

Empirical Exposition of Monetary Policy under Fixed and Managed Float Exchange Rate Regime: Any Lesson for Nigeria

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Abstract

This paper empirically investigated the relationship between monetary aggregates and the exchange rate under alternative exchange rate regimes in Nigeria. Using data spanning 1961 to 2013 to estimate vector auto-regressive (VAR) models, a number of findings ensued. One, the impulse response functions (IRFs) showed that monetary aggregates were responsive to exchange rate shocks. However, this effect was found to be closely linked with the underlying exchange rate regime. Two, the variance decompositions (VDs) indicated that exchange rate shocks had no significant weight as there was no impact recorded on inflation, interest rate and money supply after one year under the fixed regime. Third, the corresponding VDs under the flexible regime showed that the effect of exchange rate on the monetary aggregates was more significant, especially in the long-run. A key policy implication of the foregoing results was that domestic economic management policies should be proactively orchestrated to better align the objectives of exchange rate policy with broader macroeconomic goals.

I. Introduction

The choice of exchange rate regime and its implications for monetary policy have generated debates among researchers and policy makers over the past decades. To a large extent, the decision on whether to adopt a flexible or managed float exchange rate system is driven by a number of policy choices. Under the flexible exchange rate system, the central bank intervention in the foreign exchange market is optional. However, under a managed float exchange rate system, the central bank attempts to influence the foreign exchange market using some indicators, namely, the balance of payments position, the level of international reserves and parallel market development (Duttagupta et. al., 2005). A particular monetary policy rule may work well under a fixed exchange regime, but ineffective under a managed float regime.

In a floating exchange rate system, the central bank allows the Foreign Exchange Market (FEM) to adjust freely in response to the dictate of the forces of demand and supply. These actions increase the time inconsistency¹ problem and exchange rate volatility². A country that embarks on a managed float exchange rate system can effectively cushion inflationary pressure by changing the exchange rate at the expense of foreign country as a result achieve an appreciation of domestic currency.

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¹ A situation that the decision maker preference changes overtime.

² This is the measurement of the degree at which exchange rate changes and the frequency of the changes.

Monetary policy affects the exchange rate through two channels: fundamental exchange rate volatility and credibility. In a managed exchange rate system, exchange rate volatility is low due to either currency market intervention and/or an exchange rate-oriented interest rate policy. Conversely, exchange rate volatility is high in the case of a floating exchange rate regime. In addition, exchange rate becomes more volatile when the credibility of exchange rate is low, which occurs in the case of flexible exchange rate regime (Bauer and Herz, 2006).

A tight monetary policy in an open economy with flexible exchange rate system raises domestic nominal interest rate. When the domestic currency rises above the foreign currency, equilibrium in the foreign exchange market requires that the domestic currency gradually depreciate at a rate that serves to equate the risk of returns on various debt instruments, in this case, debt instruments dominated in the two currencies. The Keynesian model requires the expected future depreciation to follow an initial appreciation of domestic currency. Since prices are slow to adjust, the mechanism makes domestically produced goods more expensive than foreign produced goods. This leads to a fall in exports, aggregate income and employment (Ireland, 2005).

Nigeria has pursued different exchange rate regimes that had led to variation in monetary policy actions of the CBN overtime. The fixed exchange rate regime was in operation after the enactment of the Exchange Control Act until 1986. Exchange rate policies after 1986 involved several episodes of floating arrangements; and thus, this period was classified as the flexible regime. Although, several exchange rate systems and monetary policy targets were adopted by the CBN, the desired outcomes and objectives have not been achieved. Nigeria still experiences high rate of unemployment, dwindling foreign reserves and high rate of inflation.

This study, therefore, examines empirically, the effects of fixed and managed float regimes on monetary policy indicators in Nigeria. Annual time series data covering the period, 1961 to 2013 are deployed in estimating VAR models. It is noteworthy that earlier studies in the Nigerian context have given little attention to the comparative effects of alternative exchange rate regimes on monetary policy outcomes. To give a general sense of the results from the analysis, we report the following: One, key monetary aggregates were responsive to exchange rate shocks. Nevertheless, this effect was larger under the managed float regime. Two, exchange rate shocks also had minimal effect in both the short- and long-run under the fixed regime. Finally, under the managed float regime, the effect of exchange rate on the monetary aggregates was more substantial in the long-run.

Following this introduction, Section 2 is an overview of monetary policy and exchange rate regimes in Nigeria, Section 3 theoretical and Empirical literature, Section 4 Econometric analysis while Section 5 discusses the results and concludes.

II. Overview of Monetary Policy and Exchange Rate Regimes in Nigeria

This section initially provides information on monetary policy trends and policies in Nigeria. Next, the corresponding information in terms of the alternative exchange rate regimes is presented. The discussion is essentially structured along the lines of before, during and after the adoption of the structural adjustment programme (SAP).

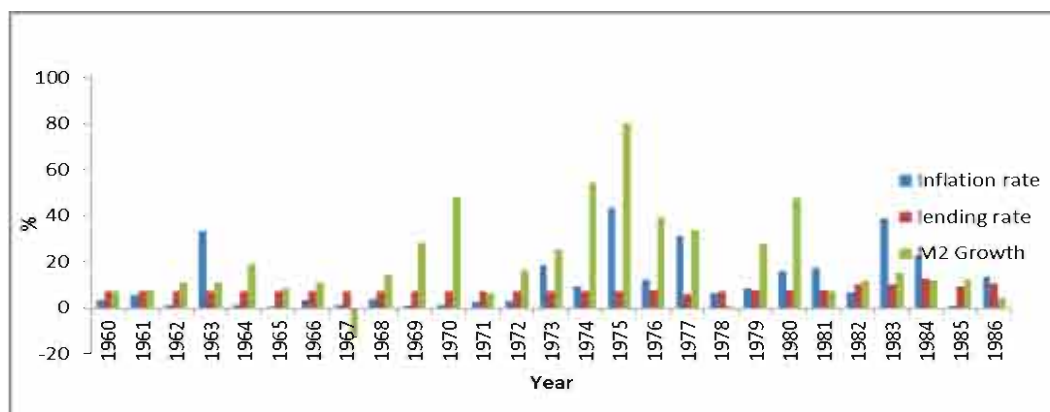
II.1 Monetary Policy Conduct in Nigeria

Since the establishment of the Central Bank of Nigeria (CBN) in 1958, it has played a dominant role in the operation and management of monetary policy in the country. Prior to the establishment of the CBN, the banking ordinance of 1952 was designed to ensure orderly commercial banking and to guide against the establishment of unviable commercial banks.

The objective of the monetary policy of the CBN was to achieve both internal and external balance. Specifically, the objectives were to maintain price stability, balance of payments equilibrium, promotion of employment and output growth, and economic development. In line with these objectives, several policy instruments were put in place by the CBN, which can be categorised under the policy instruments before and after the Structural Adjustment Programme (SAP).

