# MACROECONOMIC POLICY "SHOCKS" AND EXCHANGE RATE VOLATILITY IN NIGERIA (1986 – 2009)

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# DEDICATION

This work is dedicated to GOD the Father, the Son and the Holy Spirit without whose help and power I am naught. I also dedicate this study to my wife, Lady Titilayo – a true gem, the children; Joseph Oluwamayowa, David Ayomide and Joshua Temidayo who inspired me throughout the duration of the study. Finally, the study is dedicated to the memories of my late father, Mr. Abdul-Ganiyu Adeoye and my mother, Mrs. Omolola Adeoye.

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***Babatunde Adeoye***

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| | | |
|---|---|---|
| ACF | - | Autocorrelation Function |
| ADF | - | Augmented Dickey Fuller |
| AFEM | - | Autonomous Foreign Exchange Market |
| ARCH | - | Autoregressive Conditional Heteroskedasticity |
| ARIMA | - | Autoregressive Integrated Moving Average |
| BOT | - | Balance of Trade |
| BTA | - | Basic Travelling Allowance |
| CBN | - | Central Bank of Nigeria |
| CIRP | - | Covered Interest Rate Parity |
| CISS | - | Comprehensive Import Supervision Scheme |
| CPI | - | Consumer Price Index |
| DAS | - | Dutch Auction System |
| DF | - | Dickey Fuller |
| DFI | - | Direct Foreign Investment |
| FDI | - | Foreign Direct Investments |
| FEM | - | Foreign Exchange Market |
| FEVD | - | Forecast Error Variance Decomposition |
| GARCH | - | Generalised Autoregressive Conditional Heteroskedasticity |
| GDP | - | Gross Domestic Product |
| GEAR | - | Growth, Employment and Redistribution |
| IFEM | - | Inter-bank Foreign Exchange Market |
| IMF | - | International Monetary Fund |
| IMF | - | International Monetary Fund |
| IRF | - | Impulse Response Function |
| LCP | - | Local Currency Pricing |
| LDCs | - | Less Developed Countries |
| MRP | - | Minimum Policy Rate |
| MRR | - | Minimum Rediscount Rate |
| NER | - | Nominal Exchange Rate |
| OMO | - | Open Market Operations |
| OLS | - | Ordinary Least Squares |
| PACF | - | Partial Autocorrelation Function |
| PCP | - | Producers' Currency of Production |
| PPP | - | Purchasing Power Parity |
| PPP | - | Purchasing Power Parity |
| RER | - | Real Exchange Rate |
| RGDP | - | Real Gross Domestic Product |
| RMB | - | Real Money Balances |
| SAP | - | Structural Adjustment Programme |
| SBDW | - | Sargan-Bhargara Durbin-Watson |
| SFEM | - | Second-Tier Foreign Exchange Market |
| SSA | - | Sub-Saharan Africa |
| SVAR | - | Structural Vector Autoregressive |
| TOT | - | Terms of Trade |
| UCIRP | - | Uncovered Interest Rate Parity |
| VAR | - | Vector Autoregressive |
| VDA | - | Variance Decomposition Analysis |
| VIF | - | Variance Inflation Factors |
| WB | - | World Bank |
| WDAS | - | Wholesale Dutch Auction System |
| WPI | - | Wholesale Price Index |

# *ABSTRACT*

*This study examined the extent to which macroeconomic policy shocks had contributed to exchange rate volatility in Nigeria from 1986 to 2009. Specifically, it established the degree and severity of exchange rate volatility in Nigeria and then examined the impact of macroeconomic policy shocks on real exchange rate volatility in Nigeria during the sample period. Furthermore, the study determined the differential effects of both internal and external macroeconomic policy shocks on the exchange rate volatility in Nigeria and also analysed the implications of exchange rate policy regime shift on exchange rate volatility in Nigeria with a view to ascertaining the ascertain the causal relationship between the macroeconomic policy shocks and exchange rate volatility in Nigeria.*

*The study used secondary quarterly time series data for Nigeria for the period 1986 to 2009. A modified version of Mundel- Fleming open macroeconomic theoretical model which incorporated the Purchasing Power Parity (PPP) assumption of exchange rate determination was developed. This theoretical framework was adjusted to take cognisance of the peculiarity and structural characteristics of Nigerian economy as a small open import dependent economy. The model was dichotomised into internal and external policy shocks and several policy shock scenarios were specified to detect the possible differential effects of the internal and external policy shocks on exchange rate volatility in Nigeria. The study used Generalised Autoregressive Conditional Heteroskedasticity (GARCH) approach to determine the degree and severity of exchange rate volatility in Nigeria while the VAR and VEC models were applied to estimate the effects of macroeconomic policy shocks on exchange rate volatility in Nigeria and to establish the direction of causal nexus between the macroeconomic policy variables and exchange rate validity indices.*

*The results from the study showed that high degree exchange rate volatility existed during the sample period and it was found to be severe and persisted over sample period. The result also showed that foreign price, foreign interest rate, oil price, domestic price, foreign exchange demand-supply gap, fiscal imbalance and domestic monetary policy variables were the only macroeconomic policy variables that had significant influence on exchange rate volatility in Nigeria. The study established that there was a marked difference in the effects of internal and external macroeconomic policy shocks on exchange rate volatility. Each of the external macroeconomic policy shock variables like foreign prices, interest rate, net foreign asset and oil price shocks, explained not less than 51% of variation in exchange rate volatility, none of domestic policy shock variables explained up to 30% of the changes in exchange rate volatility in Nigeria for the sample period. In addition, the result showed that the degree and severity of exchange rate volatility also differed across exchange rate policy regimes. For instance, it was found that exchange rate volatility during the SAP era was mainly accounted for by external macroeconomic policy shocks while exchange rate volatility during Post –SAP period was accounted for by internal macroeconomic policy shocks, most especially the monetary policy shocks. The volatility of exchange rate during the NEEDS period was accounted for by both internal and external macroeconomic policy shocks.*

*The study concluded that though exchange rate volatility was caused by both internally and externally induced policy shocks, a significant proportion of the volatility was due to externally induced policy shocks which are outside the direct control of macroeconomic policy management in Nigeria. The policy implication of the results from this study is therefore that exchange rate stability could only be achieved through a well coordinated fiscal and monetary policy mix that can respond swiftly and quickly to external shocks.*

*Key Words: Exchange rate, Volatility, Shocks, Macroeconomic Policy, SVAR Model*

# CHAPTER 1
# INTRODUCTION

## *1.1 Background to the Study*

Macroeconomic policy shocks could be described as sudden and periodic reversals in macroeconomic policy of the government (monetary, fiscal, exchange rate and trade policies). Over the years, Nigeria, like many other African countries experienced macroeconomic distortions and shocks in virtually all the sectors of the economy. These economic distortions led to economic crisis in the early 1980s. The manifestation of the crises appeared in various ways, such as low growth rate of GDP, negative growth rate of per capita income, an increasing balance of payment deficits and huge debt followed by accumulation of servicing debts.

Following the unprecedented increase in foreign exchange earnings from oil in the early 1970s, largely monetised, the public sector involvement in direct economic activities escalated. Fiscal deficits soared and because of the increasing over-dependence on external sector, external equilibrium which was quite visible early in the period had virtually disappeared by the end of the decade. Compounding the existing economic challenges were the high inflationary pressures which kept on mounting while monetary management began to experience serious difficulties.

Moreover, the balance of payments position in the 1970s presented a picture of large surpluses in the early part of the period. Therefore, this period was by an emergence of deficits especially in the middle part of the period. These trends were determined by developments in the oil sector as well as changes in government policies. This reflected in the increased share of the oil sector in the export trade from under 60.0 per cent in 1970 to over 90.0 per cent starting from 1973, while the non-oil exports declined proportionately from 30.0 per cent of aggregate exports in 1970 to less than 10.0 per cent at the end of the decade (Chete, 1995; Yinusa and Akinlo, 2008).

However, it should be noted that an important factor in this development was the ban imposed by government during the second half of the period (1970 to 1980) on the exports of non-oil commodities in order to satisfy the excess demand for these commodities in the domestic market (import substitution strategy). Another major factor that could be responsible for the deteriorating external payments position was the mounting public expenditure by reason of its high import content and also due to the stimulus it gave to private sector imports (Yinusa and Akinlo).

In addition, with increases in government expenditure, occasioned by the increased role and direct involvement in production and distribution and the urge to provide social amenities and job opportunities for the teaming population, the financial sector experienced rapid monetary expansion in the 1970s because these expenditures stemmed from the monetisation of huge oil revenues. There was also significant expansion of bank credit as another stimulus to monetary growth during the period. Under these circumstances, especially in a situation of increased aggregate demand when output response to domestic requirements was not sufficiently elastic, inflationary pressures intensified. A good example was government decision to award salary increases to its workers in 1975. Private sector enterprises took similar action. Consequently, inflationary pressures worsened while further erosion of external stability was encouraged. However, with the collapse of the international oil market in the 1980s, foreign exchange earnings fell markedly and the uncontrolled taste for imported goods and services exacerbated the balance of payments problems. Indeed, government resulted to excessive borrowing and money creation to finance its deficits; hence, the financial system was overheated, leading to high inflation.

The causes of the economic problems and distortions as well as the poor state of events (as enumerated above) were many and varied. Like many other African governments, the Nigerian government put the blame on deteriorating terms of trade, high interest rates and possibly high import dependency. Though these factors contributed to the economic crisis, by far the most

important cause of poor economic performance was poor implementation of macroeconomic policy. This manifested as lack of appropriate incentive schemes to promote efficient use of resources. In general, the application of poor macroeconomic policies of developing countries, Nigeria inclusive, has led to distortions in all sectors of the economy (Adeoye, 2007a). Among the consequences of poor macroeconomic management is the overvaluation of the exchange rate of a country's currency which discourages export diversification and makes imports artificially cheap. The quantitative restrictions that were introduced in the allocation of foreign exchange were essentially the result of an overvalued domestic currency. Couple with this was the volatility in the exchange rate which could be as a result of both internal and external macroeconomic shocks.

Over the past couple of decades, in the face of an unprecedented and lasting economic and financial crisis, Nigeria introduced a wide-range of policy reforms. The first attempt was the implementation of stabilisation or demand management policies in the late 1970s and early 1980s. The economic realities of the period revealed that the structural bottlenecks which have characterised the economy for many years, could not be corrected by these short-term measures. Hence, there was the need for a more comprehensive policy to address these structural distortions and imbalances in the economy.

Consequently, government introduced and implemented a comprehensive reform policy organised within successive Structural Adjustment Programme (SAP), supported by the International Monetary Fund (IMF) and the World Bank. The deregulation of foreign exchange market which was a major plank of the reforms programme that started 1986, was a key policy measure enunciated principally to boost the international competitiveness of Nigeria's exports. As the Nigerian economy sought to eliminate the influence of parallel market for foreign exchange, naira depreciated massively. This further led to increase in the external values of African currencies especially Nigerian naira. More importantly, this level of exchange rate instability and its pass-

through effects to domestic inflation led to the move towards the use of foreign currencies in the domestic economy for transactional, unit of account and store of value purposes.

