existence of a long-run relationship among the drivers of inflation in Nigeria (see, Appendix Table 2).

Following the result of the co-integration tests, the long-run estimates from equation 4 and estimates from the short-run error-correction equation, were presented in Tables 1 and 2. Table 1 revealed that in the long-run, money supply, exchange rate and oil price were the main drivers of inflation in Nigeria. The estimates indicated that a 1 per cent increase in money supply exerted significantly about 0.29 per cent rise in inflation rate. Although the change was less than proportionate. This result conformed to the Monetarist school of thought that inflation is always a monetary phenomenon.

Similarly, the inter-bank exchange rate was positive and statistically significant. A 1 per cent depreciation in Naira led to a proportionate increase in inflation; thus, reinforcing the inflationary impact of exchange rate depreciation in Nigeria. The high magnitude showed the pervasive nature of the exchange rate depreciation in the long-run, particularly since Nigeria is an open-developing economy that is highly import-dependent. Furthermore, the results showed that oil price changes also play a significant role as a driver of inflation in

Nigeria. Specifically, a 1 percentage rise in oil price induced about 0.20 per cent rise in inflation in Nigeria.

Intuitively, a fall or rise in oil price for an oil exporting country could exacerbate inflation, depending on the transmission channel. For instance, higher oil prices could result in increase in external reserves and money supply that could exacerbate inflation, if restrictive monetary policy is not applied. On the other hand, low oil price could put pressure on external reserves and depreciation of the currency. Thus, the pervasiveness of the inflationary impact of oil price is dependent on the level of dependence on importation from other economies. Intuitively, since Nigeria is largely an import dependent economy, lower oil prices could worsen inflationary condition.

Table 5.1: Long-Run Estimates of Equation

Variables	Coefficient Estimate	Standard Error	Probability
c	-5.3618***	0.3552	0.0000
M	0.2919***	0.0448	0.0000
Y	-0.1946	0.2085	0.3551
IBR	1.0912***	0.1389	0.0000
Z	-0.0308	0.0354	0.3884
PR	-0.0611	0.1130	0.2359
OP	0.2039***	0.0439	0.0000

Source: Author's computation *** *Significant at 5%*

The short-run estimates also support the evidence provided by the long-run coefficients. The error correction mechanism term (ECM) is statistically significant and correctly signed. The ECM indicated that the gap between the current short-run disequilibrium and long-run equilibrium inflation decreased each quarter by 27 per cent. Moreover, the short-run result also affirmed that inter-bank exchange rate, imports and oil price were the main drivers of inflation in Nigeria. In other words, depreciation of the naira, increase in reserves and decline in oil prices intensified inflationary pressure in the economy.

However, the lag of exchange rate, oil price and imports showed a counter-intuitive result, indicating that as economic agents adjust to the impact of the changes in the variables, they tended to reverse inflationary condition. This underscored the role of expectations in the behaviour of inflation in Nigeria. Thus, the result highlighted a significant intuition that inflation, over this period, aligned with the external sector's development.

This generally reflected the character of the Nigerian economy as a less-diversified oil dependent economy with high-dependence on imports from other economies. Consequently, changes in these critical external variables tend to exacerbate inflationary pressure in the short-run.

In summary, the findings revealed that the combined factors of increased monetary growth, exchange rate, oil price and imports were the main drivers of inflationary pressure in Nigeria, Consistent with the literature. Depreciation of Naira resulted in inflationary pressures for Nigeria owing largely to the pressure coming from the pass-through effect of oil price fall with the attendant slowdown in reserves accretion. This tends to be aggravated by mounting import bills.

The Nigerian economy relies largely on the revenue from crude oil export. As argued earlier, there is a positive correlation between oil proceeds and reserve accumulation, which is also inversely correlated with inflation. When external reserves increase, exchange

rate appreciates and inflation declines. However, when oil price falls, reserve accumulation decreases and inflation generally, tends to rise.

Table 5.2: Short-Run Estimates of Equation (Parsimonious Result)

Variable	Coefficient	Standard Error	t-Statistic	Probability
C	0.026648	0.003379	7.887149	0.0000
D(LIBR)	0.323903	0.100789	3.213669	0.0023
D(LIBR(-1))	-0.341901	0.118974	-2.873744	0.0060
D(LOP)	0.066895	0.022240	3.007831	0.0042
D(LOP(-2))	-0.080097	0.026387	-3.035458	0.0039
D(LZ(-1))	0.006008	0.003256	1.845461	0.0711
D(LZ(-2))	-0.011625	0.003058	-3.801028	0.0004
ECM(-1)	-0.266771	0.065913	-4.047340	0.0002
Diagnostics				
R-squared	0.508050			
Adjusted R-squared	0.436308			
S.E. of regression	0.021611			
F-statistic	7.081566			
Prob(F-statistic)	0.000008			
Durbin-Watson stat	2.111491			

Source: Author's computation

Thus, there is need to accumulate more foreign asset when oil prices surge as a way of making safe buffers for the period of decline. Furthermore, there is the need to attract more foreign capital (foreign direct investment) through the engendering of stable investment friendly macroeconomic environment.

VI. Conclusion and Policy Options

The study examined the key determinants of inflation in Nigeria, using quarterly data spanning 2000:1 to 2015:1. The results corroborated findings by some past studies that growth in money supply, exchange rate depreciation, oil price dynamics and imports are the main drivers of inflation in Nigeria. Furthermore, the combination of these factors put more pressure on domestic prices, as against the impact of individual influences on inflation by most existing studies. Above all, the results also identify the role of expectations as a major determinant of inflation in Nigeria.

Thus, to effectively curtail inflation, the paper recommends that:

- The current restrictive monetary policy stance of the CBN be further consolidated to curtail aggregate demand pressure, stimulate capital flow, and check inflation;
- Central Bank, in conjunction with the fiscal authority, should grow reserve through a disciplined fiscal rule-based system; and
- There is need to encourage the diversification of the economy through intervention in growth-enhancing sectors of the economy.

References

Adenekan, A. T. and Nwanna, G. A. (2004). Inflation Dynamics in a Developing Economy: An Error Correction Approach. *African Review of Money Finance and Banking*, 77-99.

AEM (2OO8). Dealing with Inflation: Policy Options for Emerging East Asia. Asia Economics Monitor – AEM. *Asia Development Bank*. July

African Development Bank (2012). Inflation Dynamics in Selected East African Countries: Ethiopia, Kenya, Tanzania and Uganda. AfDB Policy Brief. http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/07022012Inflation%20East%20Africa%20-%20ENG%20-%20Internal.pdf

Asogu, J. O. (1991). An Econometric Analysis of the Nature and Causes of Inflation in Nigeria. *Central Bank of Nigeria Economic and Financial Review*, 29(3): 239-254.

Batten, D. S. (1981). Inflation: The Cost – Push Myth. *Federal Reserve Bank of St. Loius.* June/July.

Batini, N. (2004). Achieving and Maintaining Price Stability in Nigeria. *IMF Working Paper* WP/04/97.

Barungi, B. M. (1997). Exchange rate policy and inflation: The Case of Uganda. *African Economic Research Consortium (AERC*), AERC Research Paper 59.

Beckerman, P. (1995). Central-Bank Distress and Hyperinflation in Argentina, 1989-90. *Journal of Latin American Studies*, 27(3): 663-682.

Bevilaque A. S., M. Mesquita, A. Minella (2007). Brazil: Taming Inflation Expectations, Working Paper Series 129, *Banco Central do Brazil*, ISSN1518-3548.

Blanchard, O. (2009). *Macroeconomic*s. Pearson Prentice Hall

Dewett, K. K. and A. Chand (2001). Modern Economic Theory. S. Chand and Company.

Dornbusch R., S. Fischer and Richard S. (2008). *Macroeconomics*. McGraw. Hill International Edition: New York.

Dua, P. and U. Gaur (2009). Determination of Inflation in an Open Economy Phillips Curve framework: The Case of Developed and Developing Asia Countries. *Center for Development Economics* Working Paper No. 178.

Essien, A., E. Onwioduokit, E. Adamgbe and K. Obiora (2007). Inflation Dynamics in Nigeria, in Studies in Inflation Dynamics, West African Monetary Institute, Accra.

Fakiyesi, O. M. (1996). Further Empirical Analysis of Inflation in Nigeria. Central Bank of Nigeria *Economic and Financial Review*, 34(1): 489-500.

Feijo, C. A. and De Carvalho, F. J. C. (1992). The Resilience of High Inflation: Recent Brazilian Failures with Stabilisation Policies. *Journal of Post Keynesian Economics*, 15(1): 109-124.

Feldstein, M. (2002). *Argentina's Fall: Lessons from the Latest Financial Crisis*. Foreign Affairs, 81(2): 8-14.

Garcia, M., Guillén, D., Rio, P. U. C., Investimentos, G. and Kehoe, P. (2014). The Monetary and Fiscal History of Latin America: Brazil. *Working Paper*, University College of London.

Habermeier K. et al (2008). Inflation Pressures and Monetary Policy Options in Emerging and Developing Countries – A Cross Regional Perspective. *IMF Working Paper. International, Monetary Fund.*

Hodes, D.A. and Synder (1981). How Good is Inflation Theory? A Call to Action. *Business Economics*. Vol.11 No.4 pp 15-19.

Hossain, A. (1989). A Monetary Model of Inflation for Bangladesh, 1974-1985. *The Pakistan Development Review*, 28(2):133-155.

Ireland, P. (2014). Classical Theory of Inflation and its Uses Today. Shadow Open Market Committee Meeting. *Economic Policies for the 21st Century* – e21. The Manhattan Institute.

Khan, M. S. and Schimmelpfennig (2006). Inflation in Pakistan. *The Pakistan Development Review*, 45(2): 185-202.

Karanassou, M., Sala, H., and D.J. Snower (2006). Phillips Curves and Unemployment Dynamics: A Critique and a Holistic Perspective. *Discussion Paper Series*. *Institute for the Study of Labor* (IZA).

Kuteesa, F., Magona, I. Wanyera, M. and Wokadala, J. (2006). Uganda: A Decade of Budget Reform and Poverty Reduction. OECD *Journal on Budgeting Volume 6(2): 1-25*.

Levacic, R. and A. Rebmann (1982). Macroeconomics: An Introduction to Keynesian-Neoclassical Controversies. Palgrave Macmillan.

Marsh S and B. Winter (2014). A Timeline of Argentina's Sordid History with Default, Business Insider Australia, July 31. http://www.businessinsider.com.au/a-timeline-of-argentinas-sordid-history-with-default-2014-7

Masha, I. (2001). New Perspectives on Inflation in Nigeria. *CBN Economic & Financial Review*, Vol. 38 No. 2.

Moser, G. G. (1995). The Main Determinants of Inflation in Nigeria. *IMF Staff Papers*, 42(2): 270-289

Neil, K.S. (2004). The Structuralist Theory of Imported Inflation: An Application to South Africa. *Journal of Applied Economics*, 36. 1431–1444. Routledge, Taylor and Francis Group.

Nikitin, S. (1995). Western Economic Theories and Inflation. *Voprosy ekonomiki* No. 11 pp.43-54. Institute of Economics, Russian Academy of Sciences.

Olubusoye, O. E. and Oyaromade, R. (2008). Modelling the Inflation Process in Nigeria. AERC Research Paper 182. *African Economic Research Consortium*, Nairobi.

OnlineTexts.com (1996-2004). Introduction to Macroeconomic: Lecture Notes –Monetarism

Paddock J.V. (2002). IMF Policy and the Argentine Crisis, 34 U. *Miami Inter-Am. L. Rev*. 155 . Available at: http://repository.law.miami.edu/umialr/vol34/iss1/5

Riley G. (2014). Inflation – Policies to Control Inflation. Available at: http://beta.tutor2u.net/economics/reference/inflation-policies-to-control-inflation

Roberts, J. M. (1995). New Keynesian Economics and the Phillips Curve. *Journal of Money, Credit and Banking*. Vol. 27 No. 4. pp. 975-984.

Samuelson and Nordhaus (2005). Macroeconomics. McGraw-Hill

Sill, K. (2011). Inflation Dynamics and the New Keynesian Phillips Curve. *Business Review* Q1. Federal Reserve Bank of Philadelphia.www.philadelphiafed.org/research-and-data/publications/

Siregar, R. Y. and Rajaguru, G. (2005). Base Money and Exchange Rate: Sources of Inflation in Indonesia during the Post-1997 Financial Crisis. *Journal of Economic Integration,* 20(1): 185-215

Totoncchi J. (2011). Macroeconomic Theories of inflation. *International Conference on Economics and Finance Research*. LACSIT Press. Singapore

Wachter, S.M. (1979). Structuralism vs. Monetarism: Inflation in Chile. In Berrman J. R. and Hanson J. eds. Short-Term Macroeconomic Policy in Latin America. *National Bureau of Economic Research (NBER*)

Wikipedia. Available at HTTP://en.wikipedia.org/wiki/New_Keynesia_Economics (Accessed on May 4, 2017).

Appendix 1: Unit Root Test Result

Variables	t-Statistics	Critical Value (5%)	Order of Integration
CPI	-3.505948	-3.492149	I(1)
M2	-8.875453	-3.489228	I(1)
RYG	-5.060046	-3.493692	I(1)
IBER	-5.139996	-3.487845	I(1)
IMP	-12.68573	-3.487845	I(1)
PLR	-5.798675	-3.487845	I(1)
OP	-6.398342	-3.489228	I(1)

Appendix 2: Co-integration Test Result

Unrestricted Co-integration Rank Test (Trace)

Hypothesised No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.604684	184.5391	125.6154	0.0000
At most 1 *	0.581426	133.4953	95.75366	0.0000
At most 2 *	0.447104	85.59574	69.81889	0.0017
At most 3 *	0.402723	53.00358	47.85613	0.0152
At most 4	0.236299	24.65797	29.79707	0.1740
At most 5	0.111917	9.831155	15.49471	0.2939
At most 6	0.058291	3.303225	3.841466	0.0691

Trace test indicates 4 co-integrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Modelling the Effect of Exchange Rate Changes on Nigeria's Non-Oil Exports: A Vector Error Correction Model (VECM)

Duke, O., N. Audu and A. Aremu*

Abstract

The paper adopted the Vector Error Correction Model (VECM) approach in an attempt to model the effect of exchange rate fluctuations on Nigeria's non–oil exports using quarterly data from 1981 to 2015. The empirical results showed that real exchange rate significantly impacted on non–oil exports in Nigeria, in that the appreciation of real exchange rate in Nigeria was one of the key factors responsible for the decline of the country's non–oil exports. Therefore, the exchange rate continues to maintain a significant role in determining the competitiveness of the Nigeria's non–oil exports.