Before SAP in 1986, the policy instruments of the CBN were generally focused on direct monetary controls. The monetary policy framework before SAP relied on sectoral credit allocation, credit ceilings, cash reserve requirements, fixed interest and exchange rates, and the imposition of special deposits. The framework was designed to facilitate the Federal Government's objectives in that period that were targeted to small and medium-scale enterprises, agriculture, state-owned enterprises and exports. However, the targets of the monetary authority were not met due to inefficiency in resource allocation (CBN, 2005). A decade after the establishment of the CBN, the most active monetary policy instrument used was the interest rate. The monetary policy strategy between 1970 and 1979 was directed towards removal of ceilings on commercial banks' loan and advances and adopting strategies by which the commercial banks should make credit available to the various sectors of the economy.

Banks were encouraged to maintain a stable interest rate (see Figure 1). A major constraint on the slower rate of monetary expansion in the early 1980s was the decline in the net foreign assets of banks. The decline in foreign assets was 54.3 per cent between 1980 and 1981. This was attributed to the heavy outflow and declined inflow of foreign exchange. The reduced inflow of foreign exchange was as a result of the glut in the world petroleum market (CBN Annual Report, 1981). There was steady increase in money supply in 1985 as M_2 at the end of the year stood at 10.3 per cent above the figure obtained in the preceding year (CBN Annual Report and Statement of Accounts, 1985). Figure 1 shows the behaviour of the monetary policy indicators before SAP in Nigeria.

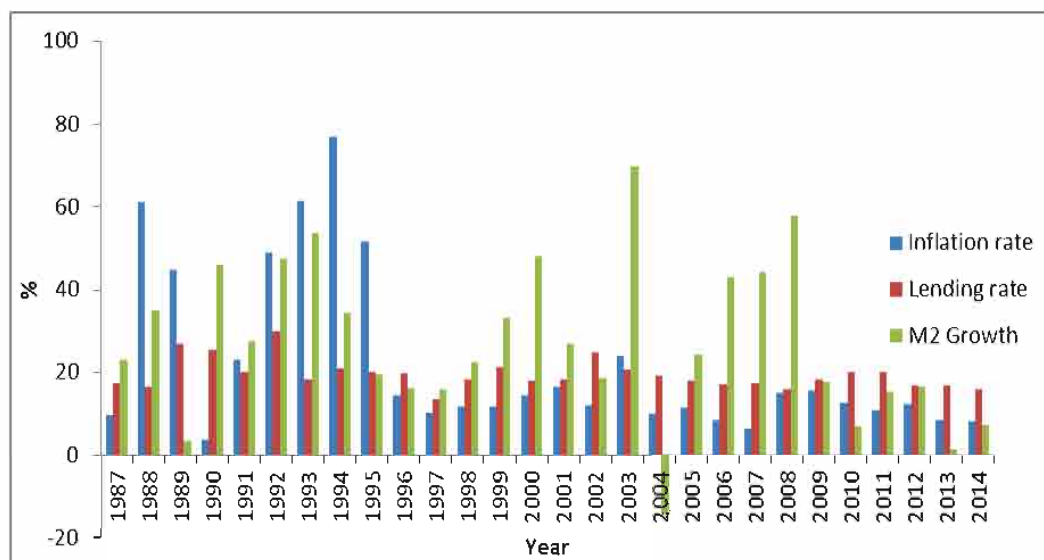
Figure 1: Movement of Monetary Policy Indicators before SAP

Source: Constructed by the authors' based on data from the Central Bank of Nigeria

The SAP adopted in 1986 was designed to achieve fiscal balance and a favourable balance of payments position by altering the production and consumption pattern of the economy, eliminating price distortions, diversifying the export base of the economy and reducing importation of consumer goods. The sudden crash in the price of crude oil at the international market and deterioration of economic conditions necessitated the adoption of the programme.

Under SAP, monetary policy emphasised market-oriented financial system for effective mobilisation of financial savings and efficient resource allocation. Furthermore, the SAP reforms embraced interest rate liberalisation and foreign exchange management. The main monetary policy instrument used was the open market operation in a market-based framework. The operation was complemented by reserve requirements and discount window operations. In addition, some measures were introduced to mop up excess liquidity from the system.

The CBN made efforts in the period 1986 to 1993 to create a new environment for an indirect approach to monetary management. The main action taken in the monetary policy reforms programme was the initial rationalisation and eventual elimination of credit ceilings for selected banks. Equally, the CBN liberalised interest rate and adopted the policy of fixing only its minimum rediscount rate to indicate the desired direction of interest rate (Nwaobi, 2012). These involved a substantial reduction in the maximum ceiling on credit growth allowed for banks; the re-introduction of the special deposit requirements aligned with outstanding external payment arrears to CBN from banks; abolition of the use of foreign currency deposits as collaterals for naira loans; and the withdrawal of public sector deposits from banks to the CBN. In 1994, direct interest rate control was introduced. However, this measure had negative economic effects in the country (Figure 2). In the last quarter of 1996, the CBN adopted total deregulation of the interest rate.

Figure 2: Movement of Monetary Policy Indicators after SAP

Source: Constructed by the authors' based on data from the Central Bank of Nigeria

In 2002, the medium-term monetary policy framework was adopted by the CBN for the purpose of reducing the time inconsistency of monetary policy and over reaction of the public due to temporary shocks. The CBN introduced a monetary policy framework in 2005, which was directed to achieve single digit inflation rate, gradual reduction in the cost of borrowing, maintenance of monetary stability and exchange rate stability. Monetary management was conducted within the framework of monetary targeting, while the main instruments were open market operations, discount window operations and foreign exchange market interventions. Through its tight monetary policy measures in most of the periods, the CBN managed to keep inflation at a single digit. The headline year-on-year inflation was estimated at 8.6 per cent in 2013, a five-year low. The monetary policy rate, the key determinant of interest rates, was fixed at 12.0 per cent throughout 2013 as was the case in 2011 (African Economic Outlook, 2014).