However, as a result of these policy reforms, the economy witnessed the introduction of Second-Tier Foreign Exchange Market (SFEM) in September 1986 and later Foreign Exchange Market (FEM) and Inter-bank Foreign Exchange Market (IFEM). This has entailed the drastic devaluation of naira beyond an imaginable level (Adeoye, 2007b). The government during this period thought that the only way out of these distortions was to introduce a comprehensive economic reform, the aim of which was to regain internal and external balances thereby promoting sustainable growth and development in all sectors. Despite all these measures, exchange rate over the years remained volatile; hence, this study examines the impact of both internal and external macroeconomic policy shocks on exchange rate volatility in Nigeria.

## *1.2 Statement of the Problem*

The centrality of exchange rate as one of the major macroeconomic policies derives from the fact that for most countries, the prevailing objective of monetary policy is price stability. Consequently, volatility in the exchange rate is generally counter-productive to the goals of price stability. This explains the political sensitivity of exchange rate regimes in both developing and developed economies. There is a widespread presumption that volatility of 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 (Philippe and Romania, 2006). 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.

Nigeria's macroeconomic policy, mostly monetary policy resulting from the comprehensive economic reforms is anchored on a monetary targeting framework (Nnanna, 2002). In this framework, price stability represents the overriding objective of monetary policy. This represents a significant departure from the past especially in the 1980s, when the promotion of rapid growth and employment represented the major objective of the policy. The focus on price stability derives from the overwhelming empirical evidence that sustainable growth cannot be achieved in the midst of price and exchange rate volatility. There is indeed, a general consensus that domestic price and exchange rate volatility undermines the value of money as a store of value, and frustrates investments and growth.

However, the ineffectiveness of both the monetary and fiscal policy frameworks was clearly reflected in the developments during 1980s and 1990s. The central monetary authority had no effective grip on the growth of monetary and fiscal aggregates in line with the stipulated targets. Moreover, the sectoral credit controls were also not very effective. The poor levels of interest rates continued to be a source of inflationary monetary expansion especially from the angle of domestic debt management (Adeoye, 2007a). The overvalued exchange rate of the naira put considerable pressure on the external sector and control of monetary expansion through the fluctuations in net foreign assets. Government fiscal operations similarly constituted a major constraint on effective monetary control. Evidence from macroeconomic data suggests that, macroeconomic policies (monetary and fiscal policies inclusive) have proved elusive in Nigeria. Inflation has been high and unstable; the balance of payments has been barely sustainable while the fiscal deficit remains unviable. Also, the nominal naira exchange rate has been highly unstable while the prevailing levels since 1990 may have contributed to a weakening of the country's international competitiveness.

Further, market interest rates have remained very high in nominal terms while real interest rates have been volatile.

Further, the exchange rate policies (often complemented by monetary and fiscal policies) introduced over the years, have not succeeded in restructuring the production and consumption patterns of the economy. Given the import dependent production and consumption structure of the economy, the persistent exchange rate volatility might be one of the factors that have aggravated the rising cost of production and cost of living in Nigeria.

The outcome of poor management of macroeconomic and exchange rate policies (particularly, in recent years) resulted in huge budget deficits which has further brought about persistent pressures on the demand for foreign exchange at the foreign exchange market with its concomitant depreciation of the naira exchange rate. Thus, the economy was characterised by structural distortions which manifested in form of: recurring deficits in trade balance; unfavourable terms of trade; rising inflation; exchange rate depreciation and instability, even after the adoption of various economic reforms.

Despite the scenarios discussed above, existing studies (Yinusa, 2004; Yinusa and Akinlo; Akpokodje, 2009) on the exchange rate volatility in Nigeria had only limited themselves to determining the presence without establishing the degree of severity and persistency of the volatility which has implications for macroeconomic management in any economy especially developing economies like Nigeria. Besides, existing studies had not explored the possibility that there could be differences in the impacts of both internal and external policy shocks on the volatility of exchange rate. Moreover, in spite of the growing interest over the link between the exchange rate volatility and macroeconomic performance, the burgeoning empirical literature on transition economies like Nigeria has paid little attention to the effect of exchange rate regime switch on exchange rate volatility and this is one of the contributions by this study. The empirical work of Ilker *et al* (2001)

suggests that macroeconomic policy variables-and also other variables influencing economic activity-do have a different impact on exchange rate movement under different exchange rate arrangement. Therefore, the preoccupation of this study is to determine the macroeconomic policy shocks contributing to exchange rate volatility in Nigeria.

## *1.3 Objectives of the Study*

The broad objective of this study is to empirically determine the extent to which macroeconomic policy shocks had contributed to real exchange rate volatility in Nigeria from 1986 to 2009 with a view to ensuring effective macroeconomic management. The specific objectives are to:

(1) establish the degree and severity of exchange rate volatility in Nigeria for the period 1986 to 2009;

(2) examine the main macroeconomic policy shocks influencing exchange rate volatility in Nigeria during the sample period,

(3) determine the differential effects of both internal and external macroeconomic policy shocks on the exchange rate volatility in Nigeria;

(4) analyse the implications of exchange rate policy regime shift on exchange rate volatility in Nigeria; and

(5) ascertain the causal relationship between the macroeconomic policy shocks and exchange rate volatility in Nigeria.

## *1.4 Research Questions*

The foregoing developments have thrown up a number of research questions. These are:

(1) What is the degree of severity of exchange rate volatility in Nigeria?

(2) What are the main macroeconomic policy shocks contributing to exchange rate volatility and how has exchange rate responded to these policy shocks in Nigeria?

(3) Are there any significant differences in the effects of internal and external macroeconomic policy shocks on exchange rate volatility in Nigeria?

(4) In what ways have exchange rate policy shifts contributed to exchange rate volatility in Nigeria?

(5) What is the nature and direction of causality between macroeconomic policy shocks and exchange rate volatility in Nigeria?

## *1.5 Scope of the Study*

The study covers a period of 24 years. It stretches from the first quarter of 1986 to the fourth quarter of 2009. The period before 1986 was not considered as part of the scope of this study because exchange rate was relatively stable during this period. This study uses secondary data of macroeconomic variables which include exchange rate, money supply, world oil price, net foreign assets, consumer price index, foreign price index, domestic and foreign interest rates. All the variables are in logarithms except interest rate and the US Federal Fund rate. This wide coverage in terms of period ensures that the study analyses the impacts of macroeconomic policy shocks on exchange rate volatility under various exchange rate policy regimes in Nigeria. Also, wide coverage is essential in order to enhance the reliability of the data used for estimation as well as reliability and consistency of the results. The study period is decomposed into three major exchange rate regimes which include; the SAP era (1986 to 1993), the post-SAP /reform lethargy era (1994 to

2003) and the NEEDS era (2004 to 2009). According to Balogun (2007), reform lethargy era is the period when there was sudden reversal in the policies of government. This period could be described as the "Guided Deregulation" period.

## *1.6 Organisation of the Study*

This study is divided into six chapters. Following this introductory section is chapter two which contains a review of macroeconomic policy management in Nigeria. It highlights and reviews the major macroeconomic policies so as to properly situate the study and to provide a basis for our analyses. Chapter three presents a vivid review of related literature.

Chapter four contains the theoretical framework and methodology that forms the basis for an elaborate model specification for the study. In this chapter, the research methods employed are discussed. The study first presents the theoretical framework for the study; the main issues here involve discussing the main theories that have been applied in the literature. These various models are reviewed with a view to gaining insight into various theoretical constructs that have influenced the current state of knowledge in this area. This was followed by the analytical framework, model specification, scope of the study and the estimation techniques. Chapter five provides the results from the models estimated while the summary of findings, conclusions and policy recommendations are in chapter six.

# CHAPTER 2

# MACROECONOMIC POLICY MANAGEMENT IN NIGERIA

## *2.1 Introduction*

This chapter provides an appraisal of macroeconomic policy and its management in Nigeria. It brings out the best indicator of macroeconomic policy in Nigeria. Also, an attempt was made to show how monetary policy and exchange rate management have affected key macroeconomic variables in Nigeria, especially those factored into the model. In the first place, the study takes a look at exchange rate management in Nigeria while the issue of monetary policy as a key macroeconomic policy was considered in the latter part of this chapter. Indeed, an overview of the evolution of monetary management in Nigeria shows that it has metamorphosed from an era of administrative controls and regulation to a market-based mechanism. An attempt was made to summarise the actions of the monetary authorities and assess the outcomes during the period.

For this purpose, the period covered was divided into three phases: the flexible exchange rate period, 1986 to 1993: the guided deregulation period, 1994 to 2003 (reform lethargy era): and the NEEDS period, 2004 to date. It is important to note that the period before 1986 is not relevant to the focus of this study since during that period exchange rate was fixed and relatively stable.

## *2.2 Exchange Rate Policies and Management in Nigeria*

The exchange rate is described as a relative price that measures the worth of a domestic currency in terms of another country's currency (Obaseki, 2001). This is because it relates the purchasing power of a domestic currency, in terms of the goods and services it can purchase, in comparison to a trading partner's currency, over a given period of time. Therefore, the exchange rate reduces the relative strengths of relating economies to measurable aggregates through a number

of conceptual frameworks. The exchange rate is useful for macroeconomic management since it reflects the performance of both the domestic and external sectors of the economy. The design and implementation of exchange rate policy is, to the extent that the exchange rate trails developments in the economy, a crucial and important policy issue and invariably an important adjunct and pivot of adjustment policy framework (Obaseki).