Keywords: Real Exchange rate, Non–oil exports, Nigerian Economy, VECM

JEL Classification Numbers: C32, F31, O13, O24

I. Introduction

The importance of exchange rate in relation to international trade lies in its impact on the price of tradables, external competitiveness, the decision to enter or exit international trade and accruable profits. Existing literature have no consensus on the effect exchange rate changes have on price and volume of trade (Greenaway et. al., 2010). Bahmani-Oskooee and Hegerty (2009) stated that an increase in exchange rate volatility directly affects profit and entry decisions into international trade, and could also positively or negatively affect the outcome of trade. Generally, loss of international trade result from the uncertainty associated with exchange rate volatility, as risk adverse buyers and sellers curb the volume of sales to hedge against losses. However, certain changes in exchange rate can promote higher volume of trade as traders seek to cover losses due to exchange rate depreciation, while importers and exporters increase demand and supply to take advantage of depreciation in exchange rate.

For most developing countries including Nigeria, foreign exchange earned from the export of tradables are used to meet the economic needs of the country such as the accumulation of sizeable external reserves to support monetary policy; and to meet balance of payments obligations amongst others. Export is thus a viable tool for economic growth, through the creation of employment, increase aggregate demand which would promote increased output and enhance economic growth (Chen and Chen, 2007).

Prior to the discovery of crude oil in 1956, Nigeria was a major exporter of non-oil products including groundnuts, palm oil, cocoa beans, rubber, cotton and palm oil. The discovery

* *The authors are staff of the Research Department, Central Bank of Nigeria. The usual disclaimer applies.*

of Crude oil moved the country's focus away from agricultural exports as Crude oil exports became the lead export produce and accounted for about 83.0 per cent of total exports by 2008. Over the years, non-oil exports continued to decline significantly averaging a meager 4.0 per cent of total exports from 1970-1986 (Englama et al., 2010). It remained low in 2012 and 2013 at 2.2 and 4.8 per cent, respectively while crude oil exports continued to dominate export in Nigeria. However, the price of crude oil, an internationally traded commodity, is determined by exogenous factors to the economy which infers that the prices per barrel is as quoted on the world commodity market with minimal influence from the Nigeria economy. This implies that the country is exposed to various global occurrences which have a significant impact on its major revenue source and hence, a direct impact on the value of the local currency, the naira.

There have been various efforts, by governments to diversify the Nigerian economy especially in the agricultural sector, mining, tourism and other non–oil sectors. Some of the programs that have been introduced over the years include the Agricultural Credit Guarantee Scheme (ACGS) and the Small and Medium Enterprises Credit Guarantee Scheme (SMECGS) amongst others. Despite these measures, the contributions of the non–oil exports to the country's gross domestic product (GDP) remained abysmal and below the level prior to 1970. This concern could in part be attributed to the uncompetitive price of the exports against other country exports in the international market. The exchange rate in Nigeria has undergone periods of varying volatility and stability which could have amongst other structural rigidity in the economy contributed to the lack of competitiveness of the non-oil exports sector. Thus, it can be suggested that identifying the magnitude of the impact of exchange rate fluctuations on the prices of Nigerian non-oil exports, could present the government with important information required to further pursue the diversification drive and promote the non-oil export sector.

Several studies in the literature have attempted to evaluate the impact of exchange rate on non-oil exports in several countries around the world using differing empirical methodologies. These studies have had conflicting results based on the unique qualities of these economies and the periods of studies. While some studies discovered evidence of adverse exchange rate fluctuations on trade, others reported the opposite and few others concluded that there was no effect at all. The general observation, however, is that most studies were focused on Asian and developed economics. Some studies however exist on African data but not so much on the Nigerian economy. This gap can be explained by the assumption that given that Crude Oil, which is priced in US Dollars is a significant part of the Nigeria's exports, exchange rate fluctuation might not have a significant impact on total exports; hence, ignoring the impact on the non-oil export sector. Studies have shown that the Nigerian exchange rate was highly volatile due to exchange rate deregulation in the mid-1980s (Yinusa and Akinlo, 2008; and Akpokodje, 2007) which raises concerns on the effect of exchange rate instability on exports particularly the non-oil exports.

This is very imperative because one of the main objectives of moving to a more flexible exchange rate regime is to support the diversification process of the economy from oil to non-oil exports to ensure a reduction the uncertainty that accompanies oil price fluctuations.

Following this introduction, this paper builds on existing studies to access the continued effect of exchange rate changes on non-oil exports in Nigeria. This study contributes to literature as it is a more recent study focusing on the period 1981–2015 and adopting a different methodology from other prior studies in the same subject area. It is aimed at answering the question of if the impact of exchange rate on non-oil export has changed overtime and what other factors impact on non-oil exports in Nigeria besides the exchange rate. This period captures the liberalization of foreign trade and exchange rate regime changes. Unlike previous studies, this paper rejects that stationarity assumption of the time series data and accesses the time series properties of all relevant variables using the ADF and Phillip-Perron unit root tests.

The paper is sub-divided into five sections. Section 1 presented the introduction and background to the study. Section 2, highlighted the review of theoretical and empirical literature, while Section 3, comprised of the data and methodology. The data analysis and interpretation of results are discussed in Section 4. Section 5 concluded the paper and proffers some recommendations.

II. Review of Literature

II.1 Theoretical Literature

The transmission mechanism through which exchange rate behaviour affects non-oil exports included demand and supply side effects. Exchange rate changes could affect the demand side directly through consumer confidence in importing economies and indirectly affect exports by increasing production costs. The supply side effect is through prices of input, thus causing lower output and reduced competitiveness of export produce.

Theories in international trade have broadly explained that efficiency was subject to costs and prices. Exchange rate is considered a cost in the international trade transaction process. The theory of absolute advantage as propounded by Smith (1776) adopted a model with the assumptions of two factors of production input (labour and capital); two products and two trading partners. He argued that a country's exports should be its most productive output compared to other countries. That is, an absolute advantage in products with more output per unit input more than other countries, while its import goods should be its less productive output compared to other countries, an absolute disadvantage. A country's absolute advantage could also stem from its natural endowments or production skills such that it specialises in produce with the lowest possible cost and, importation of goods with higher production costs. International trade, according to the theory, has a positive sum result as both trading partners benefit from the transaction.

However, the comparative advantage theory as proposed by Ricardo (1817) stated that there was still a basis for mutually beneficial trade despite the absolute cost disadvantage to a trading partner. He noted that the less efficient country could specialise in the production of its less inefficient output, while the more efficient country should specialise in the production in which it was relatively more efficient, that is with the largest absolute disadvantage. The comparative advantage theory seemed more acceptable than the

absolute advantage theory because it depended on relative costs (Carbaugh, 2004). That is, it was possible for a country not to have absolute advantage in any product, but it was not possible for a country to have comparative advantage in the production of all products, while the other country would have comparative advantage in nothing.

Another economic concept which seeks to explain the relationship between exchange rate and trade is the Marshall-Lerner condition. The Marshall-Lerner (M-L) Condition explains the relationship between exchange rate and current account balance. Generally, it is assumed that when a country's exchange rate depreciates, it results in an improvement in the country's current account which represents the balance of trade. This is because imports are discouraged following depreciation as they become more expensive. The M-L condition studies the price elasticities of demand for exports and imports in an economy. It explains that if a country's currency depreciates, the foreign demand for its output would increase causing export income to rise significantly. However, it the country's demand for import is also highly price elastic, then a slightly weaker domestic currency would cause a decrease in demand for imports, thus reducing its expenditure on imports. Given these assumptions, the M-L condition states that the depreciation or devaluation of a country's currency would result in a surplus in current account if the combined elasticities of demand for exports and imports are elastic (i.e. the coefficient is greater than 1).

This is represented the equation below

$$PEDx + PEDm > 1$$

However, the M-L condition might not always hold if the demand for export and import are highly inelastic. This results in a worsened trade deficit which shifts the current account more into deficit.

II.2 Review of Empirical studies

In the literature, some studies on exports in relation to exchange rate investigated the relationship based on total exports, while others focused on single products such as oil dependent economies. Several studies have been conducted to investigate the impact of an economy's exchange rate on its export. While some argued that the behaviour of exchange rate in an economy was subject to the regime adopted which promoted exports through favourable prices, others have stated that the impact could be negative or limited, subject to economic peculiarities.

Bernardina (2004) adopted an error correction model in the study of the impact of real exchange rate and non-oil GDP on Russia's non-oil export from 1994 to 2001. The author discovered that a significantly negative long run co-integration relationship existed between the real exchange rate and Russian non-oil exports.

The study by Masoud and Rastegari (2008) adopted a Static Ordinary Least Squared (OLS) and fixed-effect based approach on two stage Least Square, to examine the effects of some economic variables including exchange rate on non-oil exports in Iran from 1995 to 2005. The authors concluded that there was a negative relationship between the

economy's non-oil exports and appreciation in its real exchange rate; despite the positive relationship with population increase, consumer price index and per capita income within the study period.

Sabuhi and Piri (2008) studied the effect of exchange rate amongst other variables on Iran's major non-oil export product-Saffron. Adopting the Autoregressive Distributed Lag (ARDL) model, the study showed that an appreciation in exchange rate had a significant negative impact on the export price of saffron; while no significant relationship existed between export price and domestic production of Saffron in the long-run. Hasanov and Samadova (2010) investigated the impact of real exchange rate on non-oil exports in the Republic of Azerbaijan in the framework of co-integration and asymmetric error correction threshold and momentum threshold methodology. The author applied autoregressive methods over the quarterly period 2000Q1-2010Q4 and concluded that there was a co-integrated relationship between non-oil exports, non-oil trade turnover based on real exchange rate and foreign income, but noted that the adjustment process towards the equilibrium level was not asymmetric.

A study by Sorsa (1999), on the effect of real exchange rate relative to Algerian non-oil export between 1981 and 1997 revealed that the appreciation of real exchange rate impeded non-oil export growth and economic diversification in the economy. Ros (1993), examined trade in non-oil products and industrialisation process in Mexico's from 1960 to 1990. He concluded that the appreciation in real exchange rates following increased oil revenues was damaging to non-oil exports.

Adopting a panel data estimation method, Mohamad et al., (2009) estimated the influence of real exchange rate amongst other economic variables (capital investment, macroeconomic stability and terms of trade) on the export performance of Asia countries - Indonesia, Malaysia, Singapore and Thailand. They concluded that real exchange rate appreciation, volatility and misalignment had a negative impact on the performance of exports. In the work of Hooy and Choog (2010), they tested the impact of exchange rate volatility on intra-trade flows and export demand within SAARC region, covering Bangladesh, India, Pakistan and Sri Lanka using an asymmetric exponential generalised autoregressive conditional heteroskedasticity (E-GARCH) model to generate conditional exchange rate volatility. The export demand function showed that a negative long run relationship existed between, exchange rate volatility and real exports and thus supported the hypothesis that exchange rate imposes a cost on risk- averse traders. They also found that income relative price and real exchange rate all influenced the decision to export by producers and that it reduced trade with the rest of the world.

With respect to Nigeria, Oyejide (1986) studied the impact of Nigeria's exchange rate and trade policies on the exports of its agricultural produce using the Ordinary Least Squares (OLS) over the period 1960-1982. The author concluded that mostly during the period of oil boom, an appreciation in real exchange rate adversely affected non-oil exports. Ogun (2000) studied the effects of real exchange rate and its volatility on Nigeria's non-oil exports between 1960 and 1990 using the autoregressive distributed lag (ARDL) methodology. He

concluded that real exchange rate, its volatility and misalignment negatively affected the growth of non-oil exports in Nigeria.

Using the ARIMA and OLS estimation techniques, Adubi and Okunmadewa (1999) studied the impact of exchange rate and its fluctuations on Nigeria's agricultural exports from 1986 to 1993. The results indicated that exchange rate appreciation and volatilities generally had a negative impact on the export earnings of agricultural products.

Yusuf and Edom (2007) adopted the Johansen co-integration approach from 1970 to 2003 to study the relationship between non–oil exports and exchange rate. The estimation results revealed that during periods of official exchange rate depreciation, non-oil exports showed significant improvements. Using the OLS estimation method, Abolagba et al. (2010) investigated the effect of relevant economic variables including exchange rate on non-oil exports. They resolved that real exchange rate appreciations had a statistically significant negative effect on the exports of cocoa and rubber in Nigeria from 1970 to 2005.

Akinlo and Adejumo (2014) studied the impact of exchange rate volatility on non-oil exports in Nigeria from 1986 to 2008. The study confirmed the existence of a significant relationship between exchange rate fluctuations and real exports. They reported that in the long-run, exchange rate volatility and foreign income had a significant and positive impact on non-oil exports while the short run effect was statistically insignificant implying that exchange rate instability was only effective in the long run.

Imoughele and Ismaila (2015) examined the impact of exchange rate on non-oil export from 1986 to 2013. The study used the Johansen's co-integration test which confirmed that a long-run relationship existed between some independent variables and non-oil exports. They concluded that effective exchange rate, credit to the private sector, money supply and economic performance impacted significantly on non-oil exports growth in the Nigerian economy. They added that exchange rate appreciation had a negative effect on non-oil export.