II.2 Exchange Rate Regime before SAP in Nigeria

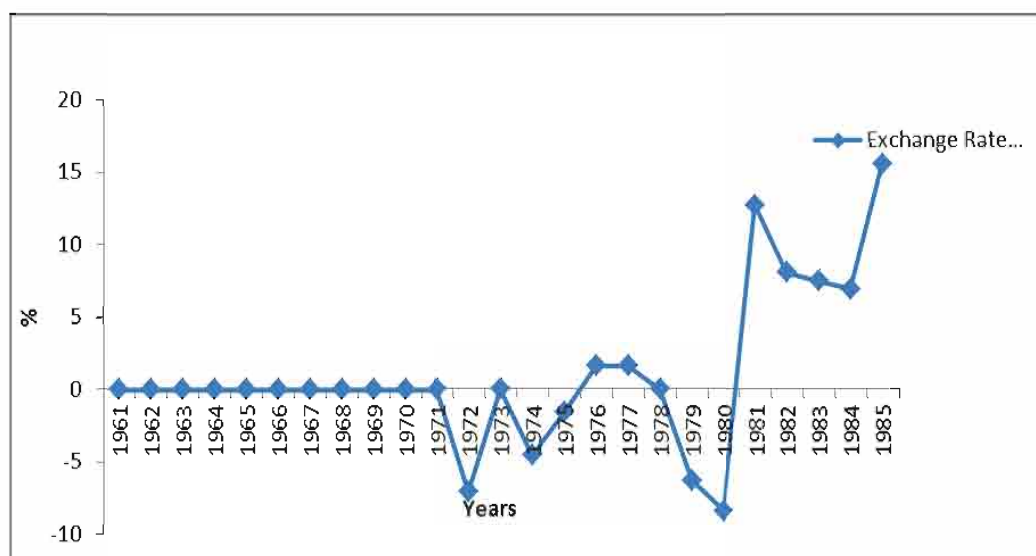
The development of the foreign exchange market in Nigeria was influenced by a number of factors such as the changing pattern of international trade, institutional changes and structural shifts in production. Before the establishment of the CBN in 1958 and the enactment of the Exchange Control Act of 1962, foreign exchange was earned by the private sector and held in balances abroad by commercial banks, which acted as agents for local exporters. During this period, agricultural exports contributed the bulk of foreign exchange receipts. The fact that the Nigerian pound was tied to the British pound sterling, with easy convertibility, delayed the development of an active foreign exchange market. Nigeria operated a fixed exchange rate regime supported by the Exchange Control Act of

1962. The fixed exchange rate regime precipitated an over-valuation of the naira that engendered massive importation of finished goods with adverse consequences for domestic production, balance of payments and the Nation's external reserves. In addition, the period was associated with sharp practices perpetrated by dealers and end-users of foreign exchange.

During the Exchange Control arrangement, the naira was pegged to the British pound sterling, but as a result of the devaluation of the pound in 1967, the domestic currency was allowed to move freely independent of the pound sterling.

The exchange rate policy in Nigeria before 1973 was in line with the IMF fixed exchange rate system. Nigerian currency was subjected largely to administrative management and control by the CBN. On average, exchange rate volatility for the period 1963 to 1972 was 0.70 per cent³. In 1973, Nigeria's pound was changed to naira, and it was very strong in value⁴. It was also pegged to a basket of currencies comprising the country's trading partners in 1978 (Obadan, 2006). Exchange rate volatility from 1978 to 1982, (under the pegged arrangement) was 0.19 per cent⁵. Consequently, the CBN embarked on deliberate appreciation of the naira to enable the economy import inputs cheaply from abroad mainly to implement the import substitution industrialisation (ISI) strategy and other development projects.

Figure 3: Exchange Rate Dynamics before SAP



Source: Constructed by the authors' based on data from IMF International Financial Statistics Publication

³ The period was a decade before the breakdown of Breton Woods system.

⁴ At the time Nigeria's Pound Sterling was changed to naira exchange rate was ₦0.66/US\$.

⁵ This value was computed by taking the standard deviation of the monthly exchange rate.

A sharp rise in the price of crude oil in the early 1970s led to a substantial increase in its exports, which enhanced the official foreign exchange receipts. There was a boom in the foreign exchange market during this period and the management of foreign reserves became necessary to guarantee the sustenance of the fixed exchange rate regime. However, it was not until 1982 that comprehensive exchange controls were applied as a result of the foreign exchange crisis that occurred. The increased demand for foreign exchange coupled with a decline in the supply encouraged the development of a flourishing parallel market for foreign exchange (CBN Annual Report, 1985). After the oil glut of the early 1980s, it became evident that Nigeria could not continue to operate a fixed exchange rate regime. Steps were taken by the CBN to embark on the deregulation of the exchange rate.

II.3 Exchange Rate Regime During and After SAP

The SAP started in July 1986. One of the major policies of the Federal Government under this was to adopt a floating exchange rate system and establish an institutional framework for its operation and trade under a market determined environment. To create an enabling environment for the trading of foreign exchange under the market determined system, the Second-Tier Foreign Exchange Market (SFEM) was introduced in September, 1986 (CBN, 1988). Under SFEM, the determination of the naira exchange rate and allocation of foreign exchange were based on the framework of market auction system. On July 2, 1987, the first and the second-tier market were merged and the Dutch Auction System (DAS) was introduced (Sanusi, 2004). The SFEM was in operation with the official exchange rate system. The official was administratively managed and allowed to gradually depreciate. It was used for a few official exchange rate and international transactions, such as debt servicing and obligations to international organisations (Obadan, 2006).

Accordingly, the dual exchange rate system was operated to avoid a sizable depreciation of the naira, while allowing gradual depreciation in the SFEM. This the CBN did through continued downward adjustment until the desirable convergence was reached. Consequently, in the first quarter of 1987, the CBN adopted a policy of steady depreciation of the exchange rate to reverse its overvaluation. However, these efforts could not achieve equilibrium in the foreign exchange market. Alongside with SAP, new mechanisms were developed for exchange rate system. To enlarge the scope of the FEM, Bureau-de-Change was introduced in 1989 for dealing in privately sourced foreign exchange.

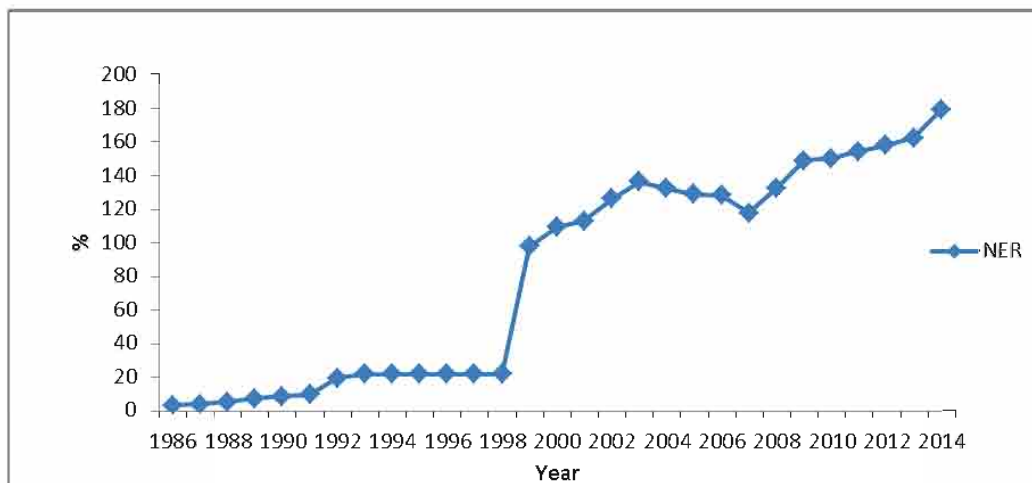
Due to the continued depreciation of the exchange rate, some reforms were introduced in the foreign exchange market in 1994. These included: the formal pegging of the exchange rate; the centralisation of foreign exchange in the CBN; the restriction of Bureaux de Change to buy foreign exchange as agents of the CBN; the re-affirmation of the illegality of the parallel market; and the discontinuation of open accounts and bills for collection as means of payments (CBN, 2000). The operation of the parallel market engendered greater volatility of the exchange rates; the volatility of the naira viz-a-viz the U.S. dollars for the

period 1986 to 1995 was 25.1 per cent. This showed that greater volatility of exchange rate was experienced during the SAP era.