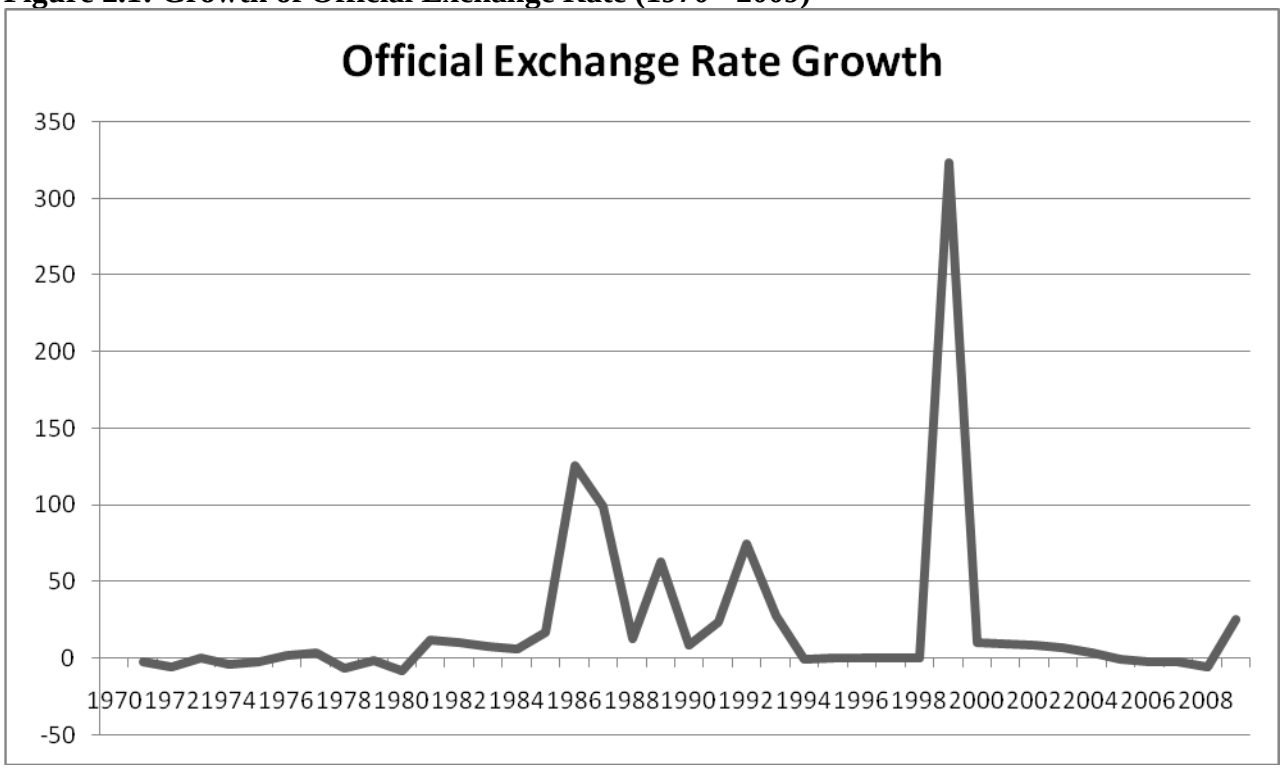
Therefore, exchange rate policy also connotes the sum total of the institutional framework and measures put in place to move relative prices towards desired levels in order to stimulate the productive sector, curtail inflation, ensure internal balance, improve the level of exports and attract direct foreign investment (DFI) and other capital flows. Therefore, exchange rate policy seeks to move the economy towards internal balance in the short-term and external balance in the medium to long-term when appropriate complementary policies are put in place.

Exchange rate policy in Nigeria has moved in a circle, starting from fixed exchange rate system from 1960 – 1986, a flexible exchange rate system from 1986 – 1993, a temporary halt to deregulation in 1994 when the official exchange rate was pegged and the reversal of policy with the "guided deregulation" of the foreign exchange rate market, through exchange rate liberalisation and the institution of a dual exchange rate mechanism. The policy thrust of 1995 was retained in 1996. The dual exchange rate system was retained in 1997 and 1998. However, all official transactions, except those approved by the government were undertaken in Autonomous Foreign Exchange Market (AFEM). Thus, transactions at the pegged official exchange rate were relatively slimmer. Owing to market imperfections and to sustained instability in the exchange rate of the naira, the AFEM was replaced with an inter-bank foreign exchange market (IFEM) in 1999. At the IFEM, a two-way quote system is expected to prevail while the market was conducted daily in this dispensation, oil companies were allowed to keep their foreign exchange in banks of their choice,

against the previous practice where they were mandated to keep such funds with the Central Bank of Nigeria (CBN).

In 2002, the Dutch Auction System (DAS) of foreign exchange management was introduced to replace IFEM. The main objective of the DAS was to devalue the naira, moderate imports and consequently strengthen the balance of payment while at the same time reduce the parallel market premium. Since the introduction of DAS till date, the naira has lost value significantly, the parallel market premium, narrowed, but it has not reduced the appetite of Nigerian's for foreign goods and persistent demand for foreign exchange. Figure 2.1 depicts the movement of official exchange rate from 1970 to 2009. A critical review of the exchange rate volatility during the different policy periods mentioned earlier flexible exchange rate period (1986 – 1993); guided deregulation period (1994 -1998); and 1999 to date) is presented in what follows.

**Figure 2.1: Growth of Official Exchange Rate (1970 - 2009)**




*Source: CBN Statistical Bulletin, Various Issues.*

### 2.2.1 Flexible Exchange Rate Period (1986 - 1993)

A market-influenced exchange rate determination and foreign exchange allocation system replaced government control in July 1986 within a framework of a Structural Adjustment Programme (SAP). Among other objectives, the SAP sought to: achieve balance of payments viability; lessen the dominance of unproductive investments in the public sector through public properties privatisation and commercialisation; reduce the level of unemployment; and bring the economy back on the path of steady and balanced growth (CBN, 1986).

The second-tier foreign exchange market (SFEM) introduced in September 1986 was the major institutional change of policy reform. Its key objectives were to allow the naira find its true value; achieve a more optimal allocation of foreign exchange; gradually eliminate the parallel market; and eliminate the vices associated with the import license regime (CBN, 1986). The SFEM was also expected to encourage increase in domestic output and export revenue, curtail imports and reduce exchange rate volatility. In essence, the second-tier market was expected to make foreign exchange management less costly.

The thesis that pre-reform policy caused exchange rate over-valuation which in turn led to distortions and hence internal and external disequilibrium in the Nigerian economy, anchored exchange policy reform. This was why the reform which was a reversal of pre-reform policies was considered necessary to positively enhance the fortunes of the Nigerian economy. It is important to note that the success of exchange rate policy reform hinges on the effectiveness of the Nigerian market system. Therefore, the discussion of post-1986 exchange rate policy and exchange rate management in Nigeria should be conducted within the context of the Nigerian foreign exchange market system.

With the adoption of SAP in 1986, the trade and exchange controls of the earlier years were replaced by a market determined naira exchange rate mechanism and liberal trade regime. That is,

with SAP, the naira exchange rate was to be determined by market forces through a number of strategies which include: the Second-tier Foreign Exchange Market (SFEM), Dutch Action System (DAS), Foreign Exchange Market (FEM), the Interbank Foreign Exchange Market (IFEM) and Autonomous Foreign Exchange Market (AFEM). In the area of foreign trade, the levels of tariff and non-tariff barriers were reduced to complement the new initiative of promoting exports through the introduction of various export incentive schemes.

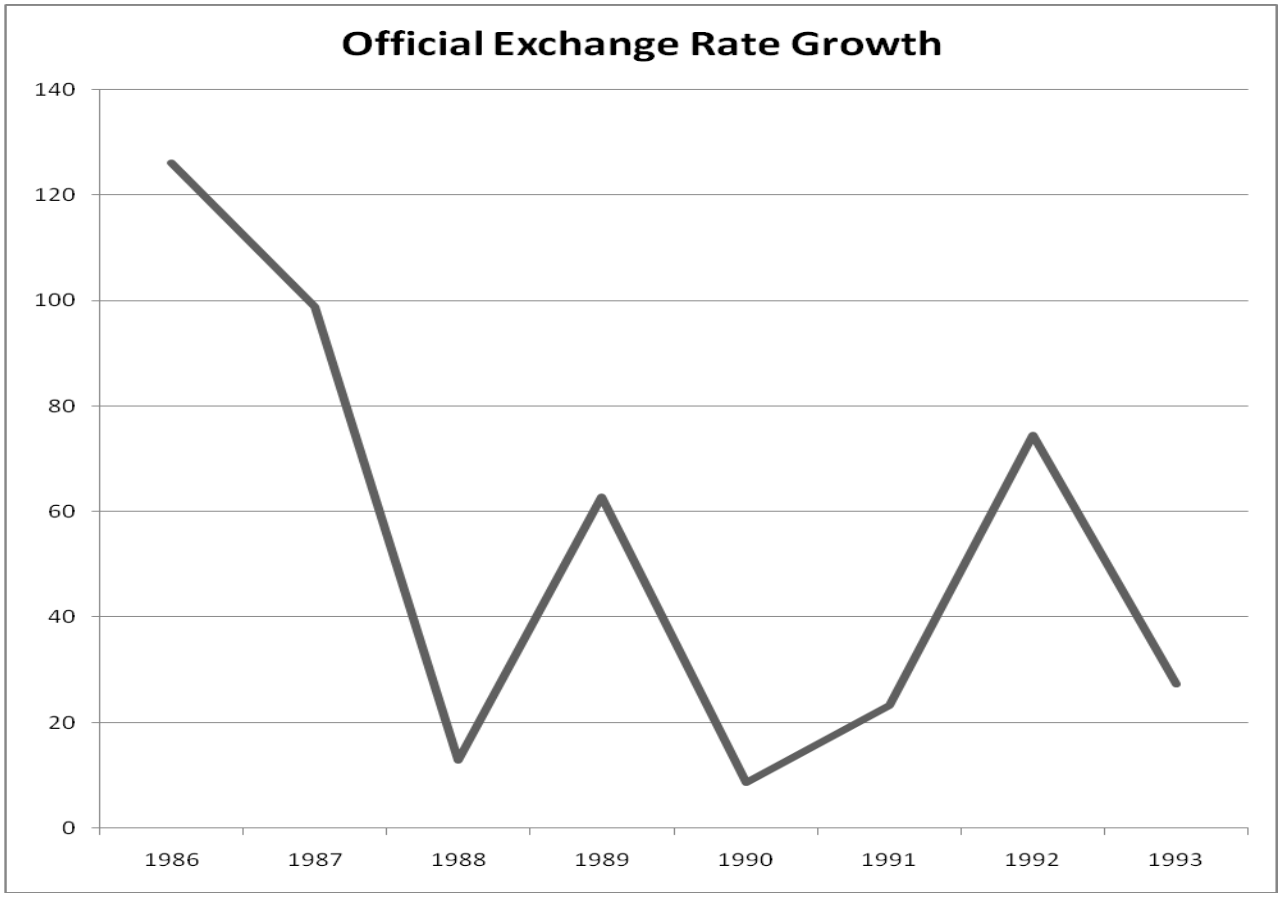
In order to stem the persistent depreciation of the naira value, the FEM which was a result of merging both the first and second-tier markets, was adopted in July, 1987. Thus, all transactions were subjected to market forces. Nonetheless, the foreign exchange demand pressures persisted and contributed to the persistent depreciation of the naira value. In 1989, the IFEM was adopted and the naira value was determined through one or more of the following exchange rate methods - marginal rate pricing, average rate pricing, highest and lowest bid, weighted average pricing, average of successful bids and consideration of developments in the exchange rates of the major international currencies. Also, under the IFEM, auctions were held daily but this did not completely remove the then prevailing exchange rate instability (Obaseki, 2001).

In order to further reduce the exchange rate instability, the CBN modified IFEM procedures in December 1990 through the re-introduction of the DAS and the adoption of the modal weighted average method of exchange rate determination in August, 1991. Although, this method was designed to reduce wide fluctuations in the naira exchange rate, it was not effective. As a result of the persistent instability in the foreign exchange market, reflected in the wide divergence of the rates between the official and parallel markets, the CBN adopted a completely deregulated system of foreign exchange trading on March 5, 1993.