III. Data, Analytical Framework and Model Specification

III.1 Data

This paper evaluates the impact of exchange rate on non–oil exports in Nigeria based on an eclectic theoretical framework from reviewed literature. Following the theoretical and empirical literature, some key variables where found to play a pivotal role in explaining this relationship. Samimi, et al., (2012) opined that variables explaining the impact of exchange rate on non–oil exports may differ between economies based on the economic and financial status of the economy under consideration. Therefore, the following variables were selected for this study: non-oil exports (NOEXP) as the regressand, while degree of openness (OPEN), inflation rate (INFR), interest rate (INTR), real gross domestic product (RGDP) and real exchange rate (RER) are the regressors. The data for this study was sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin and covered the period 1981Q1 to 2015Q4. Variables NOEXP and RGDP are expressed in semi–logarithm

denoted with small letter 'l' in the estimation process while the other variables (RER, INFR, INTR and OPEN) are maintained.

III.2 Analytical Framework and Model Specification

The total value of non-oil exports is equal to the sum of exports of locally produced goods and services less oil exports. In this study, the real GDP was used to represent the level of domestic income, inflation represented the general price level, prime lending rate was used for interest rate while degree of openness was used to ascertain the magnitude of trade openness of the Nigerian economy to the global economy. Therefore, to empirically analyse these identified variables, this study followed the supply of exports model as adopted by Jongwanich (2007). The supply model for non–oil exports can be algebraically written as:

$$EXP = \beta_0 + \beta_1\left(\frac{ep^x}{p^\alpha}\right) + \beta_2 RNGDP \qquad (1)$$

Where: $\frac{ep^x}{p^\alpha}$ = *real exchange rate (RER) as shown by* Tihomir (2004). From the foregoing, an increase in RER implies a depreciation of the domestic currency (naira). In light to the conclusion by Samimi et al., (2012), which evidenced that other variables impact on non-oil exports in developing country like Nigeria; the model by Jongwanich (2007) was augmented and adopted in this study. The augmented model rewritten as a function is shown in equation (2).

$$NOEXP = f(RER, RGDP, INFR, INTR, OP) \qquad (2)$$

Equation (2) can be rewritten econometrically in a semi-logarithmic form as:

$$NOEXP = \beta_0 + \beta_1 RER + \beta_2 RGDP + \beta_3 INFR + \beta_4 INTR + \beta_5 OPEN + \omega \qquad (3)$$

Where:

$$\beta_1, \quad \beta_4 \ \ and \ \ \beta_5 \gtrless 0; \quad \beta_2 > 0, \quad \beta_3 < 0$$

Where: $NOEXP$*= Non–oil exports,* RER *= real exchange rate, LRGDP = Real log of gross domestic product,* $INFR$ *= inflation rate,* $INTR$ *= interest rate,* $OPEN$ *= openness and* ω *= stochastic term*

The analytical tools employed in this research include the t-test, Johansen co-integration test (1990), unit root tests, regression {ECM (-1)} analysis as well as Granger Causality. The t–test was used to establish whether there exists significant difference in non-oil exports in Nigeria; while the Augmented Dickey–Fuller (1981) and the Phillips–Perron unit root (1988) tests were used to check for stationarity of the times series data. The general form of these tests is estimated thus:

$$\delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \mu_1 \delta Y_{t-1} + \mu_2 \delta Y_{t-2} + \cdots + \mu_p \delta Y_{t-p} + \varepsilon_t \qquad (4)$$

Where Y_t = times series to be tested, β_0= The intercept terms, β_1 = The coefficients of interest in the unit root test, μ =The parameter of the augmented lagged first difference of Y_t to represent the p^{th} order autoregressive process and ε_t= The white noise error term.

To avoid violating the assumptions of a classical regression model, the co-integration analysis was used to examine the long–run relationship between real exchange rate and non–oil exports in Nigeria. As part of the empirical design the basic estimating equation is specified in equation (5), while the variables were as explained in equation (3).

$$NOEXP = \beta_0 + \beta_1 RER + \beta_2 LRGDP + \beta_3 INFR + \beta_4 INTR + \beta_5 OPEN + \omega \qquad (5)$$

To test for co-integration in order to know the disequilibrium error, equation (5) is rewritten as follows:

$$\omega = NOEXP - \beta_0 - \beta_1 RER - \beta_2 LRGDP - \beta_3 INFR - \beta_4 INTR - \beta_5 OPEN \qquad (6)$$

The presence of co-integration is tested using the Johansen (1988). Here the number of co-integrating relations was tested on the basis of trace statistics and maximum Eigen statistics. Once the presence of co-integration was found, we estimated an error correction model (ECM) that included both the long–run and the short–run dynamics. Therefore, the disequilibrium errors in equation (6) formed a stationarity times series and had a zero mean and the ω was stationary at levels [I(0)] with $\sum \omega = 0$. The long–run equilibrium may be barely observed but there is a tendency to move towards equilibrium, hence, the error correction model (ECM) was used to represent the static and dynamic relationships between NOEXP and the selected variables. Also, the ECM was used to gauge the speed of adjustment from the short–run equilibrium to the long–run equilibrium path or state. This means that the greater the coefficient of the variable, the higher the speed of adjustment of the model would be from the short–run to long–run. We then derive the ECM equation from equation (5) thus:

$$\delta NOEXP = \beta_0 + \beta_1 \sum_{t=1}^{n} \delta RER_{t-1} + \beta_2 \sum_{t=1}^{n} \delta RDGP_{t-1} + \beta_3 \sum_{t=1}^{n} \delta INFR_{t-1} +$$

$$\beta_4 \sum_{t=1}^{n} \delta INTR_{t-1} + \beta_5 \sum_{t=1}^{n} \delta OPEN_{t-1} + \omega_t \qquad (7)$$

From equation (7), we conducted the over-parametised ECM to enable us use the most significant variables to form the parsimonious ECM. It is this derived ECM equation that was explained and used for proffer policy implications, while Granger causality test was conducted to ascertain the direction of causality among the variables used in the study.

The vector error correction (VEC) model is designed to use non–stationary co-integrated series because it allows short–run dynamics, but limits long run behaviour if the endogenous variables converge to their co-integrating relationship. The deviation from the long–run equilibrium was corrected gradually by short–run adjustment.

IV. Analysis of Estimation and Findings

IV.1 Summary Statistics

Table 3 represents the statistics for the variables for 1981Q1 to 2015Q4. The summary statistics of all the regressors employed in the estimation are presented in Table 3.

Table 3: Summary Statistics

Statistics	LNOEXP	LRGDP	LRER	INFR	INTR	OPEN
Mean	8.358170	11.559627	4.837249	20.19107	17.83679	0.536104
Median	8.728410	11.48375	4.978725	12.94500	17.75500	0.529223
Maximum	12.42756	12.70297	5.587623	89.57000	34.87000	0.798232
Minimum	2.131797	10.93774	3.684620	-4.980000	8.830000	0.135216
Std. Dev.	2.800975	0.477749	0.543800	19.66855	5.100700	0.111665
Jarque-Bera	8.541334	10.99388	12.57450	60.73527	4.382634	7.147806
Probability	0.013972	0.004099	0.001860	0.000000	0.111769	0.028046
Observations	140	140	140	140	140	140

The result from the summary statistics indicated that non–oil exports, real gross domestic product, real exchange rate, inflation rate, interest rate and openness averages 8.4, 11.6, 4.8, 20.2, 17.8 and 0.5 respectively while they ranged from 12.4 to 2.1, 12.7 to 10.9, 5.6 to 3.7, 89.6 to –5.0, 34.9 to 8.8 and 0.8 to 0.1 for the respective regressors with a standard deviation of 2.8, 0.5, 0.5, 19.7, 5.1 and 0.1. The variables also exhibit increasing return to scale given the JB statistics values of 8.5, 11.0, 112.6, 60.7, 4.4 and 7.1, respectively.

IV.2 Unit Root Tests

All the macroeconomic variables employed in this study were subjected to unit toot tests based on the assumption that time series data often exhibit random walks and non-constant variances. The results of the ADF and PP unit root tests as indicated in Table 1 showed that all the variables were stationary after first difference implying that they are I(1).

Table 1: Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) Tests

VARIABLES	ADF		PP		DECISION
	LEVELS	1ST DIFF	LEVELS	1ST DIFF	
LNOEXP	–2.900797	–17.57325	–0.930176	–16.31071	I(1)
LRGDP	–0.556617	–3.754298	–2.143342	–19.41283	I(1)
LRER	–3.254298	–10.33222	–2.183065	–10.38095	I(1)
INFR	–3.269835	–8.136830	–2.499149	–7.633042	I(1)
INTR	–2.218576	–11.09696	–2.321553	–11.09691	I(1)
OPEN	–3.346238	–9.079756	–3.189713	–15.81437	I(1)
Critical levels					
1%	-4.025924				
5%	-3.442712**				
10%	-3.146022				

*Note: We used the AIC for lag length selection, of which the maximal lag length selection allowed in the tests was 6. ** denotes level of significance adopted for this study. ADF denotes Augmented Dickey Fuller tests and PP refers to Phillips Perron tests.*

IV.3 Unit Root Test for the Residuals

As shown in Table 1 above, all the variables were stationary after first difference. Hence, we proceeded to generate the residuals of the model and test for the linear combination of all the variables using ADF and PP unit root tests. The result in Table 2 confirmed it to be I(0), thus implying that all the variables are co-integrated.

Table 2: Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) Tests for the residuals

VARIABLES	ADF		PP		ORDER OF INTEGRATION
	LEVELS	1ST DIFF	LEVELS	1ST DIFF	
ECM(-1)	–11.54113	–9.120525	–11.95406	–68.24236	I(0)
Critical levels					
1%	-4.025924				
5%	-3.442712**				
10%	-3.146022				

*Note: We used the AIC for lag length selection, of which the maximal lag length selection allowed in the tests was 6. **denotes level of significance adopted for this study.*

IV.4 Correlation Matrix

Table 4 represents how the explanatory variables are correlated and the strength of the relationship. We see there is a very high strong positive relationship exists between non–oil exports and (real GDP – 92 per cent, openness – 52 per cent, real exchange rate – 39 per cent), real exchange rate and interest rate (68 per cent), real GDP and openness (36 per cent), while others are moderately low but the correlation between the following variables were negative. They are: non–oil exports and inflation (–30 per cent); real GDP and inflation (–38 per cent).

Table 4: Correlation matrix

Variables	LNOEXP	LRGDP	LRER	INFR	INTR	OPEN
LNOEXP	1.000000					
LRGDP	0.916284	1.000000				
LRER	0.389835	0.246546	1.000000			
INFR	-0.303459	-0.375126	0.014642	1.000000		
INTR	0.356483	0.170521	0.684749	0.274867	1.000000	
OPEN	0.515407	0.361012	0.2361120	0.036063	0.332699	1.000000

IV.5 Co-integration

Having ascertained that all the variables in the model are integrated of order one I(1), in the next step we moved to use the Johansen co-integration approach to test if there exist at least a linear combination among the selected variables. The Johansen co-integration analysis was adopted because it helps to clarify the long–run relationship between integrated variables. Johansen's procedure is the maximum likelihood for finite–order vector autoregressions (VARs).

The Johansen's technique was chosen not only because it is VAR based but also due to evidence that it performs better than single–equation and alternative multivariate methods.

Table 5: Number of co-integrating relations by Model

Data Trend	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	2	1	1	2
Max-Eig	3	1	1	1	1

*Critical values based on MacKinnon-Haug-Michelis (1999).

The results of the co-integration test as presented in Table 5, shows that all the variables in the model are indeed co-integrated and this further confirms the findings in Table 2. However, to identify the appropriate co-integrating equation, we estimated co-integration equation for the first five specifications in Table 5 and the results are presented in Table A2 of the appendix. The result in Table A2 reveals that the third specification corresponds more to the model selection criteria between NOEXP, RGDP, RER, INFR, INTR and OPEN using the co-integration equations.

IV.6 VAR Lag Length Selection, LM and Stability Tests

Given the robust nature of the unit root tests, it was necessary to test the stability of the model using appropriate lag length based on the VAR lag length selection criteria. Most of these criteria in Table 6 shows that 2 lags are relevant based on AIC, SC and HQ. Hence, we estimate the VECM with 3 lags and this specification has no problem in terms of autocorrelation, normality and Heteroskedasticity of the residual as shown in Table 6, 7 as well as the second column of Table A1 of the appendix and equation (8).

The evidence in Table A1 indicates that the chosen CI equation conforms to our apriori expectation given the value and sign of error correction term as -0.240 and it is statistically significant.

Table 6: VAR Lag Length Selection Criteria – LNOEXP

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1146.658	NA	1.548444	17.46451	17.59555	17.51776
1	-388.6541	1435.613	0.000275	6.525062	7.442317*	6.897792
2	-356.1290	58.64377	0.000291	**6.577712***	**8.281186***	**7.269925***
3	-274.5678	139.6427	0.000147	5.887391	8.377083	6.899087
4	-187.0698	141.8528	0.000684*	5.107118	8.383029	6.438298*
5	-158.1886	44.19688	0.000782	5.214979	9.277109	6.865643
6	-119.9000	55.11241*	0.000785	5.180303	10.02865	7.150450
7	-90.34433	39.85540	0.000915	5.277944	10.91251	7.567574
8	-58.69346	39.80337	0.000105	5.343840	11.76463	7.952953

*Notes: The following acronyms: LR, FPE, AIC, SC and HQ connotes sequential modified LR test statistics (each test at 5 per cent level), Final prediction error, Akaike information criterion, Schwarz information criterion and Hanna-Quinn information criterion, respectively. The asterisk * indicates lag order selected by the criterion.*

We then conclude that there is a stable co-integration between non-oil export, real GDP, real exchange rate, interest rate, inflation rate and openness.