Further reforms in the FEM led to its liberalisation in 1995 with the introduction of an Autonomous Foreign Exchange Market (AFEM) for the sale of foreign exchange to end-users by the CBN through selected authorised dealers at market determined exchange rate (CBN, 2002). In addition, Bureau-de-Change was once more accorded the status of authorised buyers and sellers of foreign exchange. The FEM was further liberalised in October 1999 with the introduction of an Inter-bank Foreign Exchange Market (IFEM).

The IFEM was designed to diversify the supply of foreign exchange in the economy by encouraging the funding of the inter-bank operations from privately-earned foreign exchange. It was also aimed at assisting the naira to achieve a realistic exchange rate. Under IFEM, banks, oil companies, and the CBN could buy or sell their foreign exchange at rates supposedly influenced by the CBN. A large number of the informal economy, however, could only access foreign exchange through the parallel market. Companies were allowed to hold domiciliary accounts in private banks, and account holders had unfettered use of the funds. The operation of the IFEM, however, experienced similar problems and setbacks as the AFEM, owing to supply-side rigidities, the persistent expansionary fiscal stance of government and excess liquidity in the system (Sanusi, 2004).

The Dutch Auction System (DAS) was re-introduced on July 22, 2002 as a result of demand pressure in the FEM and the depletion of external reserves. Under the DAS system, the CBN determined the amount of foreign exchange sold at the price buyers quoted. The marginal rate that cleared the market represented the ruling rate at the auction. The DAS was conceived as a two-way auction system in which both the CBN and authorised dealers would participate in the foreign exchange market to buy and sell foreign exchange (Omojimiye and Akpokodje, 2010). In addition, DAS was to serve the triple purposes of reducing the parallel market premium, conserve the dwindling external reserves and achieve a realistic exchange rate for the naira. The DAS helped to stabilise the naira exchange rate, reduce the widening premium, conserve external reserves, and minimise speculative tendencies of authorised dealers (Akpan and Ata, 2012). The naira devaluation, which occurred in 2014 was largely expected due to the significant pressure on exchange rate recorded during the year. The increased funding of the foreign exchange market by the CBN to stabilise the naira would have further depleted the external reserves if those strategies were maintained (Nigerian Economic Review and Outlook, 2014).

Figure 4: Exchange Rate Dynamics During and After SAP

Source: Constructed by the authors' based on data from IMF International Financial Statistic Publication

II.4 External Reserves, Crude Oil Prices and Exchange Rate

Table 1 represents the movements in external reserves, crude oil prices and nominal exchange rate from 1961 to 2014. The external reserves serve as important instrument to manage exchange rate fluctuation in Nigeria. Since Nigeria depends heavily on crude oil, the prices of crude oil affect the accumulation of the country's reserves, in turn, determine the extent the CBN could manage fluctuations in exchange rate. The oil boom of early 1970s increased the external reserves and the ability of the CBN to keep the exchange rate fixed. The reserves leapt from an average of US\$100 million between 1966 and 1970 to US\$1.25 billion between 1971 and 1975, and further to US\$3.01 billion between 1976 and 1980. This growth trajectory was truncated with the bust in the crude oil market in early 1980s. Hence, the Nigeria's external reserves was low and the nominal exchange rate was near fixed before the adoption of the SAP. Specifically, the external reserves fell from US\$4.7 billion in 1981 to US\$0.98 billion in 1985 while the exchange rate maintained its value between N0.61 to N0.89, respectively. This posed grave challenge to the economy and therefore led to the adoption of SAP in 1986.

After the adoption of SAP, the external reserves increased substantially due to the fact that exchange rate was allowed to float, though managed, and crude oil prices increased in the international market. Exchange rate depreciated substantially from an average of N5.20 per US dollar between 1986 and 1990 to N125.58 per US dollar between 2001 and 2005. By 2014, the exchange rate had depreciated to N158.55 per US dollar. The annual figures obtained from the CBN on the movement of the external reserves show an

undulating pattern between 1981 and 2003, but largely below the US\$10 billion mark. However, this pattern is masked in the quinquennium data which shows a gradual increase in external reserves from 1961-1965 to 1996-2000, with some occasional declines (table 1). Thereafter, the reserves increased astronomically from an average of US\$12.06 billion in 2004 up to US\$58.5 billion in 2008 before declining to US\$32.6 billion in 2011 due to the dip in the crude oil price. The initial recovery made in 2013 which put the reserves at US\$45.6 billion was reversed to US\$37.2 billion in 2014. The substantial decline in the external reserves and depreciation of the exchange rate could be attributed to the developments in the international oil market.

Table 1: External Reserves, Crude Oil Prices and Nominal Exchange Rate

Years	Average External Reserves US\$' Million	Crude Oil Price USD/ Barrel	Nominal Exchange Rate	Average Growth rate of External Reserve (per cent)
1961-1965	156.74	1.49	0.71	1.90
1966-1970	100.35	1.30	0.71	-2.42
1971-1975	1247.73	5.53	0.65	146.16
1976-1980	3014.39	20.32	0.60	15.93
1981-1985	1549.20	30.13	0.73	-5.19
1986-1990	3966.49	17.01	5.20	51.84
1991-1995	4475.17	17.16	18.61	12.30
1996-2000	5799.38	19.29	52.09	40.48
2001-2005	12578.97	32.44	125.58	33.48
2006	37456.09	66.50	128.65	54.01
2007	45394.31	74.48	125.83	21.19
2008	58472.88	101.14	118.57	28.81
2009	44702.35	63.90	148.88	-23.55
2010	37355.70	80.91	150.30	-16.43
2011	32580.28	113.76	153.86	-12.78
2012	38092.16	113.47	157.50	16.92
2013	45612.95	110.99	157.31	19.74
2014	37220.33	100.35	158.55	-18.40

Source: 1961-2005 data were from BP Statistical Review of World Energy (2015) and 2006-2014 were compiled from CBN Statistical Bulletin December, 2014.

III. Literature Review

This section presents a brief theoretical literature and some relevant empirical results from previous studies.

III.1 Theoretical Literature

The Mundel-Fleming model forms the basis of the recent models of the effectiveness of monetary policy in an open economy. The basic argument of Mundell (1963) and Fleming

(1962) is that given the assumptions of a small open economy with unemployed resources, a perfectly elastic aggregate supply curve and a flexible exchange rate regime, monetary policy is extremely powerful in altering output. An expansionary monetary policy conducted through an open market operation of the central bank leads to an initial decline in domestic interest rate, which in turn, leads to a capital outflow that causes deficit in the balance of payments and exchange rate depreciation inevitably results. The rising price of the foreign exchange generate, via the Marshal-Lerner condition, an improved trade balance has an expansionary effect on income via the multiplier process as demand is switched from foreign goods to home goods (Hallwood and MacDonald, 2000). However, in a fixed exchange rate system, the central bank purchase of securities through the open market operation creates excess reserves and leads to a decline in the interest rate.