Thus, massive devaluation of the naira exchange rate was effected by the government in order to correct the distortions in the market that brought the parallel market premium to as high as

79.2 per cent in February 1992 compared with only 20 per cent in 1990, 35.5 per cent in 1991 and the universally recommended limit of 5.0 per cent and to ensure that the exchange rate reflected economic fundamentals (Figure 2.5). The policy initiative of massive devaluation of the official naira exchange rate yielded desirable results initially as the premium dropped from 79.2 per cent in February 1992 to 7.5 per cent in March 1992 and further to 5 per cent by May 1993. However, the premium resumed its upward trend soon afterwards to reach 68 per cent by the end of 1993 (CBN, 1996). Figure 2.2 shows the growth of exchange rate during the SAP period.

**Figure 2.2: Growth of Official Exchange Rate (1986 - 1993)**




*Source: CBN Statistical Bulletin, Various Issues.*

### 2.2.2 Guided Deregulation/Reform Lethargy Period (1994 -2003)

This is known as reform lethargy period (Balogun, 2007) which was characterised by adjustment fatigue with a lot of policy reversals following the change in government. Thus, this era witnessed the return to policy regulation. The foreign exchange market was segmented into two; that is, the official which accommodated government transactions at a special rate of $1 = N22 and the Parallel where the exchange rate hover around $1 = N80 which accommodated other transactions other than that of the government. This market segmentation laid the foundation for the gross abuse of exchange rate markets which defied any practical solution (Balogun, 2007).

Overall, Nigeria's government took important steps towards the creation of a less distorted and stable economy but the persistent failure of government attempts to restore fiscal and monetary stabilities finally brought about the reversal of the most important aspect of Nigeria's trade liberalisation process, that is the liberalisation of her foreign exchange regime towards the end of 1993. Thus, in 1994, the government returned to the fixed exchange rate system along with the centralisation of foreign exchange in the CBN. Also, the bureaux de change was restricted to buy foreign exchange as agents of the CBN. In addition, the illegality of the informal foreign exchange market was reaffirmed and the Open Accounts and Bills for Collection were suspended as means of payments for imports, except on specific approvals for the manufacturing and agricultural sectors. However, these measures were not able to curb the wide divergence of the naira exchange rates between the official and parallel markets that was astronomically high, reaching 283 per cent by the end of 1994.

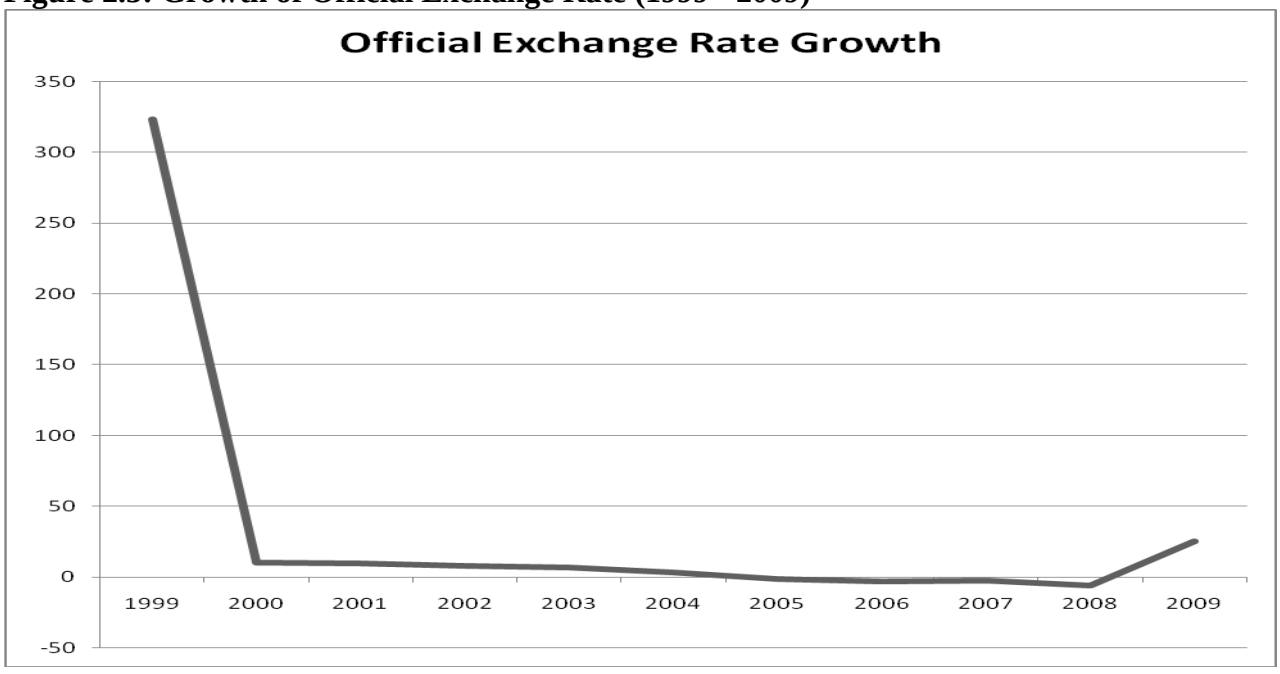
Further, this negative development prompted the government to adopt a guided deregulation of the naira exchange rate in 1995 through the introduction of AFEM. Since then, the AFEM has continued to be the main anchor for orderly deregulation of the foreign exchange market and

achievement of exchange rate stability in Nigeria. Notably, since the liberalisation of the foreign exchange market in 1986 to date, the official exchange rate of the naira to the US$ has consistently depreciated on yearly basis until recently when it appears to be stable.

### 2.2.3 NEEDs Exchange Rate Regime (2004 – 2009)

Figure 2.3 shows that there is instability in the movement of exchange rate from 1999 to 2009 capturing the periods before and during the implementation of NEEDS. This instability could be as a result of unstable macroeconomic policies of the government, especially the monetary policy during the period.

**Figure 2.3: Growth of Official Exchange Rate (1999 - 2009)**



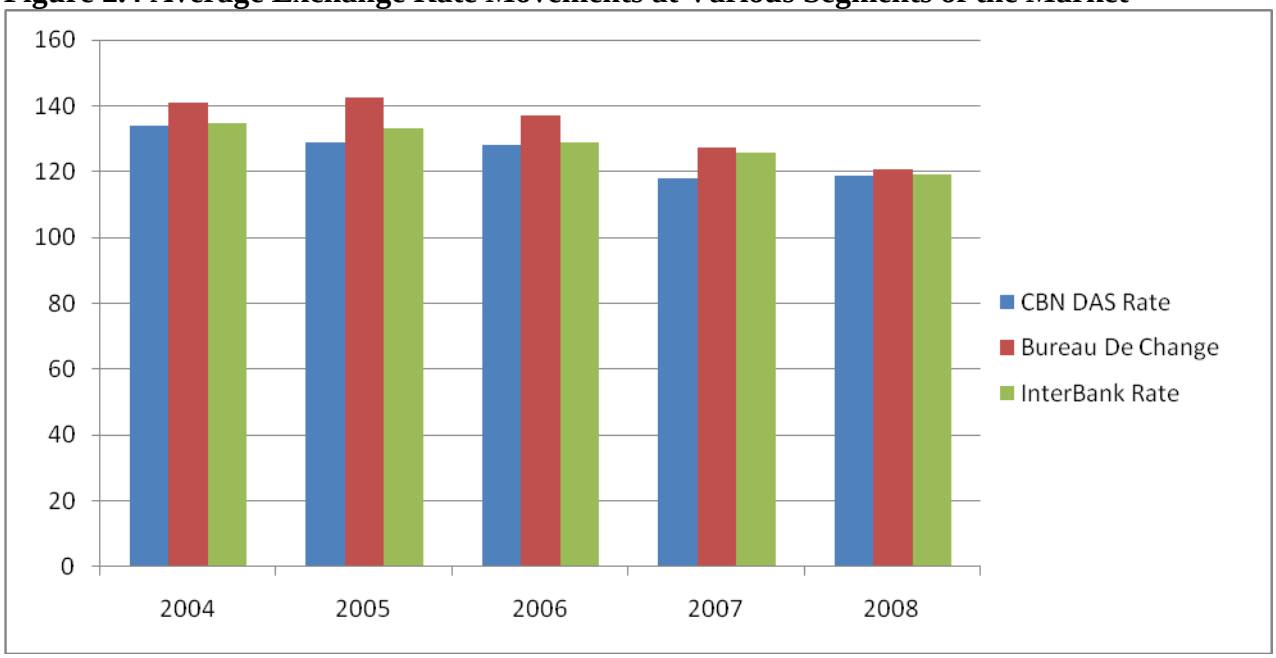

*Source: CBN Statistical Bulletin, Various Issues.*

Frequent and often large devaluation/depreciation of the naira became an issue for concern since the time of SAP whereby exchange rate policy objectives were pursued within the institutional framework of the second-tier foreign exchange market (SFEM). It was then expected that a realistic exchange rate should reduce excessive demand for foreign exchange, especially for the importation

of finished goods and services, as well as eliminate the prevailing distortions in the economy and stimulate non-oil exports. Further, it was envisaged that a realistic exchange rate would accelerate the rate of economic growth through the attraction of foreign capital, investment and discouragement of capital outflow. In addition, the exchange rate management system was to be relied upon to eliminate illegal currency trafficking, smuggling activities and foreign exchange malpractices, if the objective of eliminating bureaucratic and rigid exchange controls could be attained (Ojo, 1990). The ultimate expectation was that all the exchange rate policy and management efforts would lead to an improvement in the balance of payments position and ensure a large degree of convertibility of the naira.