Table 7: Residual tests - LNOEXP

Serial correlation	21.1156	20.0359	23.0086	31.0077	19.9010
Probability	*0.6088*	*0.5853*	*0.4987*	*0.3719*	*0.5581*
Jarque-Bera	10.4471	7.6115	5.8121	4.9207	2.0098
Probability	*0.8832*	*0.6045*	*0.7931*	*0.5792*	*0.9116*
White Hetero (Chi. Sq.)	119.5831	245.008	476.0321	400.297	540.299
Probability	*0.2277*	*7*	*0.6409*	1	0
		0.7448		*0.8843*	*0.8116*

Thus, equation (8) confirms the absence of autocorrelation, normality and heteroscedasticity of residuals as presented in Table A1.

$$LNOEXP = -0.60 - 0.04LRGDP + 0.04LRER - 0.27INFR - 0.76INTR - 0.09OPEN \quad (8)$$

Having confirmed that all the variables were stationary after first differencing once and that they are co-integrated (i.e. Table 5 and co-integration test), the stage is now set to formulate the vector error correction model (VECM) to ascertain the relationship between NOEXP and the selected variables in both the short– and long– run. The intuition behind the error correction model is the need to recover the long–run information lost by differencing the variables. The error correction model rectifies this problem by introducing an error correction term. The error correction term is derived from the long–run equation based on economic theory. The error term enables us to gauge the speed of adjustment of LNOEXP to its long–run equilibrium. It gives us the proportion of the disequilibrium error accumulated in the previous periods which are corrected in the current period. The long–run result in Table A2 column 2 as presented in equation (8) revealed that all the regressor variables are statistically significant. It also indicated that the selected variables are indeed co-integration (i.e. between LNOEXP and the explanatory variables).

From equation (8), we could infer that a 10 per cent decrease in real gross domestic product (RGDP) would contract NOEXP by approximately by 4 per cent. Conversely a 10 per cent increase (appreciation) in real exchange rate (RER) would translate to 4 per cent increase in non–oil exports. Also, if inflation and interest rates increases by 10 per cent, non–oil exports would also decrease by 2.7 and 7.6 per cent respectively. Conversely, openness (OPEN) positively impact on non –oil exports, as such, OPEN increases by 10 percent, non –oil exports would increase or rise by 9 per cent.

From the foregoing result, except LRGDP, all the other variables conform to our apriori expectation. As Nigeria's RGDP decreases, a non–oil export is expected to shrink due to foreigner lack of confident in the country's economy. Similarly, the increasing appreciation in RER is significant for Nigeria because it has appreciated about four times (i.e. from 1995–1998, 2001–2004, 2006–2008 and 2010–2013). However, this appreciation should be treated with caution as its multiplier effect could lead to a reduction in non–oil exports.

The result of the short–run vector error correction model is presented in Table 8, the result indicates that the speed of adjustment of LNOEXP to the long–run equilibrium part is moderate. Specifically, about 45.3 per cent of the disequilibrium errors, which occurred in the previous year, are corrected in the current year. It also reveals that the estimated adjusted R^2 is 74 per cent of the changes in LNOEXP are explained by the combined impact of all the selected variables while the F–statistics value of 19 revealed that the entire model is significant at both 5 per cent levels.

Table 8: Short–run Parsimonious Vector Error Correction Model (VECM)
Dependent Variable: D(LNOEXP)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0620	0.0449	1.3818	0.1695
D(LRGDP)	-0.3957	0.1152	-3.4365	0.0038
D(LRGDP(-1))	-0.4714	0.1147	4.1083	0.0000
D(LRER)	0.6767	0.2412	2.8063	0.0063
D(LRER(-1))	0.7239	0.2788	-2.5964	0.0075
D(INFR)	-0.0174	0.0061	-2.8410	0.0053
D(INFR(-1))	-0.0504	0.0167	3.0157	0.0031
D(INTR)	-0.0807	0.0213	3.7851	0.0007
D(INTR(-1))	-0.0961	0.0214	-4.4932	0.0000
D(OPEN)	0.8627	0.2096	4.1170	0.0000
D(OPEN(-1))	0.9421	0.3104	3.0349	0.0021
ECM(-1)	-0.4530	0.0176	-3.0169	0.0031
R-squared	0.8489	F-statistic		19.9874
Adjusted R-squared	0.7396	Prob (F-statistic)		0.0001
S.E. of regression	0.5096	Durbin-Watson stat		2.4395

The equation's standard error of 0.509 signifies that in about two–third of the time, the predicted value of LNOEXP would be exactly 51 per cent of the actual value, while the DW value of 2.44 indicates the absence of serial correlation. Our short–run model shows that some of the variables impacted negatively, while others were positively. However, all the explanatory variables are statistically significant and conform to our apriori expectation except LRGDP. This means that all the selected macroeconomic variables used in this study are strong determinants of non–oil exports in Nigeria.

V. Summary, Conclusion and Policy Recommendation

The study investigated the empirical relationship between exchange rate changes and non–oil exports in Nigeria, using some selected macroeconomic variables in quarterly series from 1981 to 2015. Unit root tests were carried out on all the series to test for stationarity. The estimated short– and long–run results indicated that all the selected regressors, especially real exchange rate (RER), employed in the study significantly impacted on non–oil exports in Nigeria. The stability of the model confirmed that real exchange rate had a significantly positive (i.e. depreciation) impact on non–oil exports in

Nigeria. The findings showed that an increase in interest rate resulted in an increase in cost of borrowing funds and in turn cost of doing business. This could translate to lower outputs thereby affecting contract non–oil exports negatively.

From the results, the following major findings were observed:

- Real GDP, inflation and interest rates, have negative effect on non–oil exports in both the long– and short– run in Nigeria;
- Real exchange rate and trade openness have positive impact on non–oil exports in Nigeria in both the long– and short– run;
- The coefficient of the speed of adjustment was properly signed, relatively high and statistically significant.

Based on the results, real GDP, real exchange, inflation and interest rates and trade openness have both long and short term temporary effect on non–oil exports in Nigeria due to information asymmetry. As information circulates and expectations adjust, the short run impact fizzles and generates destabilizing consequences on non–oil exports in the long run. This implied that the selected macroeconomic variables were only temporary in the short-run, and might be detrimental to non–oil exports in the long run. Also, increasing the degree of openness could enhance non–oil exports in Nigeria. Following the findings of the study that the appreciation of real exchange rate in Nigeria was one of key factors responsible for the decline of the country's non–oil exports, it is important to ensure that the exchange rate is not overvalued so as to promote the country's non–oil exports.

References

Abolagba, E., N. Onyekwere, B. Agbonkpolor and H. Umar (2010). Determinants of Agricultural Exports. *J Hum Ecol*, 29(3): 181-184.

Adubi, A. A. and F. Y. Okunmadewa (1999). Price, Exchange Rate Volatility and Nigeria's Agricultural Trade Flows: a Dynamic Analysis. *Research Paper* 87, *African Economic Research Consortium,* Nairobi, Kenya.

Akinlo, A. E. and V. A. Adejumo (2014). Exchange Rate Volatility and Non-oil Exports in Nigeria: 1986-2008. *International Business and Management*, 9 (2): 70-79.

Bahmani-Oskooee, M. and S. W. Hegerty (2009). The Effects of Exchange Rate Volatility on Commodity Trade between the U.S. and Mexico, *Southern Economic Journal*, 79:1019-1044.

Bernardina, A. (2004). Price and Income Elasticities of Russian Exports. *The European Journal of Comparative Economics*, Vol. 1, No. 2, 2004, pp. 175-193.

Carbaugh, R. J., 2004. International Economics, 6th Edition. South-Western College Publishing, Cincinnati, Ohio.

Chen, S. S. and H. C. Chen (2007). Oil Price and Real Exchange Rate. *Energy Economics*, 29. 390 – 404.

Dickey, D. and Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, Vol. 49. 1057 – 1072

Englama, A., O. Duke, T. Ogunleye and F. Ismail (2010). Oil Prices and Exchange Rate Volatility in Nigeria: An Empirical Investigation. *Central Bank of Nigeria Economic and Financial Review* Vol. 48(3).

Greenway, D., R. Kneller and X. Zhang (2010). Exchange Rate Uncertainty and Export. *Journal of Economic Integration*, 25(4), 734-753.

Hasanov, F. and I. Samadova (2010). The Impact of Real Effective Exchange Rate on the Non-oil Export: The Case of Azerbaijan, *Munich Personal RePEc Archive*, MPRA Paper No. 29556.

Hooy C. and C. Choong (2010). The Impact of Exchange Rate Volatility and Intra-trade Flows of SAACR Countries. *Indian Economic Review*, Vol. XXXXV, No. 1, 2010, pp. 67-86

Imoughele, L. and M. Ismaila (2015). The Impact of Exchange Rate on Nigeria Non-Oil Exports. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, Vol. 5, No.1, January, pp. 190–198.

Johansen S. (1988). Statistical Analysis of Co-Integration Vectors. *Journal of Economic Dynamics and Control*, 12. 231 – 254.

Johansen, S. and K. Juselius (1990). Maximum Likelihood Estimation and Inference on Co-integration with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics* 52, 169 – 210.

Jongwanich J. (2007). Determinants of Export Performance in East and Southeast Asia. *ERD Working Paper Series* No. 106. November.

Masoud, H. and F. Rastegari (2008). Analysis of Economic-Political Factors affecting Non-Oil Export of Iran, *IDOSI Publications*.

Mohamad, S., N. Mahendhiran and J. Kamaruzaman (2009). Exchange Rates and Export Competitiveness in Selected ASEAN Economies. *International Business Research*, Vol, 2. No.2.

Ogun, O. (2000). Real Exchange Rate Behaviour and Non-oil Export Growth in Nigeria. *African Journal of Economic Policy* (AJEP), 11(1), pp. 69-90.

Oyejide, T. A. (1986). The Effects of Trade and Exchange Rate Policies on Agriculture in Nigeria. *Research Report 55 International Food Policy Research Institute*, Washington, D.C.

Phillips P. and P. Perron (1988). Testing for a Unit Root in Time Series Regression. *Biometrika*, Vol. 75. 335 – 346.

Ricardo, D. (1817). On the Principles of Political Economy and Taxation. London: John Murray, ed. 1821.

Ros, J. (1993). Mexico's Trade and Industrialization Experience since 1960: A reconsideration of past policies and assessment of current reforms. Working paper No.186 – January.

Sabuhi-Sabouni, M. and M. Piri (2008). Consideration the Effect of Exchange Rate Volatility on Agricultural Products Export Price: the Case Study of Iran's Saffron. IDOSI Publications.

Samimi, A. J., N. Heydarizadeh, and M. Madadi, (2012). Exchange Rate Uncertainty and Non-oil Exports: The Case of Iran. *Middle East Journal of Scientific Research* 11(2). 162 – 166.

Smith, A. (1776). An Inquiry into the Nature and Causes of the Wealth of Nations. Edwin Cannan, ed. 1904.

Sorsa, P. (1999). Algeria-The Real Exchange Rate, Export Diversification, and Trade Protection. *Policy Development and Review Department*, International Monetary Fund. April.

Tihomir S. (2004). The Effects of Exchange Rate Change on the Trade Balance in Croatia. *IMF Working Paper*, WP/04/65. April.

Yusuf, A. and C. Edom (2007). Determinants of Timber Exports in Nigeria: An Error Correction Modelling Approach. *Munich Personal RePEc Archive. MPRA Paper* No. 2608.

Appendix

Table A1: Residual Stability Tests

VEC Residual Normality tests				VEC Residual Heteroskedasticity test			VEC Residual Autocorrelation LM tests		
Component	***Jarque-Bera***	***df***	***Prob.***	***Chi-sq***	***df***	***Prob.***	***Lags***	***LM-Stat***	***Prob***
1	35.40617	2	0.0000	2876.960	2835	0.2866	1	13.9077	0.4210
2	18.72521	2	0.0001				2	11.8436	0.9845
3	12721.34	2	0.0000				3	13.6125	0.4318
4	9.405295	2	0.0091				4	13.3071	0.6398
5	10031.7	2	0.0000				5	8.90444	0.9634
6	162.3277	2	0.0000				6	7.37013	0.9847
Joint	22978.91	12	0.0000				7	8.46489	0.9818
							8	8.50946	0.8794
							9	16.2577	0.5634
							10	23.6707	0.2164
							11	10.6445	0.5149
							12	38.9393	0.0034

Table A2: VECM Co-Integration Tests

Variables	None	None	Linear	Linear	Quadratic
	No Intercept and Trend	Intercept but No Trend	Intercept but No Trend	Intercept and Trend	Intercept and Trend
LNOEXP	1.0000	1.0000	1.0000	1.0000	1.0000
C		-0.59555	-0.31931	-13.97306	10.92702
		0.19355			
		[3.0769]			
LRGDP	-0.15705	-0.03963	-0.42809	3.17727	-0.13820
	0.08771	0.01149	0.03113	1.21838	0.39802
	[-1.7905]	[-3.4495]	[-13.7508]	[2.60779]	[-0.34722]
LRER	0.06988	0.04462	0.12602	-0.76595	0.21818
	0.08664	0.01135	0.03075	1.20346	0.39315
	[0.8066]	[3.9319]	[4.0981]	[-0.63646]	[0.55495]
INFR	0.98713	-0.26598	-0.47198	-0.58155	0.76652
	0.48449	0.06345	0.17196	6.72985	2.19853
	[2.0375]	[-4.1918]	[-2.7447]	[-0.08641]	[0.34865]
INTR	1.49395	-0.75932	0.52947	-5.42217	0.16963
	0.47948	0.06280	0.17018	6.66029	2.17581
	[3.1158]	[-12.0917]	[3.1111]	[-0.81410]	[0.07796]
OPEN	-0.19964	0.09441	0.30078	-6.17497	0.45974
	0.26447	0.02464	0.09387	3.67362	1.20011
	[-0.7549]	[-3.8323]	[3.2043]	[-1.68090]	[0.38308]
@TREND			-0.00221	-0.00619	-0.00018
(1981Q1)	-	-	0.00036		
			[-6.1612]		
ECM(-1)	-0.56489	-0.32431	-0.49201	-0.11463	-0.92300
	0.14307	0.18738	0.10782	0.19874	0.64925
	[-3.9482]	[-1.7308]	[-4.5632]	[-0.57676]	[-1.4216]
R^2	0.3445	0.6214	0.7977	0.4079	0.5151
$\bar{R}^2$	0.2509	0.5673	0.6713	0.3233	0.3114
SER	0.4583	0.0600	0.1627	6.3666	2.0799
SSR	24.9988	10.4288	13.1493	48.2352	51.4777
LL	77.8656	200.6275	64.0420	438.3422	285.0716
F-statistic	3.6795	11.4867	20.7575	4.8221	0.9100
Akaike AIC	1.3995	-2.6661	-0.6722	6.6619	4.4244
Schwarz SC	1.7832	-2.2825	-0.2885	7.0456	4.8081