A fall in the interest rate will precipitate capital outflow and could lead to the deterioration of the balance of payments. To prevent the exchange rate from falling, the central bank intervenes in the market by selling foreign exchange and buying domestic money. This process continues until the accumulated foreign exchange deficit is equal to the open market purchase and the money supply is restored to its original level. This shows that monetary policy under fixed exchange rates is not beneficial to income. The increase in money supply, arising from open market purchases is returned to the central bank through its exchange stabilisation operations. The ultimate effect of the open market purchase is an equivalent fall in foreign exchange reserves. This implies that the central bank has simply traded domestic assets for foreign assets (Mundell, 1963). The Mundell-Fleming analytical framework concludes that monetary policy is more effective under a flexible exchange rate system, while fiscal policy is more potent under a fixed exchange rate regime.

Henderson (1982) posited that in the period of instability in the financial sector, the monetary authority should hold interest and exchange rates constant to reduce fluctuations in output by allowing money stocks and international reserves to fluctuate instead. However, when disturbances affect the real sector, interest and exchange rates should be allowed to fluctuate, holding constant the stock of international reserves and money supply. This argument is in favour of a managed float exchange rate system.

The theoretical proposition of Dornbusch (1976) emphasised the role of expectations to exchange rate determination and, therefore, to monetary policies under flexible exchange rate. The conclusion of Dornbusch (1976) confirmed the Mundell-Fleming proposition that under conditions of capital mobility and flexible exchange rates, a country can conduct an effective monetary policy in the short-run. Exchange rate serves as an important channel for the transmission of monetary changes to an increase in aggregate demand and output. Hamada (1974) developed a standard open economy model following the standard Keynesian theory. The model showed that if countries are mainly concerned with the balance of payments and their income levels, then a floating exchange rate regime is preferable than a fixed exchange as it allows each country to embark on an independent monetary policy, which is devoid of any conflict.

Giavazzi and Giovannini (1989) used the standard Mundell-Fleming model, augmented with rational expectations and aggregate supply effects to compare the monetary policy responses under flexible and managed float exchange rate regimes.

Under a flexible exchange rate regime, each country takes the other country's money supply as given; hence, it is posited that a change in nominal money stock can affect the exchange rate. In a situation whereby the exchange rate affects prices through aggregate supply channels, each country's monetary policy can affect price level without significantly reducing output. However, in a regime of managed exchange rates the two countries take the output-price level differently. The foreign country assumes that it cannot affect the money supply; hence, it attempts to reduce its loss function subject to the world economy's trade-off between output and the price level.

Based on the theory of time inconsistency of monetary policy, Lucas (1980), Barro and Gordon (1983), Hall (1984) Barro (1986) and Taylor (1986) have all argued for the superiority of rule-based policy over discretion and discussed why it is important for central banks to consider ways in which they can limit discretion and use these new rules in a systematic way. The optimal rule according to Taylor (1986) should be such that stabilises both output and price fluctuations. Barro (1986), in line with the new classical theories associated with Sargent and Wallace (1975) posited that since systematic monetary policy cannot affect output, the stabilisation of price should be the main goal of monetary policy. This view has also been supported by Armeter and Bodenstein (2005). Accordingly, a rule of strict inflation stabilisation should accord the goal of the central bank. Frey (2006) extended the Barro-Gordon model to address a regime of flexible exchange rate. The welfare criterion of the analysis is the expected loss. These losses arise owing to output-supply shocks and nominal exchange rate shocks.

III.2 Some Empirical Evidences

The monetary policy rule of the central bank varies under different exchange rate regimes. In the literature, empirical findings have shown the implications of different monetary policy choices under alternative exchange rate regimes. Using a hypothetical case of two countries monetary systems, Giavazzi and Giovannini (1989) indicated that a managed exchange rate regime tends to be unstable since both countries find it desirable to affect the exchange rate.

However, a desirable outcome of managed exchange rate can only be obtained when a country that manages its exchange rate is larger than its partner. Ho and Yeh (2010) also investigated the appropriate monetary policy choice for the Taiwanese economy with heavily managed exchange rates using a VAR model with six endogenous variables. The variables considered were real gross domestic product, the short-term interest rate, broad money, the exchange rate, consumer price index and foreign reserves. It was evident that a contractionary monetary policy shock has a permanent and negative effect on real GDP, broad money and price level.

Shanbaugh (2004) investigated how a fixed exchange rate affects monetary policy using a sample of 100 developing and industrial countries between 1973 and 2000. The paper classified countries as pegged or non-pegged and examined whether a pegged country must follow the interest rate changes in the base country. It used actual behaviour for regime classifications and examined the impact of exchange rate, capital control and other control variables on interest rate using OLS. The findings showed that fixed exchange rate force countries to follow the monetary policy of the base country more closely than floating exchange rate. In a panel study of 41 developing countries, Isik (2005) showed that regardless of whether countries adopt fixed or flexible exchange rate, there is negative relationship between the degree of openness and the effect of money growth on exchange rate.

The relevance of exchange rate regime for macroeconomic stability was investigated by Bergvall (2005) using a hypothetical regime in Sweden, where output was substantially more volatile under the fixed regime than the floating regime. The argument of Simwaka (2010) favoured the peg arrangement as a viable option for the majority of low-income African economies. However, for middle income countries with relatively developed financial markets and linkages to modern global markets, floating arrangements, including the managed floating exchange rate regime should be adopted. Rutasitara (2004) used quarterly data from 1967 to 1995 to examine the major determinants of inflation with a particular focus on the role of exchange rate policy reform. The findings revealed that the liberalisation of the foreign exchange market has a large influence on inflation rate in Tanzania. Other monetary policy instruments, such as, interest rate and money supply were not considered in this study.

Devereux et. al., (2006) investigated the exchange rate regime and alternative monetary policy rules for an emerging market economy that is subjected to volatile environment. It was found that financial distortions amplified external shocks, but had little impact on the ranking of alternative policy regimes. In a single country case, Vuslat (2007) analysed the alternative monetary policy rules in Turkey under inflation targeting using a structural macroeconomic model. The alternative rules identified were the Taylor rule, monetary condition index under strict inflation targeting and monetary condition rule under flexible inflation targeting. The results showed that the monetary condition index under strict inflation targeting produced slightly better results than the one obtained under flexible inflation targeting.

Amaghiyeodiwe and Osunibi (2005) examined empirically the determinants of the choice of the exchange rate regime in Nigeria using both multinomial logit and simultaneous limited-independent models. Variables ranging from the degree of openness and macroeconomic performance to real and monetary shocks helped to explain the choice of exchange rate at different periods of time. The study found that when domestic inflation was relatively high with respect to world inflation, a fixed exchange rate regime was preferred.

