



MONETARY POLICY SHOCKS AND EXCHANGE RATE VOLATILITY IN NIGERIA

Babatunde Wasiu Adeoye

Department of Economics, University of Lagos, Nigeria

Olufemi Muibi Saibu

Department of Economics and Econometrics, University of Johannesburg, South Africa,

ABSTRACT

This paper analysed the effects of monetary policy shocks using changes in various monetary policy instruments on exchange rate volatility in Nigeria. This paper investigates the relationship between exchange rate volatility and monetary policy shocks in Nigeria. The paper applies the classical ordinary least square to examine the short-run monetary policy determinants of exchange rate volatility in Nigeria. Also, the error correction mechanism model was estimated after establishing the long-run interaction among set of incorporated variables using the Engle-Granger approach. The results from the paper show that both real and nominal exchange rates in Nigeria have been unstable during the period under review. In the short, the variation in the monetary policy variable explains the movement/behaviour of exchange rate through a self-correcting mechanism process with little or no intervention from the monetary authority (CBN).

In addition, the results from the causality tests between the exchange rate volatility and monetary policy variables showed that there is a causal link between the past values of monetary policy variables and the exchange rate. This is obvious in the case of the past value of the interest rates. Such that, a change in the level of previous values of monetary policy variables causes exchange rate volatility. Finally, the paper reiterated and concluded that inflation rate, reserves, interest rate and money supply depreciate and cause volatility in nominal exchange rate which further reinforce other findings that monetary policy is crucial to exchange rate management in Nigeria.

Keywords: Monetary Policy, Exchange rate Volatility, Policy Shocks, Central Banking

1. INTRODUCTION

Monetary policy in Nigeria is anchored on monetary targeting framework, and price stability which represents the overall objective of monetary policy. This is a clear departure from the past where the major objective of the monetary policy is purely rapid economic growth and employment. The special attention on price stability derives from new developments in monetary

theories and empirical evidences which show that sustainable growth can only be achieved when there is stability in the price level (Nnanna, 2002). Therefore, the centrality of exchange rate in the formulation of monetary policy derives from the fact that for most countries, the prevailing objective of monetary policy is price stability. Volatility in exchange rate is always seen to be counter-productive to the goals of price stability. There is indeed, a general consensus that domestic price volatility undermines the value of money as a store of value, and frustrates investments and growth.

There is a widespread presumption that volatility on the exchange rates of developing countries is one of the main sources of economic instability around the world. The impact of the global economy on emerging countries like Nigeria is driven significantly by swings among the currencies of the major economic powers like United State. In recent years these swings have been enormous, volatile and frequently unrelated to underlying economic fundamentals. This has prompted monetary authorities in developing countries that keep close ties with the economic powers to intervene on totally ad hoc and episodic basis, without any clear sense of a sustainable equilibrium. Such exchange rate stability intervention typically comes too late to prevent severe currency misalignment and volatility. These imbalances, in turn, trigger major economic distortions, protectionist trade pressures, and inevitably sharp currency reversals (Philippe *et al.*, 2006). Though, currency instability and volatility could only exist during flexible exchange rate regime.

Exchange rate regime varies with the level of financial development. Throughout the developing world, the choice of exchange rate regime stands as perhaps the most contentious aspect of macroeconomic policy. Empirical evidences have shown that exchange rate volatility in turn is caused by both real and financial aggregate shocks. Yet, despite the perceived implications of the exchange rate regime to long- run growth and economic stability, the existing theoretical and empirical literature on Africa (Nigeria in particular considering the level of the country's economic integration through trade and foreign capital inflows) offers little guidance. The theoretical literature is mainly tailored to richer countries with highly developed institutions and markets (e.g., (Garber *et al.*, 1995; Obstfeld and Kenneth, 1996), and there is almost no discussion of long-run growth. The most known theoretical explanation of long-term stability and consistency of bilateral exchange rate is Purchasing Power Parity (PPP) hypothesis. Testing for long-run PPP is important for number of reasons: many monetary models á lá (Dornbusch, 1986), hinges on the validity of long-run PPP theory, while many other macroeconomic models often use PPP to link domestic and foreign development especially in developing countries like Nigeria. Furthermore, although the PPP hypothesis may not be regarded as an explicit exchange rate theory, it may still serve to provide fundamental determinants that can be used to calculate the long-run exchange rates and assess the appropriate level of exchange rates when a long-run relationship exists. However, both nominal and real exchange rates are studied in this study since a sizable discrepancy often exists between these two exchange rates and often used alternatively in empirical research and

considering an highly regulated environments like Nigeria where the supply of foreign exchange is often insufficient to meet the market demand.

In Nigeria, maintaining a realistic exchange rate for the naira is very crucial, given the structure of the economy, and the need to minimize distortions in production and consumption, increase the inflow of non-oil export receipts and attract foreign direct investment. Moreover, the persisting problems of import dependency, capital flight, and lack of motivation for backward linkages in the production process need to be addressed, amongst others. Exchange rate and monetary policy are therefore key tools in economic management and in the stabilization and adjustment policies in developing countries like Nigeria. In most developing countries, low inflation and international competitiveness have become major policy targets. The real exchange rate is a measure of international competitiveness, while inflation mostly emanates from monetary expansion, currency devaluations and other structural factors. Despite the importance of monetary and exchange rate policies in economic management, a few studies have been done on Nigeria to assess the relationship between them.