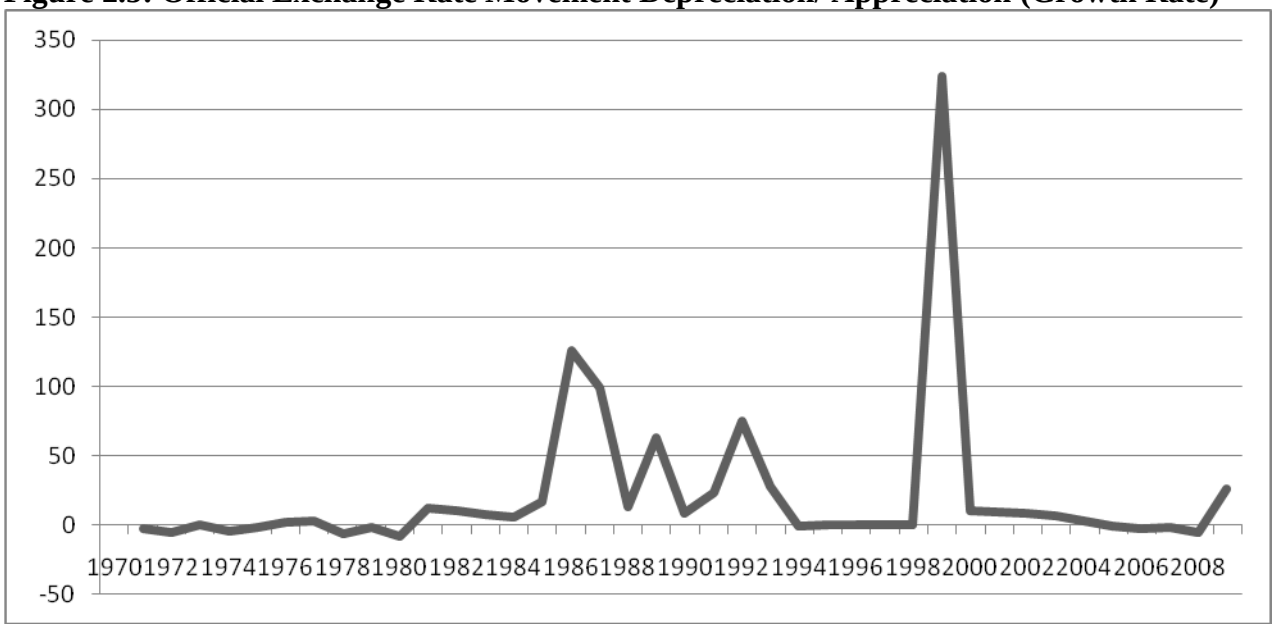
So far, most of the desired exchange rate objectives have not been achieved because the prevailing exchange rate cannot be described as realistic. In essence, it has not reduced excessive demand for foreign exchange; neither has it stimulated non-oil exports. Foreign capital inflow has been below expectation while capital flight has heightened. Yet, the parallel foreign exchange market has not been eliminated. It is waxing stronger and, indeed, it is the driver of the official exchange rate which continues to chase it *ad infinitum*. From 2004 to 2009 when the market-based rate system held sway, the naira exchange rate exhibited the feature of continuous instability, reflecting unidirectional depreciation in both the official and parallel markets for foreign exchange.

**Figure 2.4 Average Exchange Rate Movements at Various Segments of the Market**




*Source: CBN Statistical Bulletin, Various Issues.*

**Figure 2.5: Official Exchange Rate Movement Depreciation/ Appreciation (Growth Rate)**




*Source: CBN Statistical Bulletin, Various Issues.*

Figure 2.4 depicts the movements in exchange rates in the three markets from 2004 to 2008. The figure vividly portrays high degree of instability of the exchange rates in all the three markets –

DAS, Bureau de Change and Parallel Markets. As reflected in Figure 2.5, there appear to be a very high degree of exchange rate instability in both appreciation and depreciation of the naira in both the official and parallel markets. Apparently it should be noted that most of the years experienced high volatility of the naira which could be attributable to poor macroeconomic policy management.

Exchange rate stability has been an issue of concern especially since 1986 when a system of market-determined exchange rates through the SFEM was introduced under the SAP. Prior to 1986, the fixed exchange rate system was operational. Instability in the naira's exchange rate until 2006 was a unidirectional depreciation in all markets. However, for the first time in 2006, the exchange rate was stable with convergence of rates among the various segments of the foreign exchange markets (Official market/IFEM, Bureau de Change and Parallel Markets). In 2008, the Nigeria's naira exchanges for an average of N117/US $1 as against N281.7/US $1 in the parallel market in 1995. This implied that the naira appreciated with respect to the United States dollar (US$); as other comparative major currencies have also depreciated against the naira. Since early 2006, the Wholesale Dutch Auction System (WDAS) was introduced in the stabilisation of the foreign exchange market with successful results.

As stated earlier, in February 2006, the CBN liberalised the foreign exchange market through the WDAS in line with the international best practice. The economic atmosphere was conducive for such liberalisation as stability and convergence of the official and parallel market rates were achieved within a short period of time and sustained up till late 2009. This changed when the global economic crisis started. Oil prices dropped sharply from a peak of $147 per barrel to below $40. Consequently, the naira depreciated consistently from 2008 to date. For instance, the naira depreciated by 24.45 per cent between December, 2007 and March, 2009. Coupled with the increase in naira depreciation is the appetite of Nigerians for imported goods which remained high

and strong. In addition, there was heightened level of speculative activities as the demand was far beyond what the bidders could take.

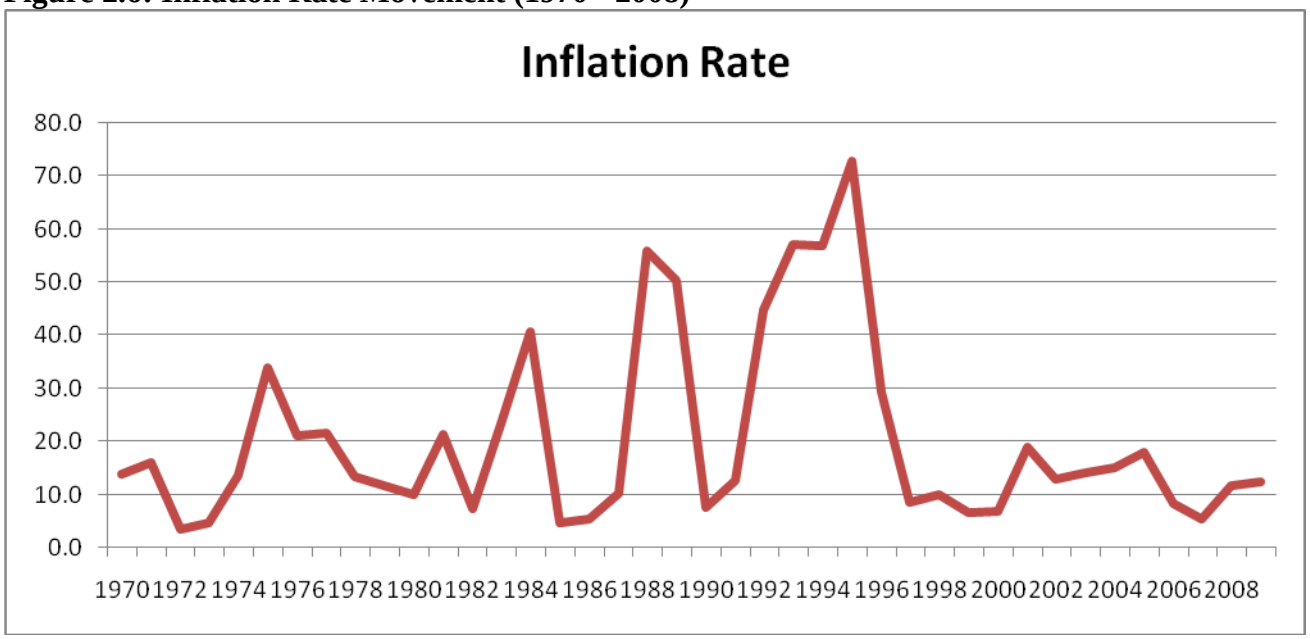
The instability and incessant depreciation of the foreign exchange value of the naira have several implications which have continued to be of great concern. Among these are:

- ✓ decline in people's standard of living, real value of output and assets;
- ✓ increased cost of imported inputs – machinery, spare parts, equipment and raw materials – and hence increased rate of inflation in the economy.
- ✓ planning and projections have become impossible tasks at the micro levels while efficient industries find it difficult to price their products;
- ✓ uncertainties for long-term macroeconomic planning and growth; and

✓ there has been a tendency for the international competitiveness of non-oil exports to be undermined as a result of the inflationary effect of depreciation.

There is virtually no exchange rate system that Nigeria has not tried in order to find the "realistic" exchange value for the naira. Till date, none of these exchange rate systems has proffered a practical solution to provide a realistic and stable exchange rate. According to Ojo (2005), "… the malfunctioning of the foreign exchange market has made the various attempts at determining a realistic naira exchange rate prove elusive". This statement was further elucidated by Balogun (2007) that it has contributed in no small measure to fuelling domestic inflation and poor macroeconomic policy outcomes.

**Figure 2.6: Inflation Rate Movement (1970 - 2008)**




*Source: CBN Statistical Bulletin, Various Issues.*

## *2.3 Profile of Macroeconomic Policy Management in Nigeria*

Macroeconomic policy involves the use of both fiscal and monetary policy instruments to achieve the desired macroeconomic goals in an economy. However, both fiscal and monetary policies of the government have since 1986 put significant pressure on the exchange rate. This was because, during the period under review, government embarked on full expansionary fiscal and monetary policies (Obadan, 2002). It should be noted that in this study, emphasis will be placed on monetary policy since most of the fiscal actions of the government to manage the economy are reflected in monetary outcomes in the economy. Therefore, subsequent analyses will focus on monetary policy management in Nigeria.

The CBN, the highest monetary authority in the country has relied on the monetary targeting policy framework for the conduct of monetary policy under two major monetary regimes. These are the direct control and the indirect control regimes. These two monetary regimes are reviewed in what follows.

### 2.3.1 Direct Monetary Policy Control Regime

The key goal of monetary policy during this monetary regime period was to promote price stability and sustainable economic growth. In the pursuance of these objectives, the monetary authority as at that time imposed a quantitative interest rate and credit ceilings on the money banks deposits and enforced sectoral credit allocation to various sectors of the economy. Generally, the focus then was to allocate credit at a rate below the market lending rate to the real sector of the economy. The preferred sectors include agriculture, manufacturing and construction.

The monetary authority most preferred and used instrument of monetary control was the setting of targets on aggregate credit to the domestic economy and the prescribing of low interest rates (Nnanna, 2002). With these instruments, CBN made an attempt to direct the flow of loanable funds with a view to promoting rapid development through the provision of finance to the so called "growth drivers" sectors of the economy. As at that period, the proactive stance of the monetary policy was justified, especially as the country's financial markets were undeveloped. The credit ceiling on individual banks to the preferred sectors of the economy, fixed at 30 to 40 per cent of banks' aggregate loans and advances in the early 1980s was later reduced to seven per cent in 1985 while the number of sectors was reduced from about 18 in the early 1970s to 4 in 1986.

It should be noted that throughout this period, the level and structure of interest rates were administratively determined by the CBN. Both deposit and lending rates were fixed in order to attain by fiat, the social optimum in resource allocation. These rates were typically below the CBN's minimum rediscount rate (MRR) and were not determined by market forces.

Empirical evidence during the control regime period revealed that the flow of credit positively influenced investment output and domestic price level. For instance, Nnanna (2002) records that between 1972 and 1985, banks' aggregate loans to the productive sector averaged 40.7 per cent of total credit, 8.7 percentage points lower than the stipulated target of 49.4 per cent.

A major factor as recorded by Nnanna (2002) which impaired the effectiveness of monetary policy during the period of the control regime was lack of autonomy instrument by the CBN. During this period, monetary policy was largely dictated by the Ministry of Finance and was influenced by short-term political considerations. The need for autonomy instrument is predicated on the fact that the Central Bank's autonomy has strong positive influence on its monetary management and its ability to achieve its monetary policy objectives (such as price stability, exchange rate stability and sustained economic growth).