Note: R^2 = R-squared; $\bar{R}^2$ = Adjusted R –Squared; SER = Standard Error of Regression; SSR = Sum of Squared Residuals; LL = Log Likelihood; T–values in parenthesis

Table A3: Short–run parsimonious vector error correction model (VECM)

Dependent Variable: D(LNOEXP)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.0620	0.0449	1.3818	0.1695
D(LRGDP)	-0.3957	0.1152	-3.4365	0.0038
D(LRGDP(-1))	0.4714	0.1147	4.1083	0.0000
D(LRER)	0.6767	0.2412	2.8063	0.0063
D(LRER(-1))	-0.7239	0.2788	-2.5964	0.0075
D(INFR)	-0.0174	0.0061	-2.8410	0.0053
D(INFR(-1))	0.0504	0.0167	3.0157	0.0031
D(INTR)	0.0807	0.0213	3.7851	0.0007
D(INTR(-1))	-0.0961	0.0214	-4.4932	0.0000
D(OPEN)	0.8627	0.2096	4.1170	0.0000
D(OPEN(-1))	0.9421	0.3104	3.0349	0.0021
ECM(-1)	-0.4530	0.1076	-4.2112	0.0000
R-squared	0.8489	Mean dependent var		0.0606
Adjusted R-squared	0.7396	S.D. dependent var		0.5296
S.E. of regression	0.5096	Akaike info criterion		1.5731
Sum squared resid	32.4619	Schwarz criterion		1.8289
Log likelihood	-95.7606	Hannan-Quinn criter.		1.6771
F-statistic	19.9874	Durbin-Watson stat		2.4395
Prob(F-statistic)	0.0001			

Table A4: Summary Statistics

Statistics	LNOEXP	LRGDP	LRER	INFR	INTR	OPEN
Mean	8.3767	11.5917	4.8371	20.3881	20.9126	0.3628
Median	8.7284	11.4838	4.9787	12.9450	21.0050	0.3700
Maximum	12.3236	12.5898	5.5876	89.5700	39.0000	0.6800
Minimum	2.1318	10.9377	3.6846	-4.9800	9.5800	0.0700
Std. Dev.	2.7892	0.4681	0.5439	19.5073	5.8599	0.1669
Skewness	-0.4816	0.5552	-0.5145	1.4927	0.0119	-0.0530
Kurtosis	2.2309	2.2572	1.9532	4.4086	3.0731	1.7872
Jarque-Bera	8.8629	10.4103	12.5697	63.5657	0.0345	8.6460
Probability	0.0119	0.0055	0.0019	0.0000	0.9829	0.0133
Observations	140	140	140	140	140	140

Currency Demand and Cash Policy in Nigeria: Implications for Monetary Policy

Alley, I.*

Abstract

This paper examined currency demand in Nigeria within a small open-economy Keynesian money demand model with a view to determining its behavioural response to Cash Policy. Analysis of quarterly data from 1990Q1 to 2016Q4 within a Regime Switching Vector Error Correction (RS-VEC) model showed that currency demand was negatively related to interest rate, price level and exchange rate in the long run, and positively related in the short run to price level and foreign interest rate. Particularly, currency demand was stemmed by the Cash Policy introduced in 2012. Though the currency-demand reduction effects of the policy were small, perhaps due phase-by-phase implementation of the policy, they were very significant; and the policy may thus be rated effective. On the basis of inverse relationship between currency ratio and transmission mechanism from monetary policy variable (high-power money) to broad money supply/demand, cash policy had strong potentials to enhance monetary policy effectiveness through its currency-demand reduction effects.

Keywords: The Cash Policy, Currency demand, Keynesian money demand model, Monetary Policy.
JEL Classification: E41, E42, E51, E52, E58

I. Introduction

Stability of money demand has been an important macroeconomic issue, given its implications for successful implementation of monetary policy. The effectiveness of monetary policy instruments in achieving policy targets and realising desired macroeconomic objectives depends on the accuracy of estimates of money demand parameters (McCallum, 1989) and their stability. Thus, money demand functions of various economies have been estimated and their stability examined (see Kumar, Webber and Farghe, 2013; and Subramanian, 2001.

Several authors have estimated the money demand function in Nigeria and its stability, both in single country studies (Kumar, Webber and Farghe, 2013; Akinlo, 2006; Nwaobi, 2002) and multiple country studies (Bahmani-Oskooee and Rehman, 2009; Fielding, 1994). Notwithstanding, estimation and re-examination is imperative, given the fact that macroeconomic events, planned (financial regulations, e. g. the Cash Policy) and unplanned (e.g. financial crises) affect parameters of the money demand function and their stability; and this explained why there were train of studies in this direction. Such macroeconomic events as financial reforms have been shown to destabilise parameters of money demand function (Haug, 2006). Thus, re-examination of money demand after such an event is essential for not only theoretical and empirical reasons, but also for policy purposes.

* *Ibrahim Alley is a staff of the Department of Economics and Development Studies, Elizade University, Ilara-Mokin, Ondo State, Nigeria, Central Bank of Nigeria. The usual disclaimer applies.*

Most studies analysing money demand function in Nigeria mainly focused on estimating parameters of the money demand function and their stability over time (See Doguwa et al, 2014 for a survey). Very few have examined how money demand, especially the currency demand component, evolved in response to changes in financial sector policies such as the Cash Policy. On the other hand, most studies on cash policy did not analyse the behavioural response of money/currency demand to the policy. Rather, they have only considered other issues around the policy such as business implications (Shonubi, 2012), social benefits and challenges (Akhalumeh and Ohiorka, 2012; Alawiye-Adams, 2012; Okoye and Ezejiofor, 2013; Solanke et al., 2013), economic and safety effects (Omotunde, 2013), financial inclusion effects (EFInA, 2013) and the success factors (Odumeru, 2013). The few that examined the effects of cash policy in relation to money demand include Alley et al (2016) and Egbetunde et al. (2015). While Alley et al. (2016) considered the effects of ATM withdrawal charges on money demand and its implications for the Cash Policy, Egbetunde et al. (2015) examined the effects of mobile payment system such as Automated Teller Machines (ATM) and Point of Sale (PoS) - used to approximate cash policy - on money demand. None of these studies actually evaluated the structural shift in money/currency demand function in response to policies regulating commercial banks in Nigeria, especially the Cash Policy. In addition, most previous studies estimated money demand function in autarkic model. Only few took cognisance of the open nature of the Nigerian economy (see Doguwa et al, 2014 for a survey). The few that did, did not theoretically justify variables relating to open nature of an economy such as exchange rate (Akinlo, 2006; for example) and foreign interest rates.

This paper contributes to the literature by bridging this gap, and in doing so, make the following innovations. It examined money demand nexus in Nigeria in a theoretically justified open-economy. It analysed quarterly data from 1990Q1 and 2016Q4[1] within a regime switching vector error correction model (RS-VECM), with the aim of examining the effects of Cash Policy introduced in 2012 on currency demand in Nigeria. Dummy variables were introduced to model the structural shift effects of cash policy on currency demand in Nigeria and determine its implications for monetary policy effectiveness. RS-VECM was employed because it takes care of endogeneity problem in money demand nexus. As all endogenous variables were modelled as such, there was no need for instrumentation and this obviates use of instruments and challenges that come with them. In addition short term and long run effects were separately estimated within the model.

The foregoing analyses yield interesting findings. There is a long run stable relationship between the variables of the currency demand nexus examined. Currency demand was discouraged by interest rates as the opportunity cost of cash holding increased with interest rates. The demand also fell with increase in price level in the long run as purchasing power of currency declined. In the short run, however, more currency was needed to finance the same level of transactions due to price level increase; hence currency demand rose in response to increasing price level in the short term. Exchange rate also discouraged the demand as the value of domestic currency, relative to others in

[1] This period (1990-2016) is very remarkable in the history of the commercial banks activities in Nigeria as it is marked with variations in the number of banks and financial activities, policies and regulations.

economic agents' currency portfolio, declined. Currency demand's response to foreign interest rates was positive and may perhaps be due to negative effects of currency depreciation on inter-currency transfer of wealth. Cash policy reduced cash balance as currency demand fell with the introduction of the policy, and this result was also evident in decline in growth rate of currency in circulation after 2012. To the extent that decline in currency demand increases the response of broad money demand to high power money (a monetary control variable), currency-demand reduction effects of the Cash Policy suggest that the policy had great potentials to enhance monetary policy effectiveness.

The rest of the paper is organised as follows. Section 2 presents overview of the Cash Policy, currency demand and related determinants while section 3 discusses relevant studies in the literature. Section 4 highlights the methods of analyses and section 5 discusses the data and preliminary analyses. Section 6 presents the results while section 7 summarises with concluding remarks.

II. Cash Policy, Currency Demand and Its Determinants in Nigeria: An Overview

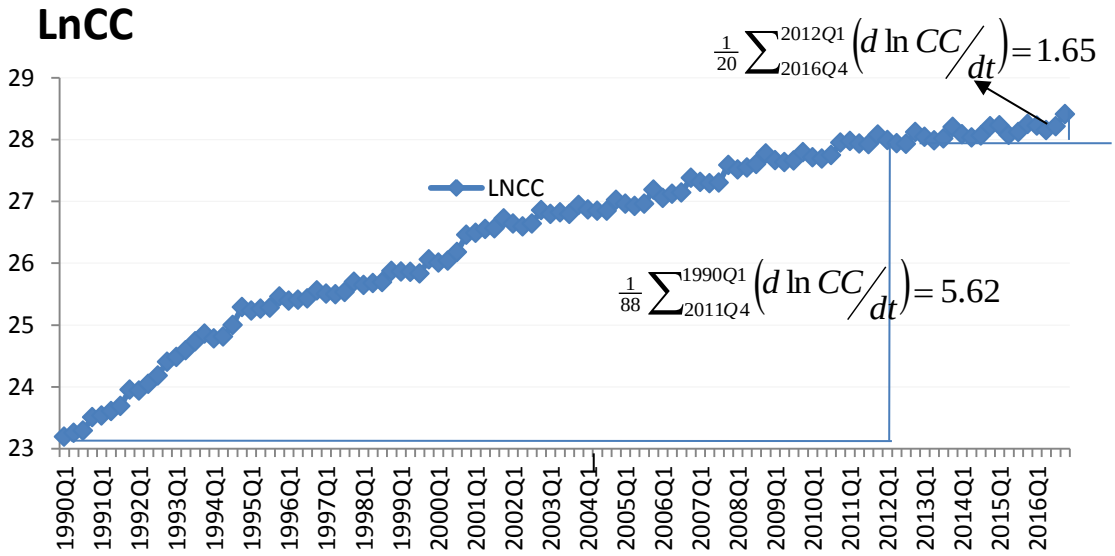
The Cash Policy, like other preceding regulatory policies, was aimed at improving the efficiency of the banking sector in Nigeria. The policy was specifically designed and targeted at reducing the volume of cash transactions (Shonubi, 2012) by shifting the payment system of the economy from largely cash-based to electronic payment system (CBN, 2012). By reducing the volume of cash usage in the economy, the cost and risk of cash management is expected to decline and the banking sector is expected to be more operationally efficient (Sanusi, 2012). The policy was also expected to improve financial inclusion and expand the frontier of formal financial system, thereby increasing the effectiveness of the monetary policies in Nigeria. The Cash Policy was introduced in the first quarter of 2012 and first became operational in Lagos. It was subsequently enforced in some other states like Anambra, Abia, Kano, Ogun, Rivers and Federal Capital Territory (Abuja) on July 1st, 2013. The policy became a nation-wide operation on the 1st of July, 2014.

With the Cash Policy in place, third party withdrawal of cash was limited to one hundred and fifty thousand naira (N150, 000). Other cash withdrawals above limits were also penalised. Withdrawal by individuals and corporate entities exceeding five hundred thousand naira and three million naira respectively attracted cash handling charges (CBN, 2012). In addition, commercial banks were directed to cease rendering cash in transit (CIT) services to their customers. In this light, some companies were licensed to render the CIT services for customers in need. This would reduce demand for CIT services as the costs were now borne by the customers who paid for the services of independent CIT companies. The banking sector (and the public) could save up to N27.3 billion spent on CIT in 2009 (24% of the total cost of cash management). Other costs of cash management include cash processing costs and vault management cost which were in 2009 N69.1 billion and N18.1 billion respectively (Shonubi, 2012). These costs were large because cash (ATM withdrawal and over-the-counter (OTC) withdrawals) dominated the payment system in Nigeria, constituting over 85% of the payment media.

Has the Cash Policy in Nigeria been effective since its inception in 2012? Insights into this question and its answer may be discerned from cursory preview of data on currency demand behaviour over time and its response in the post-policy era. The general behaviour of currency demand may also be understood in the lights of behavioural trend of its traditional determinants.