Against this backdrop, this paper examines the interplay between monetary policy shocks and exchange rate volatility in an import dependent economy (Nigeria). The paper is organised as follows: Section II provides an overview of issues in monetary policy and macroeconomic management in Nigeria. Section III outlines the review of relevant literatures and theoretical issues. Model estimation and estimation techniques are contained in section IV. While section V presents the empirical results, the conclusion and policy suggestions are contained in section VI.

2. OVERVIEW OF ISSUES IN MONETARY POLICY AND MACROECONOMIC MANAGEMENT IN NIGERIA

The Central Bank of Nigeria (CBN) as the highest monetary authority in Nigeria has continued to play the traditional role expected of a central bank, which is the regulation of the stock of money in such away as to promote the social welfare (Ajayi, 1995). This role is anchored on the use of monetary policy that is usually targeted towards the achievement of full-employment equilibrium, rapid economic growth, price stability, and external balance. Over the years, the major goals of monetary policy have often been the two later objectives. Thus, inflation targeting and exchange rate policy have dominated CBN's monetary policy focus based on assumption that these are essential tools of achieving macroeconomic stability.

Monetary policy in Nigeria has been carried out through the portfolio behaviour of the CBN in terms of the control of its credit and management of reserves. Credit control is being used to check movement in domestic price level, while the exchange rate policy serves as measure for determining the competitiveness and current account performance as well foreign reserves. Figure 1 indicates that during the first half of 1980s, CBN's reserves relative to domestic credit witnessed continual decline it however started to increase from 1986 up till 1990. Around the last quarter of 1990 the reserves nose-dived again until 1991 when it picked up again. This trend in reserves coincides with the three different exchange rate regimes.

The period 1980 to 1986 was marked by overvaluation of domestic currency, Naira vis-à-vis other trading partners currencies (especially US dollars), during this period the monetary authority adopted fixed exchange rate regime. The first substantial increase in reserves fell within the devaluation year, the third quarters of 1986 and first quarter of 1992, however the devaluation was characterized by manage or pegged exchange rate regime. In March 1992 when the floating exchange rate was adopted by the merging of official exchange rate with the parallel market rate there was an initial shock in the system and this affected the reserves negatively. The initial shock was later absorbed as evident by the subsequent increase in the reserves. Although it can be deduced that the upward trend experienced in reserves from 1994 was due to reduction in importation, the increase was as a result of great cut back in CBN's credit to the Federal Government (Folawewo and Osinubi, 2006).

The different exchange rate policies couple with the inflationary targeting of monetary policy has affected domestic price level and stopped competitiveness in several ways (Folawewo and Osinubi, 2006). First, as evident from Figure 1, there was an appreciation in nominal effective exchange rate (NEER) between the Period 1980 and 1986. The NEER however appreciated with the devaluation of 1986 until 1993 when it started depreciating again with the adoption of the floating exchange regime. On the other hand, the general price level, as depicted by consumer price index (CPI) has fluctuated, leading to high level of instability in domestic prices (see Figure 2). In fact, the different monetary policies have led to erratic inflation and the poor movement of other macroeconomic aggregates. During the fixed exchange rate regime inflation rate and interest rate were stable (Figures 2 and 3). Thus, the inflation targeting of monetary policy has only created volatility of both inflation rate and the REER. Similarly, monetary policy cannot achieve much in a situation where there is fiscal dominance, and/or the central bank is turned into a "printing press" for financing large government budgetary deficits. By the same token, financial intermediaries that are conscious of short-term gains or whose horizons are too short would always make choices that render monetary policy objectives difficult and sometimes, impossible to achieve in the long run.

A change in monetary policy stance, initiated by a change of the MRR, is initially transmitted to the nominal short-term interest rates, which influences the real interest rates, and finally affects the consumption and investment decisions of economic agents. While these interactions are going on in the financial sector, the effect is being transmitted to the real sector through its impacts on aggregate demand and the price level. Thus, the effect of monetary policy measures can be readily transmitted to the larger economy through changes in interest rates. In addition, interest rate policy is also an instrument for regulating the growth of financial savings. Financial policy changes that result in positive real interest rates, such as happened in the 1980s, would generate growth in financial savings and influence the deepening of financial markets. The development of more efficient financial markets meant that open market policies and other indirect techniques could more easily transmit their effects to the larger economy (Adeoye, 2007a).

Other price-based mechanisms include the use of exchange rate policy. The exchange rate channel has been found to be particularly useful in an economy where the money market is

shallow, but the foreign exchange market is deep. Overall, variations in exchange rate was noticed in virtually all the years especially in the 1980s. The above shows that despite the effort of monetary authority in ensuring macroeconomic stability, the different monetary policy measures put in place so far have not succeeded in wiping off instability in the economy. Thus, the inflation targeting of monetary policy has only created volatility of both inflation rate and the REER

It is important to note that monetary policy works best where financial markets are efficient and well developed, and market participants are committed to the achievement of overall national economic goals. In the absence of a well-structured financial market, the conduct of market-based monetary policy is problematic and often produces perverse results or truncates the transmission mechanisms of monetary policy. For example, as argued earlier, raising interest rates in a liberalized financial market could increase the savings rate, the marginal productivity of capital and possibly, the rate of investment, as more financial resources are available to be channelled from savers to investors. However, this outcome cannot be taken for granted in an imperfect and oligopolistic financial market.