Some quantitative studies on exchange rate and monetary policy have been based on Vector Autoregressive (VAR) Model introduced by Sims (1980). Berument (2007) considered the factors responsible for monetary policy shocks for Turkey using a Structural VAR (SVAR) model. It was identified that foreign variables are exogenous to monetary variables, domestic monetary policy were affected by the interest rate, monetary aggregate and exchange rate, but not to real gross domestic product and price level. Also, exchange rate affects both domestic and foreign variables in the economy. Cushman and Zha (1997), Berument (2007) concluded that under flexible exchange rate, the effects of domestic monetary policy shocks on small open economy revolved around the interest rate and the exchange rate effect. Further, Bjornland (2008) examined monetary policy and exchange rate interaction in Norway using SVAR model. A considerable interdependence between monetary policy shock and exchange rate was found. After a contractionary policy shock, the real exchange rate immediately appreciated and later gradually depreciated to the baseline.

One of the major challenges of VAR studies is the problem of simultaneity between monetary policy and exchange rate. This can be dealt with by placing recursive, contemporaneous restriction on the interaction between monetary policy and exchange rates. Mtonga (2011) analysed how a change in the monetary policy regime in South Africa has affected the anchorage of the exchange rate to its fundamental determinants from 1984 to 2005. The study employed a VAR approach and the findings showed that policy regime change has a significant impact on pricing of the currency with regards to fundamental determinants. Hoffmann (2007) investigated the impact of exchange rate regimes on macroeconomic stability using panel VAR. Using a sample of 42 developing countries the paper assessed whether the responses of real GDP, the trade balance and the real exchange rate to world output and world interest rate shocks differ across exchange rate regimes. The results revealed that there were significant differences in the variability of macroeconomic aggregates under fixed and flexible exchange rate regimes. The findings of Arratibel and Michaelis (2014) using time varying VAR on the impact of monetary and exchange policy in Poland showed that exchange rate shock has a time varying effect on output.

Based on Vector Error Correction Model (VECM), Sadiku et. al., (2013) reported that monetary aggregates do not have significant effect on the real effective exchange rate in the long-run in Macedonia. Using a system of instrumental variables estimation technique, Toulaboe and Terry (2013) investigated the link between exchange rate regimes and inflation performance in developing countries. Evidence showed that the rate of inflation was clearly linked to real exchange rate depreciation regardless of the exchange rate arrangement. Further, the rate of inflation was much more responsive to the real exchange rate levels in the flexible regime than in the fixed regime. The results pointed some important arguments that support the fixed exchange rate regime in Macedonia. Said et. al., (2012) employed a Dynamic Stochastic General Equilibrium Model (DSGE) to determine the optimal monetary policy rule to conduct a price stability policy in Morocco, in which the monetary authorities decided to adopt a flexible exchange rate regime. It was found that

optimal monetary rule associated with a flexible exchange rate regime will enhance macroeconomic stability in the country.

Although several studies have been conducted in developed countries on the effectiveness of monetary policy under alternative exchange regimes, literature on developing countries, Nigeria inclusive, are few. Therefore, this study will provide an insightful contribution to the empirical literature by providing evidence on the monetary policy exposition under flexible and managed float exchange rate regime in Nigeria.

IV. Econometric Technique

Data Sources and Measurement

This study used secondary data. Data for real GDP (y), inflation, interest rate (lending rate), money supply and nominal exchange rate were collected from the Central Bank of Nigeria *Statistical Bulletin* (various years). The real exchange rate was obtained by adjusting for relative prices between domestic and foreign countries (United States CPI was used for foreign). The data on CPI were gathered from the International Monetary Fund's *International Financial Statistics Yearbook*.

Since this enquiry involved the use of time series variables, unit root tests of all the variables was conducted to examine their stationarity. Furthermore, to examine the monetary policy response under alternative exchange rate regimes, a Vector Autoregressive (VAR) model was employed. A VAR technique is essential in this type of analysis because it enables the determination of the effect of policy shocks that emanated from different exchange rate regimes on monetary policy and vice-versa.

IV.1 Unit Root Test

The augmented Dickey Fuller unit root test was adopted in this study to test the stationarity of each of the variables. The null hypothesis was that the variable was non-stationary. If the value of the ADF statistic was less than or equal to the critical value, then the null hypothesis was rejected and it can be inferred that the variable was stationary at the conventional level. The expression for the unit root test is given as follows:

$$\Delta y_t = \beta + \rho y_{t-1} + \sum_{j=1}^n b_j \Delta y_{t-j} + v_t \quad (1)$$

It is important to include the lags of the dependent variable in equation (1) to eliminate autocorrelation. The hypothesis for stationarity and non-stationarity are expressed in terms of ρ . When $\rho = 0$, it implies that the series is not stationary, hence, it has unit root.

IV.2 Vector Autoregressive Model

This study employed a VAR model estimation technique to determine the behaviour of monetary policy under alternative exchange rate regimes. Though the country has experienced two exchange rate regimes since independence, for the purpose of this enquiry, the exchange rate regimes will be divided into pre-SAP and post-SAP regimes. A standard VAR model is, therefore, used to estimate the model. The choice of variables in the VAR model reflected the theoretical setup of the new Keynesian open economy model.

$$\begin{bmatrix} y \\ \text{inf} \\ M_2 \\ i \\ \text{rer} \end{bmatrix}_t = B(L) \begin{bmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{bmatrix} \begin{bmatrix} \varepsilon^y \\ \varepsilon^{\text{inf}} \\ \varepsilon^{M_2} \\ \varepsilon^i \\ \varepsilon^{\text{rer}} \end{bmatrix}_t \quad (2)$$

The VAR model comprised the growth rate of real GDP (RGDP), broad money supply (M_2), domestic interest rate and real effective exchange rate. With the five variables VAR, five structural shocks can be identified in equation (2). The structural shocks after the ordering are $\varepsilon_t = [\varepsilon_t^y, \varepsilon_t^{\text{inf}}, \varepsilon_t^{M_2}, \varepsilon_t^i, \varepsilon_t^{\text{rer}}]$.

V. Empirical Results and Discussion

The result from unit root testing is presented in Table 2. The reported t-values suggested that the variables were mostly stationary at their levels. This implied that there was no need for differencing in order for the series to attain stationarity. Nonetheless, we equally checked the first differences of each of the five series for unit roots and found them to be $I(0)$ as expected.