Currency demand in Nigeria rose throughout the entire period of analysis: both in the pre-policy and post-policy era. However, this does not necessarily suggest that the policy was not effective. Analysis of currency demand data showed that its average growth rate in the pre-policy era was 5.62% while it was 1.65% post-policy. While currency demand did not show a negative trend in the first derivative, perhaps due to driving force/factors such as GDP and saving rate (discussed below); the second derivative was negative. Though the currency demand was increasing as the underlying driver (volume of transaction/GDP) is on the rise, growth rate decline post policy. This suggests that the policy had been effective.

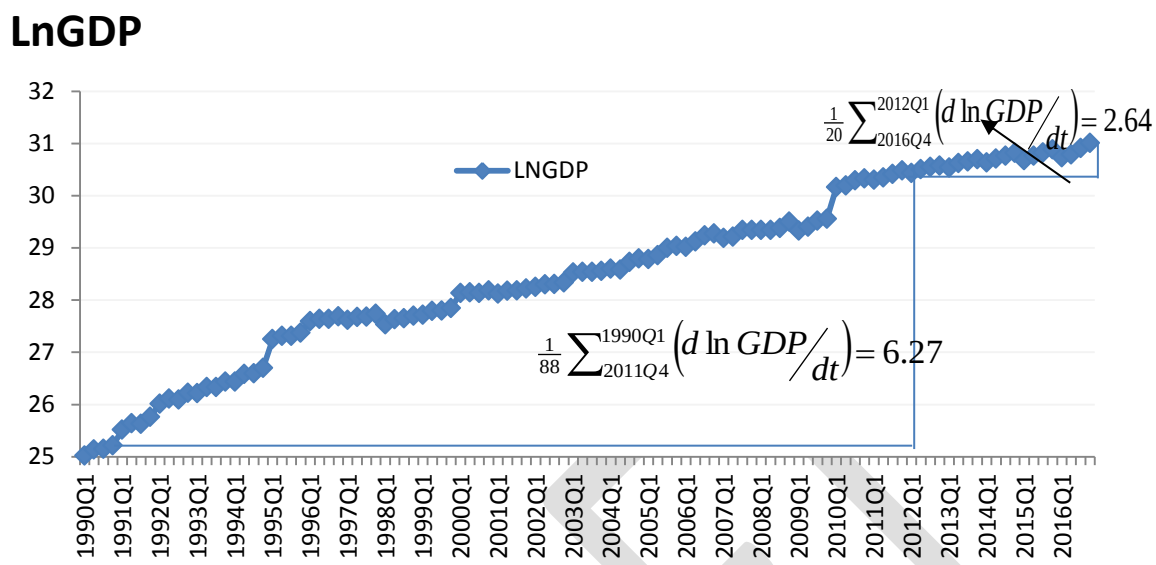
Figure 1: Currency Demand Behaviour and the Cash Policy



Source: Author's Calculation

The gross domestic product shared similar trend with currency demand. However, the decline in growth rate was not as sharp as that of currency demand: the average growth rate in post-2012 after the Cash Policy was larger than that of currency demand. It is worth of note that GDP behaviour especially that in post-2012 era may not be associated with Cash Policy, but with global macroeconomic factor such as dwindling commodity prices, especially oil prices. As a proxy for transaction volume driving currency demand, GDP behaviour should have positive effects on currency demand. Though both data have similar trend, their average growth differed remarkably, especially in the post-2012 era. This may weaken theoretically expected positive relationship between GDP and currency demand.

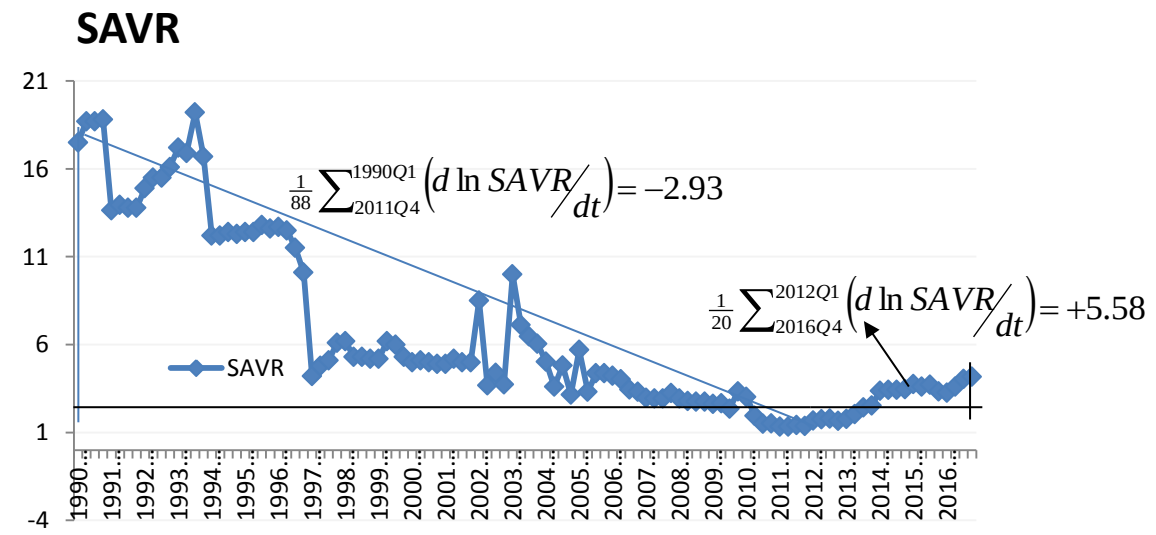
Figure 2: GDP Behaviour before and after 2012



Source: Author's Calculation

Saving rates, unlike GDP and currency demand, trended downwards pre-2012 with an average growth rates of -2.93%. The rate however ascended post 2012. The period of descent coincided with that of sharp growth in currency demand while the period of ascent corresponded with that of slowed growth. These trends in the two series agreed with the theoretical prediction that both variables were inversely related.

Figure 3: Saving Rate before and after 2012



Source: Author's Calculation

III. Literature review

Economic agents primarily demand for money to facilitate their transactions. This demand derives from the medium of exchange role that money performs. Besides this role, the desire for other functions that money performs underlies demand for money. Understanding factors driving demand for money, its behaviour and economic effects had motivated various theories and empirical research.

The Keynes's liquidity preference theory highlights the volume of transactions an economic agent wishes to finance as the main determinant of real money demand. Besides the transactionary demand and precautionary demand (money held to service contingent transactions), money is also demanded for speculative purpose of investment of cash balances in best interest-bearing assets. Total demand for real money by an economic agent, according to this theory, is thus explained by the volume of transactions (which is a function of income) the agent undertakes and the interest rates on interest bearing assets (investment). The aggregate demand for real money balances in the economy is thus just a summation of all the individual demand for real money balances.

The Portfolio Oriented Money Demand Theory by Friedman (1956) viewed money as any other good whose demand was influenced by a host of factors larger than those highlighted by the Keynesian model. According to this theory, demand for money depends on permanent income (annuity of wealth), and not current income, as the former and not the latter, determines consumption; price level; returns on bond; return on equity; and inflation. The difference between the Keynesian and Monetarist model was the explanation of money demand in terms of use of permanent income (for its more accurate description of consumption, the transaction variable) and inflation. The use of broader categories of interest rates on all forms of investments (which serve as store of value functions/demand for money demand) does not constitute a major difference as the interest rate in the Keynesian model relates to return on any interest-bearing assets.

The Baumol-Tobin inventory theory of money demand arrived at similar conclusions as the Keynesian model. The theory predicts that money demand or the inventory of cash held is inversely related to interest rates and directly related to price level and the volume of transactions (Baumol, 1952; Tobin, 1956) which, in turn, is directly related to income (McCallum, 1989). Other money demand models include the shopping time models, the cash-in-advance (CIA) models and the money-in-utility-function (MIU) models. The money demand equation has been shown, in shopping time model, to be the equilibrium outcome of the utility maximisation activity of economic agents who choose optimal values of economic variables that maximise their welfare (McCallum, 1989). The equation states that real money demand is a function of nominal interest rate and real income. While the shopping time model posits that time available for shopping is an important variable, and is inversely related to money demand; both the CIA and MIU models respectively predict that money is special in facilitating transactions and in directly yielding utility (Walsh, 2003).

In the long run money demand equates money supply, and the latter is often employed to approximate the former. Money supply has been measured in several ways, from narrow measures to broad quantities. These measures include M1, M2 and M3 in increasing order of broadness. M1 comprises currency and current account deposits; M2 comprises saving deposit and time deposits in addition to M1 (CBN, 2012); while M3 comprises M2 and other less liquid assets such as repurchase agreement and money market mutual fund shares (Mishkin, 2004). M2 is generally accepted as the main measure of money supply in the economy and is related to high-power money, H (the base money which serves as a primary monetary policy control variable) through money multiplier effects (McCallum, 1989; Mishkin, 2004). The relationship between M2 and H, and hence the extent to which government may control M2 using H, is inversely related to currency ratio[2] (McCallum, 1989, pp.59). Thus, the movement in currency in circulation/currency demand (which in turn determines currency ratio) affects the extent to which monetary control variable, H, predicts M2; and hence, monetary policy effectiveness.

Many studies in the literature tow either the line of the Keynesian model or the monetarist model. Studies that adopted the Keynesian direction (such as Narayan and Narayan, 2008) estimated money demand using income and interest rate only; while studies in line with the monetarist perspective estimated money demand with permanent income as an argument (e.g. Arango and Nadiri, 1981). Most other studies extended the Keynesian model, explaining money demand in terms of not only the income and interest rates but also other variables to capture empirical realities such as exchange rate and foreign interest rates (for open economies) as well as inflation - a proxy for return on real goods (Subramanian, 2001; Doguwa et al., 2014).

Many studies on money demand analysis not only estimated the parameters of the function but also tested their stability (Narayan and Narayan, 2008; Akinlo, 2006; Bahmani-Oskooee and Rehman, 2009) using various techniques including cointegration analysis (e.g. Autoregressive Distributed Lag (ARDL) model, Engle-Granger (EG) Cointegration technique), Johansen Maximum Likelihood (JML) method, Cumulative Sum (CUSUM) of recursive residuals and Cumulative Sum of Squares (CUSUMSQ) of the residuals. Many others examined money demand stability along the structural breaks that occurred in response to macroeconomic events (for example Kumar, Webber, and Farghe, 2013; Narayan and Narayan, 2008 and Chowdhury, 1995).

Money demand has been found to be positively and signifcantly related to income, and negatively related to cost of holding money (proxied by various interest rates and inflation) in many countries, as predicted in theory (see Subramanian, 2001, for a survey). The income and interest elascticities of money demand were however different across countries, reflecting each country money's demand conditions. Moreover, money demand has been found to be stable in most countries (African countries inclusive), irrespective of the form/measure examined (M1, M2 or M3). There were only few occasions where money has been found to be unstable (Kumar, Webber, and Farghe, 2013; and

[2] $M2/H = \mu(R;k;cr)$; $\mu_1 > 0; \mu_2 < 0; \mu_3 < 0$; R = interest rate; k = required reserves; cr = currency deposit ratio

Subramanian, 2001). Very few studies on money demand, especially in advanced economies, had however examined the effects of cash policy on currency demand; and this may be due to the fact that their payment systems were less cash-based. Also, only few have considered the effects of card and non-cash payments on cash demands (Stix, 2004). The few report that card and other electronic payment systems such as ATMs reduced cash demand (Avery et al., 1986; Boeschoten, 1992; Attanasio et al., 2002) through a number of dynamics. First, ATM transactions enable consumers to withdraw as frequently as they want; they thus do not have to keep large cash balance (Stix, 2004; Alley et al., 2016). Second, Electronic payment system gives conumer direct access to their accounts to conduct their transaction without recoursing to cash (Stix, 2004). The resulting decline in cash transaction reduce optimal cash holdings/currency demand (Markose and Loke, 2003).

Studies on money demand function in Nigeria have employed various techniques and measure of money demand to estimate its function parameters and their stability; while some have examined the effects of macroeconomic events on the functions stability using structural break tests. Using JML on quarterly data on M1 from 1986 to 2001, Anoruo (2002) found that M1 was stable. Using the same technique on quarterly data on M2 from 1986 to 2005, Owoye and Onafowora (2007) found that M2 in Nigeria was stable. Akinlo (2006) also found that M2 was stable when ARDL was deployed to examine stability of money demand function in the country, using quarterly data from 1970 to 2004. Allowing for structural breaks to capture the effects of the Structural Adjustment Programme (SAP) policies on money demand function, Kumar, Webber, and Farghe (2013) estimated money demand function with annual data from 1960 to 2008 on Nigeria, using Engle-Granger cointergation technique, Gregory-Hansen structural break test and error correction model (ECM). They found that M1 was stable. Most of these studies found that money demand was positively and signifcantly related to income but negatively related to cost of holding money, such as interest rates and inflation.

Very few studies on money demand in Nigeria had paid adequate attention to the effects of new Cash Policy on money (currency) demand. This may be due to the recency of the policy. On the other hand, studies on the new cash policy in Nigeria largely neglected the policy's effects on money demand; rather they focused on such other issues as the policy's business implications (Shonubi, 2012), social benefits and challenges (Akhalumeh and Ohiorka, 2012; Alawiye-Adams, 2012; Okoye and Ezejiofor, 2013; Solanke et al., 2013), economic and safety effects (Omotunde, 2013); financial inclusion effects (EFInA, 2013); and success factors (Odumeru, 2013). The few that examined the effects of cash policy in relation to money demand include Alley et al. (2016) and Egbetunde et al. (2015).