In such circumstances, high interest rates may actually not only discourage investments and slow economic growth, but could possibly precipitate financial sector crisis. Financial crises become unavoidable when financial intermediaries finance high risk and quick-return projects with low value added (e.g. merchandise trading) rather than more productive long-term economic activities. In price instruments affect the real sector, with varying degree of lags. Quantity based instruments, mainly reserve money and other monetary aggregates are chosen as intermediate targets for the purpose of achieving desired policy objectives. Most of them affect the availability (and also cost) of funds and, therefore, the decisions of economic agents. The quantity instruments operate mainly through Open Market Operations (OMO), where treasury bills purchases/sales increase/decrease the stock of reserve money, defined as the deposits, which banks keep with the central bank. Variable cash reserve ratio, the ratio of cash to deposit liabilities that a bank must hold, liquidity ratio, the ratio of liabilities to be held in liquid assets, and discount window operations are sometimes used to enhance the effectiveness of open market intervention, particularly in a relatively underdeveloped financial market environment (Adeoye, 2007b).

The effect of changes in any of these variables eventually impact on the real sector. Therefore, in pursuance of the goals of price stability, the central bank is mindful of the fact that its actions have important repercussions on the real sector. The primary objective of monetary policy that cuts across the mandates of most central banks is the maintenance of price stability, which is fundamental to the attainment of sustainable growth. While the focus of central banking in an increasing number of economies is the fight against inflation, the CBN is still saddled with developmental functions, with the attendant risk of policy conflicts. The pursuit of price stability invariably implies the indirect pursuit of other objectives such as economic growth, which can only take place under conditions of price stability, and allocative efficiency of the financial markets. Economic growth is determined by many factors, some of which are within the ambit of central banks, while others are exogenous to monetary policy.

3. REVIEW OF RELEVANT LITERATURE AND THEORETICAL ISSUES

3.1. Literature Review

Interrelationship between monetary policy and exchange rates has long been a focus of research in international economics. Numerous past studies study the relationship between monetary policy and exchange rate volatility especially in developed countries with less emphasis in the developing countries (for example, [Lewis \(1995\)](#); [Kaminsky and Lewis \(1996\)](#); [Faust and Rogers \(1999\)](#) and [An and Sun \(2008\)](#)).

[Dalla and Varelas \(2013\)](#) investigated the influence of monetary policy on the optimal behavior of a monopolistic bank. They discussed how the overdraft rate and the minimum reserve requirements affect the equilibrium values of lending rate and deposit rate as well as the corresponding quantities especially, when there is only one commercial bank in the economy and the Central Bank. Moreover, we examine the impact of these changes on the magnitude of the spread between the equilibrium rates and demonstrated that monetary policy via the overdraft rate does not affect the spread, while the effect of a change in the fraction of the minimum reserve requirements differs depending on the case.

[Asad et al. \(2012\)](#) investigated the impact of real effective exchange rate on inflation in Pakistan using the time series data of real GDP, nominal GDP, real effective exchange rate, prices and money supply for the period of 1973 to 2007. Their finding shows that the real effective exchange rate has impact upon inflation in Pakistan and a positive and strong relationship between the real effective exchange rate and inflation was found.

[An and Sun \(2008\)](#) analyses the interaction among monetary policy, foreign exchange intervention and exchange rate in a unifying model for Japan. The study addresses major research issues such as - Is the monetary policy the major source of the exchange rate fluctuation? In response to monetary policy shocks, do exchange rates “overshoot” their long-run values as implied by the uncovered interest rate parity (UIP)? [An and Sun \(2008\)](#) anchor their study on the “signaling” and the “leaning-against-the-wind” theoretical bases to explore the relationship among monetary policy, foreign exchange intervention and movement of exchange rate in Japan. The findings from the study lend support to the “leaning-against-the-wind” hypothesis and “signaling” hypothesis, but the evidence for the “signaling” hypothesis is minor. Second, intervention is ineffective or even counter-effective. Third, conventional monetary policy has a great influence on both exchange rate and foreign exchange intervention. The study concludes by pointing to the fact that in response to contractionary monetary policy shocks, the exchange rate appreciates for a short while with the maximum effect coming within several months, and then depreciates over time to the original level in Japan.