The severe economic crisis in the early 1980s forced the government to adopt SAP as a policy option to put the economy back on the path of sustainable growth. The introduction of SAP marked the end of the control regime characterised by exchange rate control, subsidised and regulated interest rate, fixed credit allocations and import licensing. Thus, the introduction of SAP in 1985 ushered in the regime of financial sector reforms characterised by the use of indirect instruments of monetary controls. Figure 2.7 captures the movement of M2/GDP during the period of direct monetary policy control.

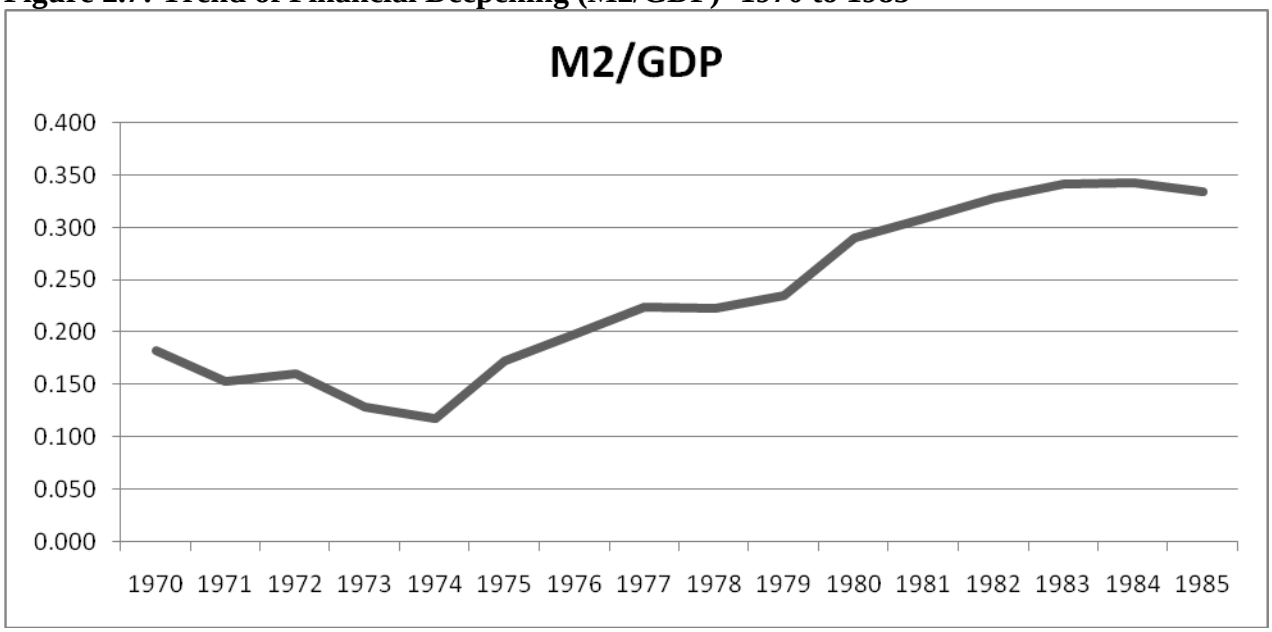
### 2.3.2 Indirect Monetary Policy Control Regime

The objective of monetary policy under SAP was to ensure the mobilisation and efficient allocation of financial savings. The implementation of monetary policy has, however, been such that actual monetary variables deviated significantly from targets and produced excess liquidity in the economy with adverse consequences for the exchange rate (Obadan, 2002). The explosion of money supply growth was significant in 1988, 1990, 1992 and 1994. The Central Bank's credit to government was the main expansionary factor for $M_1$.

In general, the dominance of government either through the monetisation of oil receipts or borrowing from the CBN was a major factor which pushed $M_1$ and M2 growth rate beyond target.

In other words, the significant deviations of actual growths of monetary variables from targets were largely accounted for by over-runs in banking system's credit to government. This results in excess liquidity and pressure on the exchange rate. Excess liquidity has also been identified as a major factor in the depreciation of the exchange rate (Obadan, 2002). Figure 2.8 shows the movement of M2/GDP from 1986 to 1993.

**Figure 2.7: Trend of Financial Deepening (M2/GDP) -1970 to 1985**

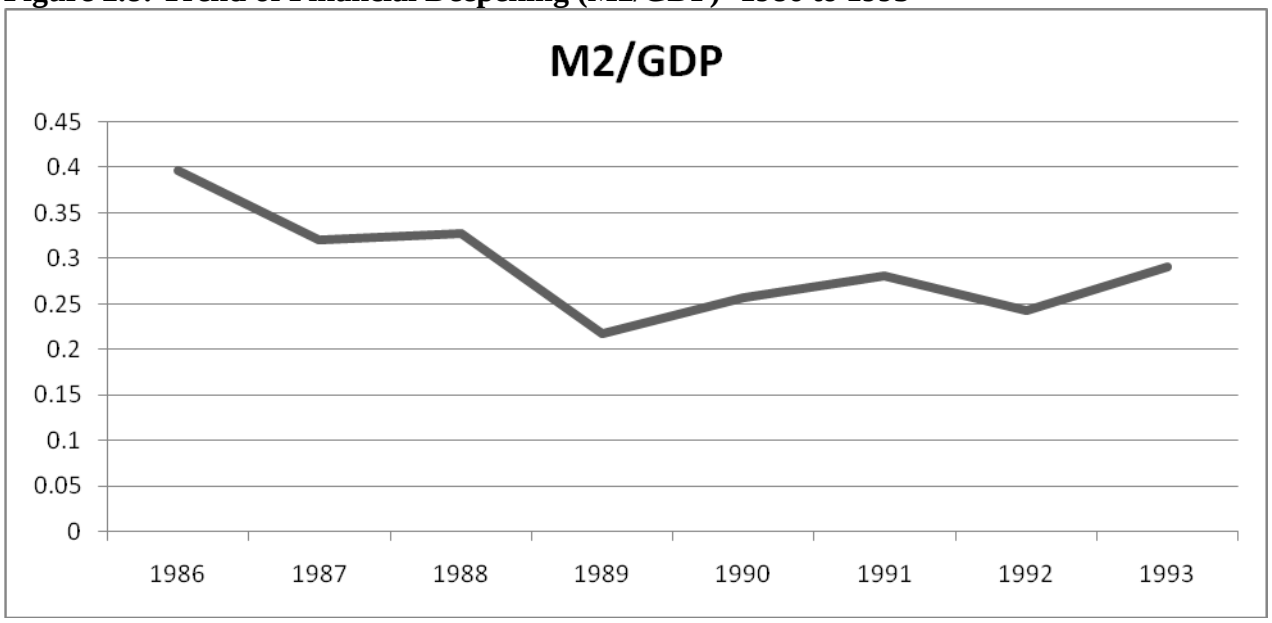



*Source: CBN Statistical Bulletin, Various Issues.*

The problem of monetary instability is linked to the expansion of government's fiscal operations and the resort to deficit financing with the monetary policy accommodating the excesses of fiscal expansion. The SAP document had envisaged a fiscal deficit/GDP ratio of 3.0 per cent during the SAP period in order to enhance the attainment of macroeconomic stability. But the actual ratio realised averaged 10.6 per cent (Obadan, 2002). Since 1986, the fiscal operations of the Federal Government resulted in deficits every year except in 1995 and 1996. The deficits jumped from an average of 3.9 per cent of GDP between 1980 and 1985 to an average of 6.7 per cent from 1986 t0 1999 (Obadan, 2002). As a result of this, there was a need to finance the rising and

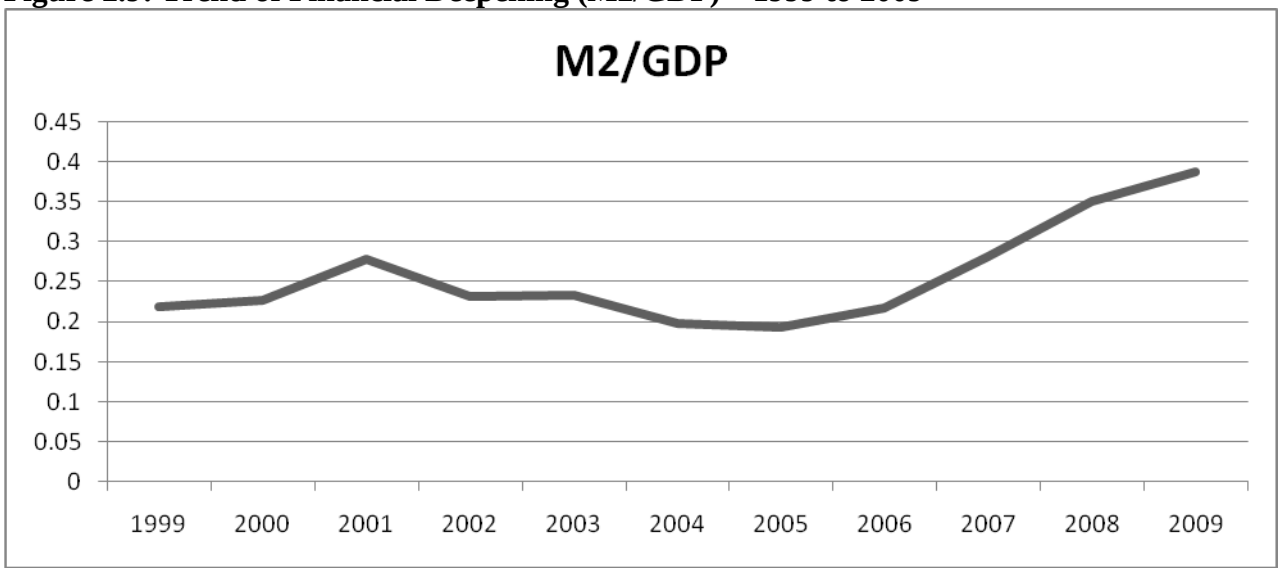
mounting fiscal deficits, and this made monetary policy to become increasingly slack. According to Obadan (2002), the fiscal deficits at this period were financed by credits through ways and means advances from the CBN and these have implications for the movement of exchange rate due to its inflationary consequences.