While Alley et al. (2016) considered effects of ATM withdrawal charges on money demand and its implication for Cash Policy effectiveness, Egbetunde et al. (2015) analysed the effects of Cash Policy (proxied by mobile payment system such as Automated Teller Machines (ATM) and Point of Sale (PoS). Reporting negative effects of ATM on broad money supply (M2), the authors concluded that the policy reduces money demand. Proxying Cash Policy with this electronic system was however erroneous on many grounds. Electronic payment system predates the Cash Policy; the former may thus not capture the

timing and the effects of the latter on money demand. Second, Cash Policy encompasses a set of financial regulation on cash withdrawals and other related transactions and was thus different from electronic payment channel, even though channels may have essentially similar effects on money demand. As Cash Policy has a commencement, there is need to model policy shift into money demand functions to assess the policy effects. No study, to the best our knowledge, has done this in analysing the effects of the new Cash Policy on money/currency demand in Nigeria.

IV. The Model

The study employed the Keynesian money demand theory as the theoretical framework because it was built on microeconomic foundations. According to this theory money demand is the equilibrium outcome of microeconomic utility maximisation process by which every rational economic agent chooses optimum level of currency/money that maximises her utility (McCallum, 1989). The money demand equation is presented in equation (1) and re-written in equation (2) below: Equation 2 presents money demand nexus in autarky.

$$\frac{M_t}{P_t} = L(i_{t,}, Y_t) \quad \text{..... .....(1)}$$

$$M_t = f(P_t, i_{t,}, Y_t) \quad \text{..... .....(2)}$$

where

M_t = money demand was measured here as currency in circulation (CC) as this measure is the direct target of Cash Policy thrust.

P_t = Price level;

i_t = Nominal domestic interest rates;

Y_t = Gross domestic product/income

Assuming that the interest rate parity condition in equation (3) below holds, equation (2) becomes equation (4):

$$\frac{(1+i_t)}{(1+i_t^*)}\frac{E_{t+1}^e}{E_t} = 1\text{.....ß)}$$

$$M_t = f(P_t, i_t, i_t^*, E_t, E_{t+1}^e Y_t) \quad \text{..... .....(4)}$$

where

i_t^* = foreign nominal interest rates proxied by 3-month interest rates on Unites States Treasury bill;

E_t = exchange rate;

E_{t+1}^e =expected exchange rate

Equation (4), which represents an open-economy money demand model due to effects of foreign interest rate and exchange rate, is explicitly specified in log-linear form (in equation 5 below), with expected exchange rate removed due to its high level of multicollinearity with current exchange rate:

$$\ln M_t = \alpha_0 + \alpha_1 P + \alpha_2 i_t + \alpha_3 i_t^* + \alpha_4 E_t + \alpha_5 \ln Y_t + \varepsilon_t \text{ ....(5)}$$

Equation (5) is estimated within a Vector Error Correction (VEC) model due to its advantages. First, all endogenous economic variables are endogenised and this obviates use of instruments and challenges that come with them. In addition, exogenous variables are also accommodated and treated as such. Also short term effects may be separated from their long term counterparts.

Representing Equation (5) in a Vector Error Correction (VEC) model in a way to test the effects of the Cash Policy as an exogenous policy shift on money demand, we have

$$\Delta Z_t = \sum_{i=1}^{T} \Delta Z_{t-i} + \lambda(CC_t - \sum_{i=1}^{T} X_{t-i}) + \Pi_t + u_t \text{ .....(6)}$$

Where

$Z_t = CC_t, P_t, i_t, E_t, Y_t$;

$X_t = P_t, i_t, E_t, Y_t$;

$\Pi_t = i_t^*, CP$;

u_t = error term

Z and X are endogeous vectors while Π is exogeous. The exogeneity of Π derives from the fact that i_t^*, the foreign interest rate is exogenous to the economy while CP, the cash policy is exogenous to money demand funtion. CP is a dummy variable defined as below.

$$CP = \begin{cases} 0 \ if & 1990Q1 < T < 2012Q1 \\ 1 \ if & T \geq 2012Q1 \end{cases}$$

Equation (6) is a regime-switching vector error correction model (RS-VECM) with a regime shift in the intercept alone. It is similar to Markov-Switching Vector Error Correction Model (MS-VECM) with regime shifts in intercepts (Sarno, Valente and Wohar, 2003; Thams, 2007) It is also consistent with Arrau et al. (2003) in explicitly modelling the Cash Policy (a form of financial innovations) in a money demand nexus. Lag length selection criteria were not solely based on the traditional lag lenght tests such as the AIC and SBC. Only models where the variables are cointegrated and the estimators do not violate a priori theoretical expectation are considered for AIC and SBC examinations.

V. Data and Preliminary Analysis

Currency in circulation (CC) was used as proxy for money demand due to being the direct target of the Cash Policy. Interest rate is defined as interest on saving deposit (SAVR) because it is the opportunity cost of currency (money) demand, while income is measured as Gross Domestic Product (GDP). General price level is measured as Consumer Price Index (CPI) because we assumed that consumption transactions was the largest driver of currency demand in most economies with no exception to Nigeria. Exchange rate was measured as the Wholesale Dutch Auction Naira Price of USD dollars because we assume that flows of funds between the country and other nations occur at official rate. Foreign interest rate was measured as 3-months United States treasury bills (USR3). Data on domestic variables were collected from the Central Bank of Nigeria's database while those on 3-months United States treasury bills rate were collected from the database of the Federal Reserve Bank of St. Louis.

Results from unit roots analyses, presented in Table 1, showed that all series was I(1)[3]. The Johansen cointegration analysis treating all domestic variables as endogenous and US interest rates and cash policy dummy variables as exogenous showed that there is a long run stable relationship between the variables (Table 2). Findings from the Gregory and Hansen cointegration test with structural breaks, also reported in table 2, support findings from Johansen test. Both cointegration tests showed that the tests were robust to specification.

Table 1: Unit Roots Tests

	Unit Roots without Breaks				
	ADF		PP		I(q)
Series	Level	1st diff.	Level	1st diff.	I(1)
LnCC	-2.96	-3.99***	-2.44	-13.48***	I(1)
LnGDP	-2.19	-10.67***	-2.21	-10.68***	I(1)
SAVR	-2.01	-8.02***	2.41	-16.65***	I(1)
EXR	-0.69	-10.83***	-0.69	-10.84***	I(1)
CPI	-1.69	-9.01***	-1.63	-9.03***	I(1)
US3R	-4.78***	-4.35***	-2.87	-5.02***	I(0/1)

LnCC= natural log of currency in circulation, LnGDP = natural log of gross domestic product, SAVR= interest rate on saving deposit, EXR, Exchange rate, CPI=consumer price index, US3R=interest rate on 3 month US Treasury Bills; ADF= Augmented Dickey Fuller Test; PPP=Philip Perron Test; I (q)= order of integration
*** *denotes 1% levels of statistical significance*

Source: Author's calculation

[3] The two unit roots test employed disagree on US interest's integrational properties. While Augmented Dickey Fuller (ADF) unit root test shows US interest rates as being I(0), Phillip-Perron (PP) unit root test established that this series is I(1).

In other words, the variables were cointegrated. In addition, error-correction terms of the VECM were negative and statistically significant. These results show that short run disequilibria were corrected and the long relationship between the variables were stable; hence, they corroborated findings from the Johansen cointegration and Gregory and Hansen cointegration analyses.

Table 2: Co-integration Tests

Series	**Assumption**	**Trace Stat.**	**5% Crit. Value**
Endogenous	No deterministic trend	123.30**	76.97
LnCC, LnGDP, SAVR, EXR, CPI	Linear deterministic trend Unrestricted	115.12**	79.34
Exogenous	Linear Deterministic Trend Restricted	124.76**	88.80
US3R, CP	Quadratic Deterministic Trend	115.57**	69.82
	Gregory Hansen Co-integration Test		
Series	**Assumption**	**ADF Stat**	**5% Crit. Value**
LnCC, LnGDP,	Break in Regime and Trend	-6.93**	-6.84
SAVR, EXR,	Break in Regime Only	-6.92**	-6.41
CPI	Break in Trend Only	-5.90**	-5.83

*** denotes 5% levels of statistical significance*

Source: Author's calculation

VI. Currency Demand, Cash Policy Effects and Monetary Policy Implications

Prior analysing currency demand and cash policy effects in the most suitable model, various models were estimated, statistics were compared and several econometric considerations were made to determine the best model for analysis. The choice of model, in terms of lag lenght, depends not only on traditional lag lenght selection criteria - Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC) - but also on congruence of the model's empirical estimates with theoretical prediction (a priori expectation) as well as existence of a stable long run relationship between the variables of interest (Table 3). While AIC appears to be a decreasing function of lag lenght, SBC appears to be an increasing function. Models for which AIC and SBC statistics were minimised were models 5 and 1 respectively. These models were however unstable because the short run errors/disequlibria were never corrected since the error correction parameters are insignificantly negative and positive respectively. Only models 2 and 3 were stable with the variables cointegrated in the long run because error correction parameters were significantly negative. Model 3 was however preferred to model 2 because the former had short term disequlibrium dissipated at a faster rate of 8.7% (with error corrected in 11 quarters) compared to the latter where the error correction rate was 5.6% taking 18 quarters for errors to be corrected. In addition, model 3 had lowest AIC, though larger SBC.

It also had savings (interest) rate to be more statistically significant, suggesting that it was more congruent with theoretical predictions/a priori expectations.

Table 3: Model Selection Analysis

Model/Lag lenght	Lag selection criteria		A priori Expectation Long run estimates of traditional parameters		Error correction parameter
	AIC	SBC	Savings (interest) rate	Income	
1	13.4	14.7	0.081 (1.280)	0.754* (1.899)	0.015 (0.865)
2	13.6	15.5	-0.089* (1.684)	-0.048 (-0.145)	-0.056*** (3.182)
3	13.4	15.9	-0.080*** (2.635)	-0.132 (-0.709)	-0.087*** (-4.483)
4	12.9	16.0	-0.050*** (-2.377)	-0.478*** (-3.624)	0.002 (0.062)
5	12.9	16.7	-1.049*** (-4.148)	0.924 (0.580)	-0.002 (-0.701)
6	13.3	17.8	-0.196*** (-3.762)	-0.479 (-1.449)	-0.015 (-0.745)

*p values in parentheses; *, **, and *** denote 10%, 5% and 1% levels of statistical significance*

Source: Author's calculation

Table 4 presents both long run and short run estimates of money demand determinants and effects of the Cash Policy in model 3. Income had insignificant effects on currency demand, both in short and long runs. While this was incongruent with a priori expectation these results suggest that increase in income over time did not correspondingly drive increase in currency. This may be due to the fact that policies supporting alternative payments systems such as POS, internet banking had dragging effects on currency demand and hold it from keeping pace with rise in income etc. Alternatively, these results may suggest some form of decoupling between income and volume of transactions. Income may be driven by few huge transactions not financed with cash, while most transactions using cash were a small proportion of income/GDP. Therefore, income may not approximate transaction volume, the latter being the main driver of cash/currency demand.

Saving (interest) rate negatively affected currency demand in the long run. Increase in the rate reduced currency demand; and this showed that interest rate was an opportunity cost of holding cash instead of deposits. Currency demand thus falls when the rate increases. This result was reflected in the data: figures 1 and 3 showed that average growth rate of currency demand was high when saving rate was declining, especially in the pre-Cash Policy era. The relationship reversed in the post-policy era: the average growth rate of saving rate became positive and the growth rate of currency demand decline. The effects of interest rates on currency demand in the short run were however

not significant. This may lead to perceived insensitivity of currency demand to interest rate movements.

Table 4: Currency Demand, Determinants and Cash Policy Effects

Dependent Variable: lnCC		
Endogenous Series	**Long Run Estimates**	**Short Run Estimates**
lnGDP (-1)	-0.132 (-0.709)	-0.053 (-0.641)
lnGDP (-2)		-0.034 (-0.398)
lnGDP (-3)		-0.094 (-0.398)
SAVR(-1)	-0.079*** (-2.635)	0.008 (-0.273)
SAVR(-2)		-0.001 (-0.273)
SAVR(-3)		-0.003 (-0.563)
CPI (-1)	-0.013*** (3.091)	0.007* (1.903)
CPI (-2)		-0.003 (0.899)
CPI (-3)		-0.006 (-1.589)
WDAS(-1)	-0.012*** (-6.619)	-0.0002 (-0.380)
WDAS(-2)		-0.001** (-1.990)
WDAS(-3)		-0.0004 (-0.732)
Exogenous Series		
USR3		0.012** (2.344)
Cash Policy		-0.084*** (-2.716)
Constant		0.092*** (3.675)
Co-integrating Parameter	-0.087*** (-4.483)	
Post-Estimation Statistics		
F-statistics	4.541	
LM (Serial Correlation) Test (-3)	30.462 (0.208)	
VAR Stability Test (Max. Modulus)	0.883	
Heteroscedasticity Test	445.01 (0.995)	

*p values in parentheses; *, **, and *** denote 10%, 5% and 1% levels of statistical significance*

Source: Author's calculation

Increase in the general price level increased currency demand in the short run but had opposite effects in the long run. The short run effects showed that more currency was required to finance the same level of transaction when price increased. However, increase in price level reduced value of currency, and in the long run diminished demand to hold it. Foreign interest rate (proxied by interest rate on US 3 month Treasury Bills) did not reduce currency demand but rather increased it. This may not be unconnected to the effects of negative effects of exchange rates in both short run and long run. Exchange rate's negative effects, both in short and long runs, suggested that rise in depreciation of Naira reduces international value of Naira directly and its domestic value indirectly through imported inflation; hence the demand for domestic currency falls. While holding foreign currencies or bills offers attractive alternative to holding currency, currency depreciation delayed inter-currency transfer of wealth; hence, domestic currency balance held by economic agents accumulated. This was reflected in positive effects of US interest rate on currency demand.