[Ndung'u \(1999\)](#), assesses whether the exchange rate in Kenya is affected by monetary policy and whether these effects are permanent or transitory. The premise of the study is that the choice of the exchange rate regime is determined by various factors – such as the objectives pursued by the policy makers, the sources of shocks hitting the economy and the structural characteristics of the economy in question –but that once this choice is made, the authorities are presumed to adjust their

macroeconomic policies (especially fiscal and monetary policies) to fit the chosen exchange rate policy. The study is premised on a simple analytical framework of the role of exchange rate in stabilization and adjustment process. The results of the study show that the nominal exchange rate in Kenya between 1970 and 1994 is determined by real income growth, the rate of inflation, money supply growth, the cycles in the real exchange rate volatility, the cointegrating vectors and the shocks. In addition, the results from the causality tests between the official exchange rate and the parallel rate show that even though the parallel market was illegal, the Central bank in determining the crawl (during the crawling rate regime in Kenya) took into account the value of the currency in the parallel market, but did not hook the crawl entirely on the parallel market developments, which shows an element of backward indexation.

(Cagliarini and McKibbin, 2009), use the multi-sector and multi-country G-Cubed model to explore the potential role of three major shocks – to productivity, risk premia and US monetary policy – to explain the large movements in relative prices between 2002 and 2008. An interesting conclusion of the simulations exercise carried out by the study is that monetary policy tends to affect relative prices for up to four years because the effect of a temporary change in real interest rates varies across sectors. The effect depends on each sector's relative capital intensity as well as on the change in the demand for the output of each sector as consumption and investment adjust. Eventually the effect of monetary policy on relative prices dissipates.

In Nigeria however, a few studies have been done in the area of interrelationship between exchange rate volatility and macroeconomic policies. Among such studies is Adebisi (2007) which investigates the impact of foreign exchange intervention in the Nigerian foreign exchange market. The study does not explore the relationship between monetary policy shocks and the movement of exchange rate. The study only determines whether foreign exchange intervention is sterilized or not.

In a related study, Ubok-Udom (1999) analyses the relationship between annual growth rates of total GDP, non-oil GDP and exchange-rate variations for the 1991-1995 period. The findings from the study show that the growth rates of total and non-oil GDPs tend to decrease or increase with decreases or increases in the nominal exchange rate. Thus, the overall implication as deduced from the study is that there has been a general tendency in the Nigerian economy for currency appreciation to promote output growth and for currency depreciation to retard it. The results from the study however, are generally contrary to the theoretical expectation which calls for both further investigation and some caution in using currency depreciation as a policy instrument for stimulating domestic output and factor employment in Nigeria. In the same vein, Ayodele (1997) examines the empirical relationship between Nigeria's floating exchange rate and non-oil exports. Also, Chete (1995) attempts to evaluate Nigeria's experience with exchange rate depreciation since 1985 particularly in relation to the objective of achieving external balance.

3.2. Theoretical Issues

Exchange rate policy is regarded as a facet of monetary policy by several scholars (Mundell, 1968) (Mckinnon, 1973). There have been several views on the appropriate choice of monetary policy framework during different exchange rate regimes. Despite the plethora of theoretical and empirical literatures, a general consensus on the right policy framework is yet to emerge. Thus, a Van't dack (2001) observed, a right strategy under a particular economic and financial environment stands to enjoy acceptability and in turn, will grant the central bank the credibility which would further amplify its effectiveness. Numerous regimes have been considered in the literature, ranging from the extreme regions, such as the fixed exchange rates (currency boards and unions) to a completely free floating, to intermediate regimes (adjustable or crawling peg and target zones/crawling bands). There are a number of theoretical arguments and experiences about the relative stability of the exchange rate under these regimes. Whatever the case, the choice of regime has great implications for the monetary policy of a country.

The early literature focused on the question whether a country would be better off or otherwise, under a fixed or flexible rate arrangement. Most of the empirical works suggest that small open economies are better served under a fixed exchange rate regime. Similarly, it has been argued that the less diversified a country's export and production structure and for the country to adopt a fixed exchange rate regime (Nnanna, 2002). Consequently, policy makers adopt a fixed exchange rate regime in the hope of gaining credibility in their fight against inflation. Although using a fixed exchange rate to control inflation may provide price stability, however, it undermines policy flexibility, which can have serious implications for internal and external balance.

A major consideration in choosing an exchange rate regime would be its effect on various random shocks on the domestic economy. Thus, the optimal regime is that which ensures macroeconomic stability. The general consensus in the literature prefers a greater degree of fixity, if the source of macroeconomic instability is predominantly endogenous. Conversely, a flexible regime is preferred if disturbances are predominantly exogenous in nature. Generally, a fixed exchange rate regime entails the pegging of exchange rate of the domestic currency to a reference currency. Pegging generally implies the loss of monetary discretion. The advantages and disadvantages of pegging have been discussed extensively in the literature (Greene, 2000; Nnanna, 2001).

A floating exchange rate regime on the other hand, implies that the forces of demand and supply will, perforce, determine the exchange rate. A floating exchange rate on the other hand, implies that the forces of demand and supply will determine the exchange rate. A floating exchange rate regime serves as a buffer against external shocks and allows monetary policy-makers full discretion in the manipulation of monetary aggregates. Several disadvantages of the floating regime have been documented. These include persistent exchange rate volatility, higher inflation, and high transaction costs. The greater advantage of the floating regime is monetary policy independence,

which is based on the claim that monetary policy independence is defined in terms of a country's ability to control its monetary aggregates and influence its domestic interest rate.