**Figure 2.8: Trend of Financial Deepening (M2/GDP) -1986 to 1993**




*Source: CBN Statistical Bulletin, Various Issues.*

**Figure 2.9: Trend of Financial Deepening (M2/GDP) – 1999 to 2009**

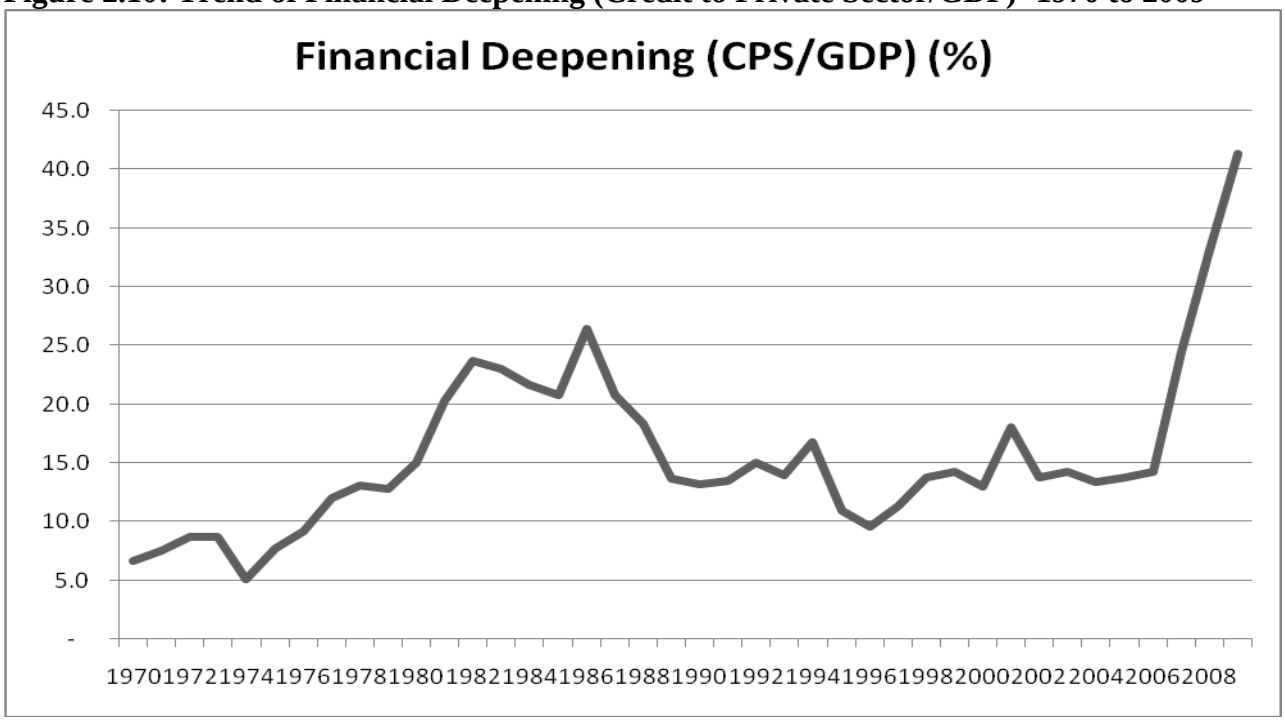



*Source: CBN Statistical Bulletin, Various Issues.*

The degree of financial deepening from 1999 to 2009 is captured in Figure 2.9. It should be noted that the operational framework for the indirect monetary policy management involved the use of market (indirect) instruments such as the open market operations (OMO), to regulate growth in major monetary aggregates. Under this framework, only the operating variable, viz the monetary base, or its components is managed while the market is left to determine the interest rates and credit allocation.

The CBN complements the use of OMO with reserve requirements as well as the MRR. The MRR is used to influence the level and direction of other interest rates in the domestic money market. Thus, its rate of change determines whether the monetary authorities wish to adopt a policy of monetary ease or otherwise.

**Figure 2.10: Trend of Financial Deepening (Credit to Private Sector/GDP) -1970 to 2009**




*Source: CBN Statistical Bulletin, Various Issues.*

To date, other monetary instruments such as the CBN certificate, as well as moral suasion are in use. Overall, CBN's experience with monetary targeting has been characterised by the problem of target overshooting with the actual monetary aggregates exceeding their targets. This has led in most cases to excess liquidity in the economy as captured by the ratio of credit to the private sector to GDP as shown in Figure 2.10. The degree of financial deepening was more intense since 2005 due to series of reforms especially in the financial sector of the economy.

## *2.4 Conclusion*

A review of the Nigerian experience of macroeconomic management (especially monetary policy management) shows that the interventionist policy stance dominated monetary management in the first one and half decades after which an era of liberalisation and deregulation of the financial sector followed. Among the instruments employed during the period included direct credit control and allocations (aggregate and selective), direct interest rates regulations, open market operation, rediscount rate, moral suasion, reserves and supplementary reserves. The shortcomings of direct instruments of monetary policy have been identified.

However, despite the considerable progress made in building the financial infrastructure and use of market – based instruments for the conduct of monetary policy, a more robust policy outcome was largely constrained by a number of factors. These include – the absence of fiscal discipline for a greater part of the period; lack of true central bank independence, frequent policy changes and widespread distress in the financial sector. Therefore, the review of macroeconomic management in Nigeria shows that excessive fiscal expansion, especially of the non-productive type during the liberalisation period, was reflected in the excessive growth of aggregate demand, coupled with an expansionary monetary policy have contributed to macroeconomic instability including the volatility of exchange rate.

# CHAPTER 3

# LITERATURE REVIEW

## *3.1 Introduction*

In this chapter, various theoretical studies on exchange rate and macroeconomic policy as well as empirical literatures were examined and reviewed. These studies were reviewed with a view to gaining insight into pertinent theoretical constructs that have influenced the current state of knowledge in this area. Moreover, previous empirical studies were examined to determine their adequacy and to serve as guide to this study. The chapter is divided into four sections. Section 3.2 that follows this section examines and reviews studies that investigated the impact of macroeconomic policy shocks on the entire economy (Mallick, 2010; Khamfula, 2004; Gauthier et al, 2004; Pericoli and Taboga, 2009; Cagliarini and McKibbin, 2009). Section 3.3 presents studies that examined the relationship between macroeconomic policy and exchange rate (Lewis,1995; Kaminsky and Lewis,1996; Faust and Rogers, 1999; An and Sun, 2008;Yiheyis, 2000; Edward, 1989; Ndung'u,1999; Roca and Priale,1987; Adewuyi, 2003; Ubok-Udom,1999; Adebiyi, 2007; Ajakaiye,1994; Ayodele,1997; Olopoenia,1993; Obadan, 1994; Amin and Amin, 1997; Parikh, 1997; Daniel and Vollrath, 1994; Ogun, 1998; Cottani et al, 1990; Chete, 1995). This was followed by section 3.4 which provides a review of studies on exchange rate volatility and the macroeconomy (Crossby, 2000; Carrera and Vuletin, 2003; Ito et al, 2005; Supaat et al, 2003; Morana, 2007; Benita and Lauterbach, 2007; Iwata and Wu, 2005; Yinusa and Akinlo, 2008; Akpokodje, 2009; Ogunleye, 2009; Aliyu, 2009). It reviews literature that tries to shed light empirically on the effects that macroeconomic policy shocks have on exchange rate. This enables us to identify the gap (s) which this study stands to fill.

## *3.2 Macroeconomic Policy Shocks and the Macroeconomy*

In this section of the literature review, the study tries to review studies on impact of macroeconomic policy shocks on the macroeconomy by considering the various issues addressed by different authors and how the issues were addressed. This helps in identifying macroeconomic variables that go into the model to assist in capturing macroeconomic policy shocks.

For instance, Mallick investigates the role of nominal exchange rate and macroeconomic shocks in influencing monetary policy, long-term interest rate and fiscal policy in a structural vector-autoregressive (SVAR) model of the Indian economy. In other words, the author examines the impact of monetary and fiscal policies shocks on the macroeconomy of the India economy. The author develops a theoretical setting and a model to identify structural shocks along with carrying out variance decomposition of different shocks. As revealed by the study, there is a strong evidence of exchange rate shocks being exogenous, given the regular intervention by the central bank in the foreign exchange market. The findings further reveal that exchange rate, supply and monetary policy shocks influence inflation more than the demand shocks. In order to further validate these results, the study examined monetary and exchange rate shocks within a sign-restriction based VAR to demonstrate the case of exchange rate targeting by restricting it not to appreciate which in part explains the persistent inflation at high single-digit levels in India.

In another study, Khamfula reviews the macroeconomic problems faced by South Africa since it emerged from apartheid era and tries to wrestle with the multiple objectives of reducing poverty, increasing employment, restructuring employment, increasing international trade and increasing the rate of economic growth. The study then briefly looks at the macroeconomic goals and policies introduced in Growth, Employment and Redistribution (GEAR) strategy and how these have been fulfilled. It was noted that macroeconomic policies were incorporated in 1996 by the new government into a strategy to promote GEAR. The major macroeconomic variables considered in

the study include government expenditure, income tax rate, nominal interest rate, inflation target, foreign aid and domestic credit. In terms of methodology, a simultaneous-equation system was applied that includes the following behavioural equations: domestic inflation rate, real income growth, real effective exchange rate, government revenue and net capital inflows.

Statistical methods for systems of simultaneous equations capture the mutual dependence among the variables in the model. In addition, the study investigates the types and channels of shocks that affect long run economic growth by employing the *Johansen technique*. Through this, impulse responses and variance decompositions of the shocks were generated that affect the equations of domestic inflation, foreign inflation, economic growth, exchange rate, money stock, nominal interest rate, income tax rate, government expenditure, government revenue, imports and investment.

The results of the study show that real income growth is positively related to gross domestic savings, changes-in-the-money-stock variable, total mining production and its past values. But the growth in real income is negatively related to imports, total government expenditure, tax, USA interest rate, changes in the USA CPI and changes in the South African nominal interest rate. The study concludes that mainly movements in domestic nominal interest rate, corporate income tax, money stock, domestic savings and imports in South Africa determine economic growth. On the other hand, from the same results of simultaneous-equation system, changes in the real effective exchange rate are negatively related to changes in the money stock and its past values and positively related to changes in the foreign price and domestic nominal interest rate. Therefore, premised on findings from the study, monetary and fiscal policies shocks are not important in determining the long run course of economic growth in South Africa. While net capital inflow shocks have a small positive effect on economic growth, import shocks have a negative one. External shocks do not

affect the long run path of economic growth, as well as fiscal and monetary policies' variables in South Africa.

Gauthier *et al* empirically determine how the dynamics of nominal bond yields are related to domestic macroeconomic fundamentals in a small open economy like Canada. According to the authors, the determinants of long-term nominal interest rates have not yet been fully explained by either economic theory or empirical studies. Since long-term nominal interest rates are the sum of long-term real interest rates and inflation expectations, any macroeconomic factor that impacts expected inflation, real rates or both should affect long-term nominal interest rates. A technical innovation of the study is the identification of structural stochastic trends in a VECM including exogenous variables which addresses the special features of a small open economy. This methodology allows researchers to assess the importance of various disturbances—defined in terms of monetary, fiscal and supply shocks—as sources of movements in nominal bond yields. Moreover, it provides a convenient way to assess the level of nominal interest rates consistent with the fundamentals. The focus on the long run impact has the advantage of filtering out temporary responses of public policies to business-cycle movements. As a result, it is easier to make the distinction between genuine (fiscal and monetary) policy shocks and systematic (business cycle-related) reactions to stabilise economic activities in the short run. Three main results emerge from their empirical analysis. First, the fiscal position has a sizeable effect on interest rates. More specifically, an unexpected permanent fiscal deterioration – defined as a one percentage point increase in the primary deficit-to-GDP ratio - results in a-250 base points increase in long-term nominal interest rates. This impact - higher than what is generally found in existing studies - can be explained by the methodology used here to assess the impact of fiscal policy on interest rates. More precisely, within a VAR framework, the results provide an estimate of the impact of unexpected movements—basically the structural shocks—and not an estimate of the systematic component of

the variables in the model. Further, the structural shocks are defined in terms of permanent shifts. Consequently, such long-lasting movements in fundamentals have a stronger impact on interest rates than temporary movements. Second, additional evidence regarding the importance of monetary shocks in the dynamics of nominal variables was provided by the study, thereby confirming the impact of monetary policy on the inflationary component of nominal interest rates. A one per cent permanent unexpected rise in inflation increases the long-term nominal interest by around 0.6 per cent in the long run. Finally, in the long run, supply shocks were found to have no significant impact on long-term nominal interest rates.