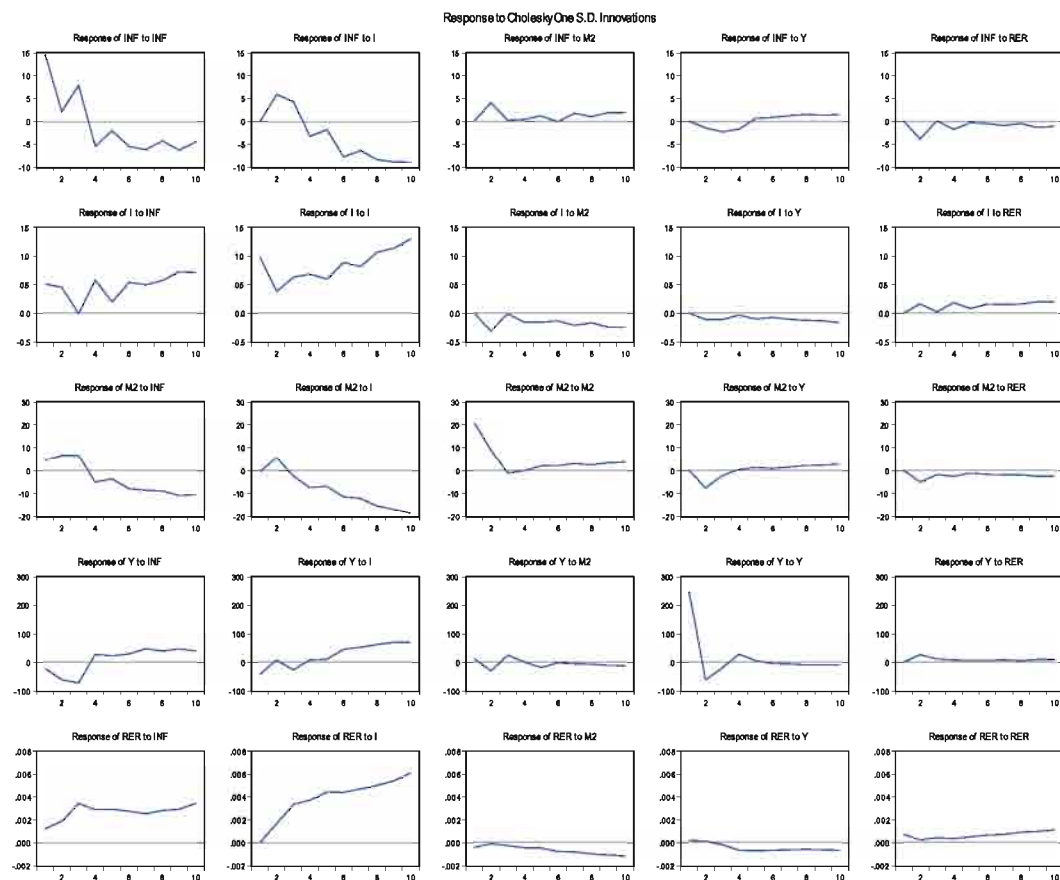
Table 2: Augmented Dickey-Fuller Unit Root Test Results

Series	Level		1 st Diff.		Decision
	Drift	Drift&Trend	Drift	Drift&Trend	
INF	-4.1438*	-6.5489*	-9.2084*	-9.6782*	I(0)
I	-1.4095	3.3287**	-11.1678*	-12.1254*	I(0)
M2	-5.5862*	-7.1528*	-10.6422*	-11.7392*	I(0)
Y	-8.1824*	-9.2371*	-7.2114*	-9.4365*	I(0)
RER	-3.2712**	-4.3790*	-6.2333*	-7.2133*	I(0)

Note: *, ** and *** denote statistical significance at the 1, 5 and 10 per cent levels respectively.

The foregoing results implied that a vector autoregressive (VAR) model can be fit to the levels of the variables. Furthermore, the impulse response functions (IRFs) and variance decompositions (VDs) can be used to gauge the strength of the relationships among the variables in the VAR model.

Figure 5: Impulse Response Functions for the 1961-1985 Sub-sample



We turn to this line of analysis subsequently and noted at this juncture that the discussion was bifurcated into the fixed and floating exchange rate regimes. For the first regime spanning 1961 to 1985, Figure 5 displays the full set of IRFs on the basis of one standard deviation Cholesky matrix.

To gauge the magnitude of the response of monetary aggregates to the exchange rate under the fixed episode, the last column of Figure 5 is of prime interest. It is clear that both inflation and the money supply decline on impact in response to a one standard deviation shock to the exchange rate variable. This drop peaks at about two years following the shock in both cases. However, decline is more pronounced with inflation. By the fifth year, the impact of the shock to the exchange rate on both monetary aggregates is almost nil. On the part of the interest rate, a jump is observed on impact and this tendency appears

not to abate even till the tenth year. Beyond the initial upswing in output, its response to exchange rate shocks is trifling at best.

For the same sample, the VDs are presented in Table 3. The VDs account for the relative proportion of the individual shocks to all variables within the VAR system. Expectedly, own shocks account for the largest proportion of forecast error variance except in the instance of exchange rate shocks. Overall, exchange rate shocks do not appear to have significant weight as there was no impact recorded on inflation, interest rate and money supply after one year.

Table 3: Variance Decomposition Results for the Fixed Exchange Regime (1961-1985)

Horizon (Years)	INF	I	M2	Y	RER
Shocks to INF explained by innovations in:					
1	100.000	0.000	0.000	0.000	0.000
5	73.557	15.593	3.861	2.650	4.338
10	49.914	42.685	2.850	2.002	2.548
Shocks to I explained by innovations in:					
1	21.049	78.951	0.000	0.000	0.000
5	24.436	68.213	4.398	1.109	1.845
10	24.064	69.826	3.235	1.051	1.824
Shocks to M2 explained by innovations in:					
1	4.730	0.091	95.179	0.000	0.000
5	16.467	15.722	56.419	7.215	4.176
10	23.118	50.062	21.183	3.225	2.413
Shocks to Y explained by innovations in:					
1	0.777	2.745	0.171	96.308	0.000
5	12.902	3.243	2.409	80.437	1.009
10	16.976	18.314	2.226	61.471	1.012
Shocks to RER explained by innovations in:					
1	68.801	0.032	10.651	0.879	19.637
5	39.777	56.793	1.091	1.393	0.946
10	28.027	66.879	2.305	1.329	1.500