In recent time, due to many experiences with currency crises in emerging markets like Nigeria, a standard policy suggestion is to tighten monetary policy in order to stabilize exchange fluctuations. There are, therefore, debates on whether a certain monetary policy tools like interest rate stabilize exchange rates. The relationship between exchange rates and monetary policy framework during crisis periods is still unclear theoretical and in empirical studies (Chen, 2004). The view supporting the high interest rate policy comes from the traditional wisdom that a higher interest rate raises the expected return of the assets denominated in domestic currency, induces capital inflow, and discourages speculation. However, a revisionist view argued by Radelet and Sachs (1998), Furman and Stiglitz (1998), and Stiglitz (1999) asserts that tight monetary policy may be counterproductive. They claim that in view of default risk and the weakness of the financial and corporate sectors, raising interest rates may depreciate, rather than appreciate, the currency.

In examining the interaction between monetary policy tools and exchange rate volatility most studies have adopted the use of Markov-switching model developed by Hamilton (1989) in explaining the possibility of switching between the regimes of high and low volatility of exchanges rate i.e. the shift between “crisis” and “tranquil” incorporating the features of multiple equilibria. This suggests that in order to ensure balance between the switching periods, appropriate multiple monetary policy tools, inclusive of interest rate need to be employed as expressed as:

$$e_t = \alpha \Pi_{st} + \mu_t \quad (1)$$

$$\mu_t \sim N(0, \sigma_{st}^2) \quad (2)$$

Where e_t is the exchange rate volatility during either the regime of crisis or tranquil, being determined by set of appropriated selected monetary policy instruments (Π) and observed state variable μ_t which follows a normal distribution. In explaining the macroeconomic theory of exchange rate determination, Chen (2004) posited that st is assumed to follow a two-state Markov process (i.e., the “tranquil” state when σ_{st}^2 is low (state L), and the “crisis” state when σ_{st}^2 is high (state H)) with time varying transition probability matrix:

$$P_t = \begin{bmatrix} p_t^{11}(i_t) & 1 - p_t^{22}(i_t) \\ 1 - p_t^{11}(i_t) & p_t^{22}(i_t) \end{bmatrix} \quad (3)$$

where, $p_t^{kj}(i_t) = P(s_t = j / s_{t-1} = k, i_t)$, and i_t is the nominal interest rate taken as one of the monetary policy tools. Therefore, it is obvious that the time-varying transition probability matrix in equation (3) guides how the two different regimes shift over time. The probability of transition between the periods of either high or low volatility is expected to vary with the appropriate selecting of monetary policy tools in order to ensure stability.

Empirical evidence indicating whether raising nominal interest rates leads to higher exchange rate volatility or not subject the ease of switching between currencies regimes are much. Also numbers of studies have empirically investigated the effectiveness of monetary policy in stabilizing exchange rate volatility. These studies either focus on whether a higher interest rate defends the currency during speculative attacks, or examine whether raising the interest rate is useful for stabilizing the exchange rate in the aftermath of currency crises. Unfortunately, the results from these studies are mixed. Using a large panel data set, Goldfajn and Gupta (2003) find that high interest rates support the currency, but only when the banking system is strong. Kraay (2003) looks at several currency crisis episodes from 1960 to 1997 and finds that there is little evidence for or against the use of tight monetary policy to defend currencies. Papers that use time series data and focus on the 1997 currency crisis have also produced mixed results. Dekle *et al.* (2002), and Baig and Goldfajn (2002) find some evidence that higher interest rates are associated with stronger exchange rates though the impact is small, while Gould and Kamin (2001) are unable to find a significant or consistent relationship between interest rates and exchange rates for Indonesia, Korea, Malaysia, Mexico, Philippines and Thailand. A recent paper by Cho and West (2003) uses a structural model and high-frequency time series data to examine the interest rate exchange rate nexus. Their findings are mixed as well: exogenous increases in interest rates led to an appreciation of the currency in Korea and Philippines but a depreciation in Thailand. Most importantly, all of the studies seeking to find a systematic relationship between interest rates and exchange rates have been based on linear models.

4. MODEL SPECIFICATION AND ESTIMATION TECHNIQUES

As argued by Chen (2004), exchange volatility is either a crisis or a tranquil regime which is dependent on the appropriate selected monetary policy tools (especially interest rate) employed as stabilization instruments. Following from this however, this paper intends to extend the argument of Chen (2004) by adopting the theoretical framework of Markov model at the multiple equilibria process expressed as:

$$e_t = \alpha \Pi_{st} + \mu_t \quad (4)$$

Experience has shown in Nigeria that the monetary authority uses either the quantitative or qualitative measures of stabilizing the macroeconomic activities. But most often, money supply, interest rate and inflation are the major quantitative measures employed by the Central Bank in maintaining a close watch of monetary balances in Nigeria. However, the exchange rate deepening

experienced in the past prompted the monetary authority to strengthen the stock of money reserves in order to decelerate exchange rate volatility and watch the overall economy performance closely in terms of productivity.