Cash policy significantly discouraged currency demand: the amount of currency used in the economy fell by 0.08 % with the introduction of the policy. The marginal decline reflects phase-by-phase application of the policy; that is, the effects of not implementing the policy nation-wide but in selected states in one phase before extension to other states in another phase. The statistical significance of the cash policy estimator, however, suggested that the policy was effective. Currency-demand reduction effects of cash policy had strong implications for monetary policy effectiveness. With the theoretical prediction that broad money response to high power money is inversely related to currency ratio, and by extension currency demand (McCallum, 1989, Mishkin, 2004), cash policy may, through its currency-demand reduction effects, tightened the relationship between high power money (monetary policy variable) and broad money, and thus increase the influence of the monetary policy on broad money. To this extent, the Cash Policy appeared to have strong potentials to improve effectiveness of monetary policies in Nigeria.

The entire model significantly explains currency demand as F-statistics of 4.541 was greater than the critical value of 2.898 at 1% degree of statistical significance. In other words, all the variables jointly explained the behaviour of currency demand in Nigeria. The model was also stable as the cointegration parameter indicated that the variables coexisted in a stable long term relationship. The VAR stability also lends credence to the model's stability as maximum autoregressive roots of the VEC model of 0.883 lied within the unit circle. The model neither suffered from autocorrelation nor heteroscedasticity; hence, the estimators were robust.

VII. Conclusion

Cash Policy as one of the banking reforms was put in place to enhance banking sector operational and financial performance efficiency. It was aimed at reducing currency in circulation, reduced cash management costs and improved efficiency of the banking

sector. The effects of the policy on demand for currency had not, however, been thoroughly explored. Analysing quarterly data from 1990 to 2016 within a regime switching vector error correction model (RS-VECM), this study estimated a currency demand function in Nigeria to determine whether the Cash Policy had been effective in reducing currency demand/cash usage in Nigeria.

Currency demand in Nigeria in the 1990-2016 period was not driven by income both in the short and long runs even though both variables co-trended. This result suggested that GDP does not approximate the volume of transactions, the primary driver of money/currency demand. Currency demand was however significantly interest rate sensitive. The interest rate reduced currency demand in the long run, as people invested in deposit to earned increased return on saving deposits. The reduction in currency demand growth occurred post-2012 when the saving rates began to rise. Cash demand was reduced by rising price level in the long run due to latter's diminutive effects on currency's purchasing power. The demand was however positive in the short run as more cash was required to finance transactions in inflation times. Exchange rate depreciation discouraged demand for domestic currency as its value relative to others in the currency portfolio fell, directly through currency depreciation in the international market and indirectly through reduced purchasing power in the local market. While economic agents might be willing accumulate cash for investment in foreign asset, exchange rate depreciation may had delayed transactions due to inherent exchange rate loss; hence, cash demand may increase with rising rate on US Treasury Bills.

Currency demand declined after the introduction of the Cash Policy in Nigeria. Besides the decline in average rate of its growth in post-policy period, econometric analysis showed that autonomous currency demand in the short run statistically declined after the policy. This result suggested that the policy was effective in achieving set objectives. To the extent that decline in cash/currency demand increase the response of broad money demand to high power money, a monetary policy control variable, the Cash Policy had great potentials to enhance monetary policy effectiveness in the country.

References

Akhalumeh, P. and Ohiorka, F. (2012). Nigeria's Cashless Economy: The Imperatives. International, *Journal of Management & Business Studies*, Vol. 2, No. 2, pp. 31-36.

Akinlo, A. E. (2006). The Stability of Money Demand in Nigeria: An Autoregressive Distributed Lag Approach. *Journal of Policy Modelling*, Vol. 26, pp. 445-452.

Alawiye, A. (2013). Is CBN Over-regulating the Banks? Retrieved on 27 July, 2014 from http://www.punchng.com/business/money/is-cbn-over-regulating-the-banks/

Alawiye-Adams, A. A. (2012). The Cashless Nigeria Project. Subsequent back pedaling in the course of implementation and recent updates. Global Advanced Research *Journal of Management and Business Studies* Vol. 2, No 1, pp. 37-43

Alley, I. S., Adebayo, L. A., Oligbi, B. and A. Lawal (2016). Cancellation of ATM Withdrawal Charges and the Cash Policy in Nigeria. *Global Journal of Management and Business Research, Vol. 16, No 3, pp. 57-52.*

Anoruo, E. (2002). Stability of the Nigerian M2 Money Demand Function in the SAP Period', *Economics Bulletin,* Vol. 14, No. 3, pp. 1-9.

Arango, S. and M. I. Nadiri (1981). Demand for Money in Open Economies. *Journal of Monetary Economics*. Vol. 7, pp. 69-83.

Arrau, P. De Gregorio, J., Reinhart, C. and Wickham, P. (2003). The Demand for Money in Developing Countries: Assessing the Role of Financial Innovation. *World Bank Working Papers Series* No. 721

Attanasio, O., Tullio, J and Luigi G. (2002). The Demand for Money, Financial Innovation, and the Welfare Cost of Inflation: An Analysis with Household Data. *Journal of Political Economy* 110(2), 317-351.

Avery, R., Elliehausen, G. E., Kennickell, A. B. and P. A. Spindt (1986). The Use of Cash and Transaction Accounts by American Families. *Federal Reserve Bulletin*, Vol. 72, No 2, pp. 87-108.

Bahmani-Oskooee, M. and H. Rehman (2009). How stable is the demand for money in African countries?, *Journal of Economic Studies*, Vol. 36, pp. 216-235.

Baumol, W. (1952). The Transactions Demand for Cash: An Inventory Theoretic Approach. *Quarterly Journal of Economics*, Vol. 66 No. 4, pp. 545-556.

CBN, (2012). The Cashless Nigerian Project, Central Bank of Nigeria, accessed at 20th December, 2016, from http://www.cbn.gov.ng/cashless/

Boeschoten, W. C. (1992). Currency Use and Payment Patterns. Financial and Monetary Policy Studies, Vol. 23. Dodrecht. *The Netherlands: Kluwer Academic Publishers*.

Chowdhury, A. R. (1995). The Demand for Money in a Small Open Economy: The Case of Switzerland. *Open Economy Review*, Vol. 6, pp. 131-144.

Doguwa, S. I., Olowofeso, O. E., Uyaebo, S. O. , Adamu, I. and Bada A. S. (2014). Structural Breaks, Co-integration and Demand Money in Nigeri. CBN Journal of *Applied Statistics,* Vol. 5, No. 1, pp.15-33

EFInA (2013). What does the CBN's Cash-less Policy mean for Financial Inclusion in Nigeria?. *Bankable Frontier Associates*

Egbetunde, T., Ayinde, T. O. and A. A. Adeyemo (2015). Demand for Money and Cashless Policy in Nigeria. *Indian Journal of Management Science*, Vol. 5, Issue 1, pp. 83-95.

Fielding, D. (1994). Money Demand in Four African Countries. *Journal of Economics Studies*, Vol. 21, pp. 17-51.

Friedman, M. (1956). The Quantity Theory of Money: a Restatement. *In M. Friedman (Ed.), Studies in the Quantity Theory of Money*, Chicago.

Haug, A. A. (2006). Canadian Money Demand Functions: Co-integration-rank stability, *Manchester School*, Vol. 74, pp. 214-230.

Kumar, S., Webber, D. J. and S. Fargher, (2013). Money Demand Stability: A Case Study of Nigeria. *Journal of Policy Modelling*. Vol. 35, Issue 6, pp. 978-991

Markose, S. M. and Y. J. Loke. (2003). Network Effects on Cash-Card Substitution in Transactions and Low Interest Rate Regimes. *The Economic Journal*, Vol. 113. Pp. 456-476.

McCallum, B. T. (1989). Monetary Economics: Theory and Policy. *New York: Macmillan Publishing Company.*

Mishkin, F. S. (2004). The Economics of Money, Banking and Financial Markets. 7th Edition, New York: Addison Wesley

Narayan, P. K. and S. Narayan (2008). Estimating the Demand for Money in an Unstable Open Economy: the Case of the Fiji Islands. *Economic Issues*, Vol. 13, pp. 71-91.

Nwaobi, G. (2002). A Vector Error Correction and Non-nested Modelling of Money Demand Function in Nigeria. *Economics Bulletin*, Vol. 3, pp. 1-8.

Odumeru, J. A. (2013). Going Cashless: Adoption of Mobile Banking in Nigeria. Arabian *Journal of Business and Management Review*, Vol.1, No. 2, pp. 9-17

Okoye, P. V. C. and R. Ezejiofor (2013). An Appraisal of Cashless Economy Policy in Development of Nigerian Economy. Research *Journal of Finance and Accounting* Vol.4, No.7, pp. 237-252

Omotunde, M., Sunday, T. and A. T. John-Dewole (2013), 'Impact of Cashless Economy in Nigeria', *Greener Journal of Internet, Information and Communication*, Vol. 1 No. 2 pp. 38-43.

Owoye, O. and O. A. Onafowora (2007). M2 Targeting, Money Demand and Real GDP Growth in Nigeria: Do rules apply?. *Journal of Business and Public Affairs* 1:1-20.

Sanusi, L. S. (2012). Banking Reform and its Impacts on the Nigerian Economy. *CBN Journal of Applied Statistics,* Vol. 2, No. 2, pp. 115-122.

Sarno, L., Giorgio, V., and Mark E. W (2004). Monetary Fundamentals and Exchange Rate Dynamics under Different Nominal Regimes. *Economic Inquiry* 42, 179-193.

Shonubi, A. (2012). Toward a Cashless Economy: Tools, Strategies and Business Implications, *A paper presented at the National Conference of the Nigeria Computer Society*, 25th July.

Solanke, I. O., Aigbokhan, E. E., Alakir, H. O. And A. A. Omotunde (2013). Towards Cashless Nigeria: Role of Information Technology and Opportunities for Poverty Alleviation. *actaSATECH,* Vol. 4, No (2), pp. 79-92

Stix, H. (2004). The Impact of ATM Transactions and Cashless Payments on Cash Demand in Austria. Monetary Policy and the Economy, *Quarterly Review of Economic Policy of Oesterreichische National Bank.* pp. 90-95

Subramanian, S. S. (2001). A Survey of Recent Empirical Money Demand Studies. *IMF Staff Papers,* Vol. 47, No 3, pp. 1-32.

Tobin, J. (1956). The Interest-Elasticity of Transactions Demands for Cash. *Review of Economics and Statistics,* Vol. 38, No. 2, pp. 241-247.

Walsh, C. E. (2003). Monetary Theory and Policy, 2nd Edition, London: *The MIT Press.*

SUBMISSION OF MANUSCRIPT TO CBN ECONOMIC AND FINANCIAL REVIEW

1. Three (3) hardcopies and a softcopy of the original manuscript should be addressed to the:

   The Editor
   CBN Economic and Financial Review
   Research Department
   Central Bank of Nigeria
   P.M.B.0187, Garki, Abuja

   The softcopy of the papers can also be submitted via email as electronic document, preferably Microsoft word document to the following email address: rsdpublications@cbn.gov.ng

   The article should not be more than 20 pages on A4 size paper and should be typed double-spaced with a margin of 1.5 inches on all sides. The manuscript must be accompanied with a letter of submission written in English. Submission of a paper is assumed to imply that its contents represent original and unpublished work and is not under consideration elsewhere for publication. Normally, the review process is expected to take not more than three months. There is neither a submission charge nor page fee. A return address (postal/email) should be indicated.

2. Papers may be accepted or returned for specified revisions. A paper is expected to be published approximately six months from the date of acceptance.

3. *Comments on published article/notes* and *reviews* of up to 2,000 words will also be considered for publication. Notes deal with relevant topics not meeting full length articles. Reviews may be about articles published recently by this journal or elsewhere. A copy of the review/comments should be sent to the articles' author for clarification of any points or misunderstandings.

4. All submitted manuscripts are referred to an Editorial Board comprising of an in-house editorial committee and external referees. All comments by the referees will be sent to the author(s) together with a decision of the Editorial Board.

5. The purpose and scope of the article should be clearly stated in an abstract summarising the article's essential points. The abstract should be typed on a separate page and should be between 80-100 words in length. In addition, the JEL classification code (s) as well as keywords should be clearly indicated on the abstract page.

6. The author's institutional affiliation and necessary background information on the article should appear at the foot of the first page. Footnote to the text should be listed at the end, followed by the list of references

7. References for quotations or statements should be in parentheses in the text, not as notes. E.g. Hess (1906:20) or Cagan (1958) or Majer (1975:35). Where more than three authors are involved, cite senior author and use *et al.*, E.G. Johnson *et al.* (1988).

8. Citations listed under the reference sections must begin on a new page. All entries must be typed double-spaced, listed alphabetically by last name of senior author and chronologically for two or more articles by the same author. The typed layout must conform to the following examples:

   Nnanna, O. J. (2003). Promoting Savings and Investment Culture for National Development. *CBN Economic and Financial Review*, 41(3), 1-10.

   Oresotu, F. O., & Mordi, C. (1992). The Demand for Money Function in Nigeria: An Empirical Investigation. *CBN Economic and Financial Review*, 30(1), 32-69.

   Croxton, F. E., Cowden, F. E., & Klein, S. (1968). *Applied General Statistics*. London: Sir Isaac Pitman and Sons.

9. All tabular materials should be separated from the text in a series of tables numbered consecutively in Arabic numerals preferably in Microsoft Excel. Each table should be typed double-spaced and identified by a short descriptive at the top. Notes for table should be at the bottom of each table, before the source, and marked by lower case superscript letters. Appropriately placed tables should be indicated in the text.

10. Diagrams, graphs, charts, etc. must be separated from the text and clearly drawn in black ink on a white paper with all axes clearly positioned. They should be submitted in a form suitable for reproduction without redrawing, preferably in camera-ready artwork.

11. Where mathematical equations and formulae are used, they should be typed clearly. Notations, exponents, etc., which are simple to reproduce should be used. The equations should be numbered consecutively in Arabic numerals. The full mathematical workings necessary for justifying each step of the argument should accompany all the articles of a mathematical nature. This is meant to assist the reviewers and will not be published.