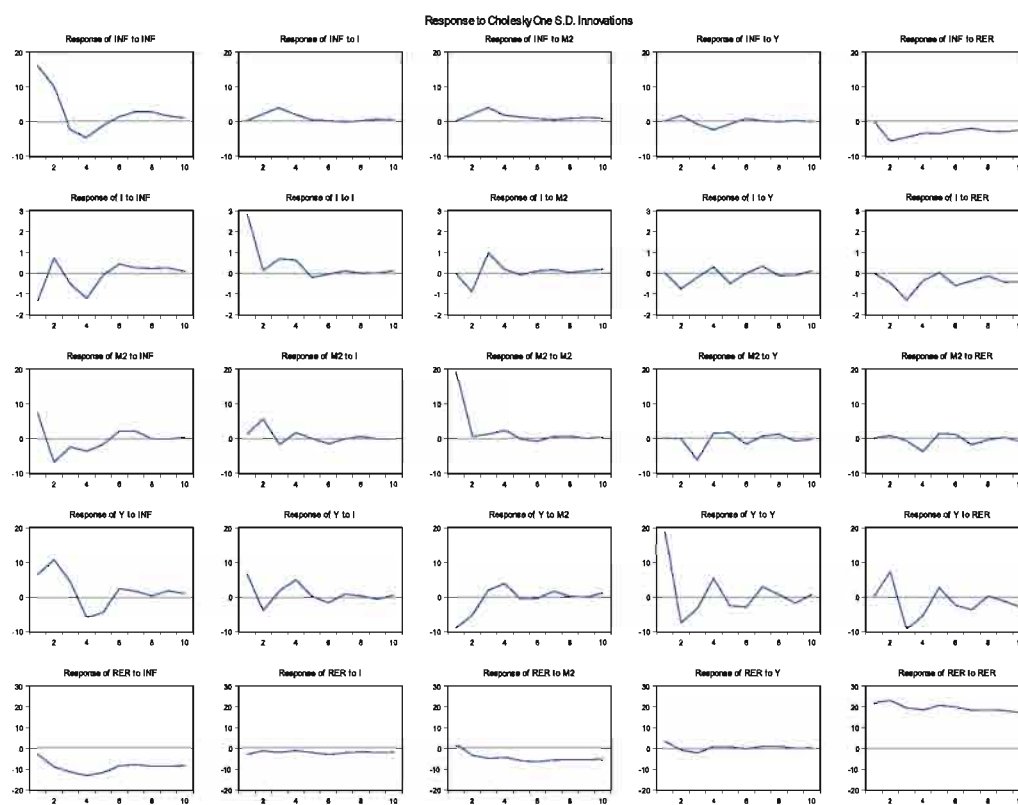
However, following a five-year horizon, about 4.3 and 4.2 per cent of the observed variations in inflation and money supply was accounted for by exchange rate shocks. The 1.85 per cent recorded for interest rate is only about one-third in magnitude. This implied that exchange rate more directly influenced the latter aggregates and their effects on interest rate were likely to be second round effects.

The effect on output settled at a minimal 1 per cent even after the passage of ten years. Interestingly, over the same horizon, the own effect of exchange rate dissipates to a mere 1.5

per cent. This suggested that the persistence of exchange rate shocks in the Nigerian context was miniscule.

The second sub-sample for analysis covers the period 1986 through 2013. The summary of the results is aptly depicted in Figure 6. Again, for completeness and comparability, we retain our focus on the last column of Figure 6. A number of observations are noteworthy in this case. First, there is an initial drop in inflation. This showed a much larger magnitude *vis-a-vis* the preceding regime (that is, 1961 to 1985). This effect was also more persistent in the latter sub-sample.

Figure 6: Impulse Response Functions for the 1986-2013 Sub-sample



Second, the decline in interest rate was considerably large on impact and it stayed negative over the entire ten-year period following the exchange rate shock as against the positive impact observed in Figure 5. Moreover, wide swings were also evident within this negative interest rate range. Third, in response to shocks to the exchange rate, the money supply alternated between positive and negative values regardless of the horizon considered. This starkly contrasts with the response under the 1961-1985 scenario where a muted effect was visible beginning from the fifth year. Also, under the floating exchange rate regime, output

displayed more variability as against the almost zero effect observed in the case of the fixed exchange rate regime. Finally, own shocks to exchange rate were somewhat permanent in nature.

Turning to the VDs in Table 3, the effects of exchange rate on both the monetary aggregates and output are more palpable. From a situation of no influence after one year, by the fifth year, exchange rate shocks accounted for about 14.8, 11.2, 2.8 and 16.1 per cent of innovations to inflation, interest rate, money supply and output, respectively.

This figure increased over the following five-year period to settle at 19.3, 14.9, 3.6 and 17.7 per cent in that order. Unlike the earlier sub-sample (see Table 3), own shocks to exchange rate accounted for the bulk of observed variations in the exchange rate. This effect was vividly persistent as it reduced by less than 20.0 per cent over the ensuing ten-year horizon.

Overall, the key monetary aggregates, namely, inflation, interest rate and money supply were all quite responsive to exchange rate shocks. Nevertheless, the magnitude of responsiveness varied depending on the exchange rate regime in operation. Particularly, the managed float regime exchange rate regime coincided with more substantial response of these variables in the wake of shocks to the exchange rate. The dynamics of output was also found to be similar.

Table 4: Variance Decomposition Results for the Flexible Exchange Regime (1986-2013)

Horizon (Years)	INF	I	M2	Y	RER
Shocks to INF explained by innovations in:					
1	100.000	0.000	0.000	0.000	0.000
5	74.859	4.164	4.274	1.877	14.826
10	70.577	3.860	4.408	1.807	19.348
Shocks to I explained by innovations in:					
1	17.763	82.237	0.000	0.000	0.000
5	22.350	51.207	9.850	5.346	11.247
10	22.628	47.341	9.488	5.675	14.868
Shocks to M2 explained by innovations in:					
1	12.528	0.449	87.023	0.000	0.000
5	20.064	6.671	63.599	6.853	2.813
10	20.799	6.834	61.311	7.433	3.623
Shocks to Y explained by innovations in:					
1	8.076	8.656	15.425	67.843	0.000
5	21.318	8.141	11.859	42.620	16.063
10	21.155	7.979	11.457	41.743	17.666
Shocks to RER explained by innovations in:					
1	1.876	2.075	0.387	2.308	93.404
5	19.312	0.900	3.659	0.640	75.450

10	18.050	1.120	5.477	0.408	74.946
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VI. Concluding Remarks

This paper examined the association between key monetary aggregates and the exchange rate under the two broad exchange rate regimes in Nigeria. Time series data of 53-year period spanning 1961 to 2013 were deployed to estimate VAR models with the aim of empirically quantifying the response of monetary variables (inflation, interest rate and money supply) to exchange rate shocks. This analysis was undertaken under two exchange rate regimes corresponding to the era of fixed exchange rate and the period of managed float exchange rates, respectively. Several interesting findings arose from the analysis. Here, we briskly highlighted a number of the more striking ones in what follows. First, for the fixed exchange rate regime, all three monetary variables were responsive to exchange rate shocks as evidenced by the IRFs.

However, this impact was far less than what was displayed by these variables under the alternative managed float exchange rate regime. Second, the VDs revealed that exchange rate shocks do not appear to have significant weight as there was no impact recorded on inflation, interest rate and money supply after one year under the fixed regime. In the managed float exchange rate sub-sample, inflation, interest rate and money supply had not only more pronounced, but also longer lasting responses to impulses originating from the exchange rate. Third, the corresponding VDs clearly showed that the effect of exchange rate on the monetary aggregates was more significant and increased in importance over the long-run. Policy-wise, this suggested a clear role for more proactive domestic economic management policies in an era characterised by alternative experimentation with variants of managed float exchange rate system like it had been in the Nigerian case following the adoption of structural reforms in the mid-1980s.

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