On the basis of the above argument, the empirical model for analyzing the effect of monetary policy shocks on generated exchange rate volatility series in Nigeria by considering the most employed monetary tools in expanding equation (4) is specified as:

$$erv_t = \delta_0 + \delta_1 ir_t + \delta_2 ms_t + \delta_3 pr_t + \delta_4 rsv_t + \delta_5 ry_t + u_t \quad (5)$$

Where erv is the exchange rate volatility generated from the nominal bilateral exchange rate of naira vis-a-vis U.S dollar using the standard deviation approach; ir is the interest rate proxy as the minimum policy rate which is the rate at which the central bank lends to the bank; ms is the broad money supply; pr is the price level taken as inflation rate; rsv is the reserve money; ry is the real output; and u is the error term which determines the probability of transition between regimes as described in Markov model.

The empirical specified model (5) is estimated using the classical ordinary least square because of its linear forms and normality assumptions as also made by [Chen \(2004\)](#) in expression (2). In order to examine the short-run monetary policy determinants of exchange rate volatility in Nigeria, the error correction mechanism model to be estimated after establishing the long-run interaction among set of incorporated variables in model (5) using the Engle-Granger approach is expressed as:

$$\Delta erv_t = \phi_0 + \phi_1 \Delta ir_t + \phi_2 \Delta ms_t + \phi_3 \Delta pr_t + \phi_4 \Delta rsv_t + \phi_5 \Delta ry_t + \phi_6 \ell_{t-1} + \varepsilon_t \quad (6)$$

Where Δ signifies the first difference of the incorporated series; and ℓ_{t-1} is the first lag of the estimated residual (u) in expression (4) which dictates the speed of adjustment of exchange rate volatility disequilibrium in transiting regimes periods.

However considering the controversies in literature about the precise causal link between monetary policy and exchange rate volatility in lead-lag terms, the Granger causality test is carried out to establish the causal link and give provide clear causal distinctions. Since estimated regression results do not provide answer which variables causes changes in the other while ignoring the impact interaction.

In terms of data requirement and sources, the paper uses a time series data on nominal exchange rate of naira vis-a-vis U.S dollar, minimum policy rate as proxy for the interest rate, money supply, inflation rate, money reserve and real output. These data are sourced from the Central Bank of Nigeria Statistical Bulletin of several issues.

5. EMPIRICAL RESULTS AND ANALYSIS

This section of the paper presents the results and interpretation of the estimated regression model (5) for the analysis of effect of monetary policy shocks on exchange rate volatility in Nigeria. The long-run estimated regression model is presented in table 5.1.

5.1. Regression Results and Discussion

Table-5.1. Estimated Regression Result of the Analysis of Monetary Policy Shocks on Exchange Rate Volatility in Nigeria

Endogenous: Exchange Rate Volatility (ERV)			
Method: Least Square			
Sample: 1980 – 2009			
Exogenous	Coefficient	T-Stat	Prob.
C	-2.641675	-6.48104	0.0000
Ir	0.050365	2.040685	0.0535
Ms	4.57E-06	5.388133	0.0000
Pr	0.009811	1.903761	0.0701
Rsv	-1.44E-05	-5.87598	0.0000
Ry	1.26E-05	8.064456	0.0000
R-squared	0.945957	F-statistic	77.01698
Adj. R-squared	0.933675	Prob(F-stat)	0.00000
D.W stat	1.651275		

Source: Authors' Computation

The estimated regression results presented in Table 5.1 revealed that exchange rate volatility is more responsive to interest rate positively in magnitude, indicating accelerating effect on volatility level. This justify [Chen \(2004\)](#) argument that interest rate is key determinants of exchange rate volatility in any transiting and switching regimes for the case of Nigeria. The accelerating effect of interest rate on exchange rate volatility in Nigeria is even found to be statistically significant at 10% based on the reported t-statistic result. However, other incorporated monetary policy instruments like money supply and reserves are found to exert positive and negative influence on exchange rate volatility respectively in Nigeria and they are statistically significant at 5% critical level.

Also, exchange rate volatility is found to respond positively to changes in other considered macroeconomic indicators, inflation rate and real output growth in Nigeria. This indicates that inflation and real output contributes to the accelerating level of exchange rate volatility in Nigeria and these macroeconomic factors exert significant accelerating effects on exchange rate volatility at 10% and 5% critical levels. However, the integration of other monetary policy tools (money supply and reserve) and macroeconomic factors (inflation and real output) rather than interest rate only as employed by [Chen \(2004\)](#), have proved that interest rate, money supply, and reserve money are the appropriate selected monetary policy tools to stabilize the exchange rate volatility in Nigeria and also with the influence of inflation and real output.

In examining the stability of the estimated regression model (5) explaining the link between monetary policy and exchange rate in Nigeria, the adjusted R-squared result revealed that 93.4% of the total variation in exchange rate volatility is explained by changes in the incorporated monetary and macroeconomic factors. It is instructive to note that the result of the F-statistic which determines the overall stability of the estimated model based on the joint significance of the estimated parameters revealed that the null hypothesis of “no simultaneous significance” is rejected at 5% significant level.

5.2 Cointegration Test

The Engle-granger cointegration test result is presented in Table 5.2 in order to establishing the existence of long-run relationship between monetary policy tools and exchange rate volatility in Nigeria. The results revealed that the generated residual series (which account for the Markov probability of two switching periods) known as the error correction term (ECT) subject to unit-root test reject the null hypothesis of “no cointegration” for test model with intercept and linear deterministic trend. This implies that the error correction term is stationary at level suggesting that the linear combination of exchange rate volatility series and incorporated monetary policy instruments yields stationarity. Therefore, there is existence of long-run relationship between exchange rate volatility and monetary policy in Nigeria and the regression model (5) is the long-run/ cointegrating regression linking exchange rate volatility and monetary policy in Nigeria.

Table-5.2. Engle-Granger Cointegration Test Results

	ADF Tau Statistics		Order of Integration
	Intercept	Linear Trend	
$ECT = u_t = erv_t - (\delta_0 + \delta_1 ir_t + \delta_2 ms_t + \delta_3 pr_t + \delta_4 rsv_t + \delta_5 ry_t)$	-4.98452*	-5.19912*	$ECT = I(0)$

Note: ECT -Error Correction Term generated from the estimated model linking exchange rate volatility and monetary policy in Nigeria based on the result presented in Table 5.1. Significant at (*)-5% McKinnon Critical values. The tau statistic are estimated using optimal lag length selected based on the minimum AIC and SIC.

Source: Authors' computation

5.3 Short-Run Behavioural Analysis

The estimated error correction mechanism (ECM) model (6) which result is presented in Table 5.3 revealed the short-run behavioural influence of monetary policy tools on exchange rate volatility in Nigeria.

Table-5.3. Estimated Error Correction Mechanism Model (ECM)

Endogenous: Change in Exchange Rate Volatility (Δ ERV)			
Method: Least Square			
Sample: 1980 – 2009			
Exogenous	Coefficient	T-Stat	Prob.
C	0.078466	0.928979	0.364
Δ ir	0.009008	0.520248	0.6086
Δ ms	1.55E-06	2.372874	0.0278
Δ pr	0.006645	1.7671	0.0925
Δ rsv	-5.12E-06	-2.58033	0.0179
Δ ry	7.26E-06	1.858505	0.0779
ECT_{t-1}	-0.44864	-2.45952	0.0231
R-squared	0.351626	F-statistic	1.807729
Adj. R-squared	0.157113	Prob(F-stat)	0.148583
D.W stat	1.577436		

Source: Authors' Computation

The estimated ECM model presented in table 5.3 indicated that there is disequilibrium in short-run which is below the equilibrium established between monetary policy and exchange rate volatility in Nigeria as indicated by the negative error correction term. In order to restore the equilibrium between monetary policy and exchange rate volatility, the one period lag of error correction term (ECT) will increase by 0.4486 units by accelerating the changes in exchange rate volatility in the short-run.

The exhibited behaviour of the influence of monetary policy instruments and key macroeconomic factors on exchange rate volatility is similar to the long-run reported influence in Table 5.1. Likewise, the changes in exchange rate volatility is found to be more responsive to changes in interest rate, though not significant at any critical levels. While, other incorporated monetary policy instruments and macroeconomic factors were found to exert significant influence on changes in exchange rate volatility. Surprisingly, stock of money reserve is also found to be significant in stabilizing exchange volatility in the short-run as interacted in the long-run.

5.4 Granger-Causality Test

Since impact analysis does not suggest causal relationship, the Granger causality test is employed to determine the causal link between monetary policy variables and exchange rate in Nigeria. The granger causality results are presented in Table 5.4.

Table-5.4. Pairwise Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Probability
MS does not Granger Cause ERV	27	0.64933	0.42826
ERV does not Granger Cause MS		11.5797	0.00234
PR does not Granger Cause ERV	27	0.14272	0.70891
ERV does not Granger Cause PR		0.23568	0.63174

IR does not Granger Cause ERV	27	6.57744	0.01701
ERV does not Granger Cause IR		0.02791	0.86871
RY does not Granger Cause ERV	27	0.50722	0.48321
ERV does not Granger Cause RY		3.85530	0.06128
RES does not Granger Cause ERV	27	0.74291	0.39726
ERV does not Granger Cause RES		4.28316	0.04942

Source: Authors' computation

The reported Granger causality test results in Table 5.4 revealed that rejection and acceptance of the causal link between exchange rate volatility and monetary policy in varying cases. From Table 5.4, one lag period of exchange rate volatility is found to granger cause current changes in money supply, real output and money reserves among incorporated factors in the estimated regression. Although, these variables were found to have effect on exchange rate but this effect does not translate to causal link. While, among all other incorporated monetary policy variables, only previous interest rate is found to granger cause current exchange rate volatility. This implies that previous level of interest rate lead to changes in exchange rate volatility. Even though, base on the estimated long-run regression model interest rate is found to exert accelerating effect on exchange rate volatility in Nigeria.

Figure-5.1.Trends of Exchange rate in Nigeria (1980 -2008)

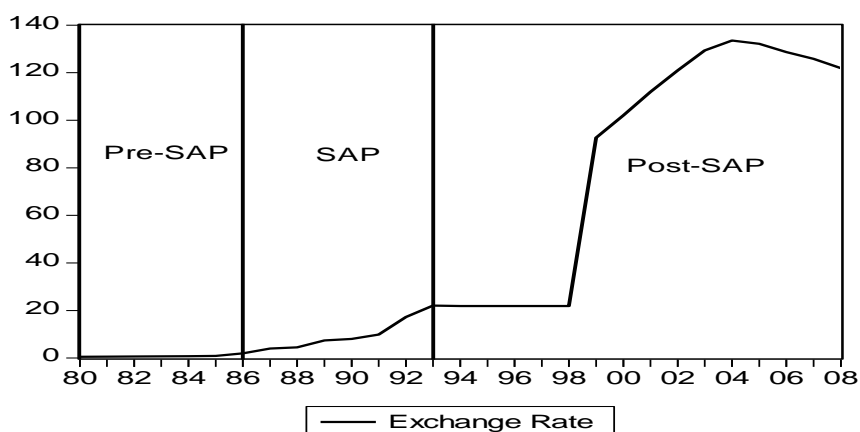


Figure-5.2.Trends in Inflation rate in Nigeria (1980 -2008)

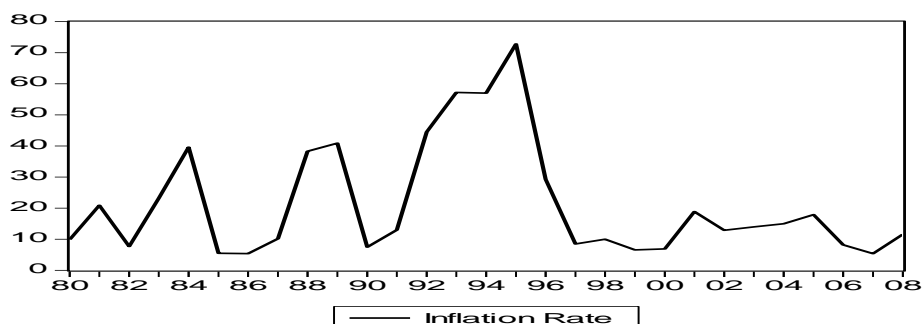
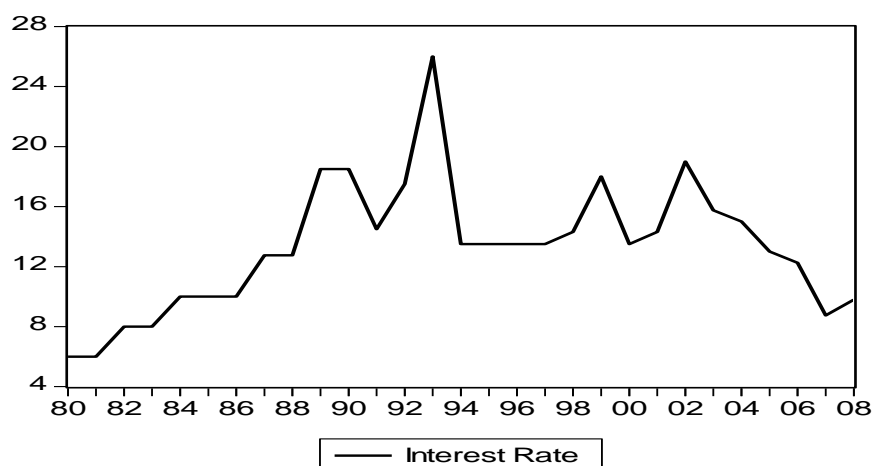


Figure-5.3.Trends of Interest rate in Nigeria (1980 -2008)

6. CONCLUSION

This paper analysed the effects of monetary policy shocks using changes in various monetary policy instruments on exchange rate volatility in Nigeria. Since the focus of this study is to investigate the relationship between exchange rate volatility and monetary policy shocks in Nigeria, we started by detailing the fundamental macroeconomic management problems that led to domestic exchange rate instability with its pass-through effects to domestic prices. It was noted that as inflation rate grows, exchange rate instability increases.

The results from the paper both real and nominal exchange rates in Nigeria have been unstable during the period under review. In the short, the variation in the monetary policy variable explains the movement/behaviour of exchange rate through a self correcting mechanism process with little or no intervention from the monetary authority (CBN). Therefore, the deductions that could be made from the analysis so far is that the prolonged (accumulated) monetary shocks on exchange have shown the ineffectiveness of the monetary policy of the CBN and other macroeconomic policies in stabilising the rate of Exchange over time.

In addition, the results from the causality tests between the exchange rate volatility and monetary policy variables showed that there is a causal link between the past values of monetary policy variables and the exchange rate. This is obvious in the case of the past value of the interest rates. Such that, a change in the level of previous values of monetary policy variables causes exchange rate volatility.

The implications that can be drawn from the analysis so far is that exchange rate policy has not been supported by appropriate monetary policy. This is because we find that the long-run monetary shocks affect the real exchange rate with feedback effects. Not only that, the model was able to show that the exchange rate policy accommodated monetary disequilibrium in order to protect reserves or to have a market determined exchange rate responding to excess money supply. This is inconsistent with the floating exchange rate paradigm. Finally, inflation rate, reserves, interest rate and money supply depreciate and cause volatility in nominal exchange rate in Nigeria. These

results provide further evidence and reinforce other findings that monetary policy is crucial to exchange rate management.

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