In a similar analysis, Pericoli and Taboga introduce a two-country no-arbitrage term-structure model to analyse the joint dynamics of bond yields, macroeconomic variables and the exchange rate. The model facilitates the understanding of how exogenous shocks with respect to the exchange rate affect the yield curves, how bond yields co-move in different countries and how the exchange rate is influenced by the interactions between macroeconomic variables and time-varying bond risk premia. Estimating the model with US and Germany data, the authors obtain an excellent fit of the yield curves and they are able to account for up to 75 per cent of the variability of the exchange rate. The study findings show that time-varying risk premia play a prominent role in exchange rate fluctuations, due to the fact that a currency tends to appreciate when risk premia on long-term bonds are denominated in that currency rise. A number of other novel empirical findings emerge in the study. The study went ahead to propose a no-arbitrage term-structure model that allows to contemporaneously price bonds in two different countries, taking into account the dynamics of the exchange rate and of observable macroeconomic variables such as inflation and the output gap. In the model, the domestic pricing kernel and the exchange rate are specified exogenously and the foreign pricing kernel is derived endogenously. Impulse response analysis reveals that a currency tends to persistently appreciate when risk premia on long-term bonds

denominated in that currency rise, when investors expect large capital gains on long-term bonds denominated in that currency. The delayed overshooting phenomenon found by many previous studies with reference to short-term policy rates seems to cover expected returns on long-term bonds. Further, differences in bond risk premia between countries drive deviations from uncovered interest rate parity: the higher the divergence between bond risk premia in two countries, the more portable is a carry trade strategy based on such divergence. After controlling for macroeconomic variables, bond risk premia in one country have fairly limited influence on that of another country. Finally, the study also noted that exogenous shocks to the exchange rate have a negligible impact on the yield curves.

Cagliarini and McKibbin, 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. The study considers a stylised representation of three major shocks affecting the global economy during the period from 2002 to 2008. These shocks were: a large rise in the productivity growth of manufactures relative to non-manufacturing sectors in developing economies; a fall in global risk premia; and the relatively easy monetary policy stance of the Federal Reserve Bank (FRB) starting after the bursting of the dot-com bubble in 2001 and lasting up until the early part of 2006. The three shocks are considered in a global model that captures the interdependencies between economies at macroeconomic and sectoral levels. There are a number of insights that suggest a need for further empirical analysis as stated in the study. The first is that the shift in relative prices observed since 2002 can be partly explained by the adjustment in the model in response to the assumed shocks, however, the scale of the actual rise in the prices of energy, mining and agriculture relative to manufacturing since 2004 are not well-captured. Other factors outside the fundamentals in the model are needed to explain the scale of this more recent experience. The second insight is that the model suggests that there were

some contributions to global inflation due to the FRB keeping interest rates low after the bursting of the dot-com bubble in 2001 and the effect was reinforced by the fact that the Chinese and other monetary authorities pegged their currencies to US dollar. However, the effect on global relative prices of US monetary policy is relatively small compared to the productivity shocks in developing economies. According to the study, one interpretation of these results is that the short-term deflationary impact of developing economy productivity growth on the US economy was to a large extent neutralised in the United States by the change in FRB policy as modelled in the study. An interesting conclusion of the simulations exercise carried out in 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.

### *3.3 Macroeconomic Policy and the Exchange rate Fluctuation*

Interrelationship between monetary policy and exchange rate behaviour has long been the 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 on developing countries (Lewis, 1995; Kaminsky and Lewis, 1996; Faust and Rogers, 1999; and An and Sun, 2008).

An and Sun analyse 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 anchor their study on the "signalling" 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. By developing a structural vector autoregression (SVAR) model with non-recursive contemporaneous restrictions, the authors identify monetary policy, foreign exchange intervention and exchange rate shocks. The model is applied to Japan from 1991:01 to 2004:07. The analysis starts from a set of sensible identifying assumptions which are consistent with Japan's economic structure. The resulting predictions from the model support the identifying assumptions in that the estimated dynamic responses are close to the expected movements of macroeconomic variables. The empirical analysis of the relationship between macroeconomic policy and exchange rate movement in Japan produces several results. First, the findings of the study lend support to the "leaning-against-the –wind" hypothesis and "signalling" hypothesis, but the evidence for the "signalling" 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.

Yiheyis (2000) examines the fiscal consequences of exchange rate adjustment, drawing on the experiences of selected African countries. The salient channels through which the exchange rate is expected to influence fiscal variables were examined. The author rests his study on the salient channels through which the exchange rate is expected to influence fiscal variables (that is, revenue and expenditure). The fiscal effects of devaluation were shown to depend, *inter alia,* on the size of the real devaluation, the share of traded goods in government and aggregate expenditure and on the output effect of devaluation. An econometric model was explored to show the relationships between exchange rate and the two fiscal variables (revenue and expenditure). A three-equation model which

endogenises the three variables is specified. Findings of the study among other things indicate that the fiscal effects of devaluation depend on the size of the real devaluation, the share of traded goods in government and aggregate expenditure and on the output effect of devaluation.

Edward (1989) provides more systemic evidence on the links among the fiscal variables, the trade variables and the RER, by testing the behavioural relations for these variables for the sample countries using Rodriguez's model. Econometric estimates from the study were derived for the sensitivity of the trade balance and the RER to various fiscal variables. To provide a more systemic evidence on the links among the fiscal variables, the trade variables and the RER, the author applies an ordinary least square method to test behavioural relations for these variables for the sampled countries. The analysis shows a split results for the sampled countries: higher government spending leads to an appreciation of the RER for Argentina, Cote d'Ivoire, Morocco and Zimbabwe and to depreciation for Chile, Colombia and Mexico. These empirical results from various studies support the notion that the RER is sensitive to both policy and external variables, with the fiscal variables being prominent. It is also considered necessary to test this hypothesis. Therefore, to our knowledge, little or few studies have examined macroeconomic effects of exchange rate adjustment within a comprehensive framework which provides additional justification for this study.

Ndung'u (1999) assesses whether the exchange rate in Kenya is affected by monetary policy and if the 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 policymakers, 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) to fit the chosen exchange rate policy. The study is premised on a simple analytical framework of the role of exchange rate in stabilisation and adjustment process. As stated in the study, the RER, being a measure of international

competitiveness, has become a policy target and in most exchange rate regime changes, aimed at to maintain a stable and competitive real exchange rate. The author decomposes the RER into cyclical and permanent components. Causality tests are performed between several measures of monetary shocks (consistent with other empirical works) and the cyclical component of the RER. The cyclical components of the RER together with a measure of monetary shock is meant to determine whether the monetary authorities contribute to short run fluctuations in the RER through the money market.

The results from Ndung'u 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 RER 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. In an earlier study by Roca and Priale (1987) on the effects of both fiscal and monetary policies on exchange rate behaviour in Peru, it was noted that both fiscal and monetary policies had adverse effects on the movement of exchange rate in Peru during the period of economic deregulation. According to the study, stabilisation programmes, of which devaluation of exchange rate is a part, have led to a greater fiscal deficit as a percentage of GDP.

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 Adebiyi (2007) which investigates the impact of foreign exchange intervention in the Nigerian foreign exchange market. It does not explore the relationship between monetary policy shocks and the movement of exchange rate. The study only determines whether foreign exchange intervention is sterilised or not.

Adewuyi (2003) examines only the dynamics of trade and exchange rate policies and their impacts on macroeconomic adjustments and economic performance in Nigeria. He applies both probity regression analysis and the ordinary least square estimation technique to show how trade policy reforms and devaluation or variations of exchange rate are complementary policies to balance of payments adjustment. The empirical results from the study show that there exist some relationships between trade policy and exchange rate policy dynamics. Thus, it was found that trade policy changes induce exchange rate policy adjustments. Further, the results of the study reveal that trade policy changes is neither influenced by changes in exchange rate policy, import growth nor current account positions.

In a related study, Ubok-Udom (1999) analyses the relationship between annual growth rates of total GDP, non-oil GDP and exchange-rate variations from 1991 to 1995. The findings 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) evaluates Nigeria's experience with exchange rate depreciation since 1985 particularly in relation to the objective of achieving external balance.

Ajakaiye (1994) measures changes in sectoral producer prices induced by exchange rate depreciation between 1986 and 1989 using an input - output price model with 1985 as the base year. The model applied focuses mainly on the various production channels through which exchange rate

depreciation can affect sectoral prices. However, due to data problem, the study was unable to evaluate the effects of exchange rate depreciation on sectoral prices through the three main channels identified; viz; imported intermediate input, imported labour; and imported financial capital.

Olopoenia (1993) explores a number of policy issues related to the RER in Nigeria. The issues addressed are: the extent to which observed movement in the country's RER represent deviations from its equilibrium level; what have been the influence of monetary variables and macroeconomic instability on the actual RER in Nigeria's experience?; and what has been the effect of nominal exchange rate changes on the trend of observed RER movement? In this context, models based on trade theory are employed to investigate the effect of terms of trade (TOT) and trade policies on the movement of RER. The model provides the time path for the RER as a function of its fundamentals, the terms of trade, trade policy regime, international capital flows (i.e. external borrowing and lending), fiscal policy as reflected in the allocation of government expenditure between periods as well as between tradeable and non-tradeable as well as non-tradeable and technological progress. However, unlike Cottani *et al* (1990), Olopoenia classifies the fundamental determinants of RER external and internal components. In the former are the international terms of trade and foreign capital flows. The latter are those which are "policy-related" such as the trade, foreign exchange and capital controls as well as the composition of government expenditure. The most important non-policy related domestic fundamental is technological progress.

The explicit theoretical linkages between technical progress (productivity growth) and the RER were first provided in the context of Purchasing Power Parity (PPP) definition of RER. According to the study, apart from the fundamental determinants, the macroeconomic environment can impact considerably on the movement of the RER. The theoretical discussion of RER dynamic presented by Olopoenia, suggests that a vector of variables determines the observed movements in

the RER. Some of these are expected to have long run influence on the RER and thus, are critical in dictating its path. Others have only transient effects on its observed movement.

Olopoenia adopts a model that is similar to that of Cottani *et al* and since Olopoenia (op. cit) unlike Cottani *et al* (1990) proposes using error correction mechanism as additional estimation technique for estimation of the model, the first step in his approach was the specification of a long run equilibrium RER model. The findings from the study indicate that real GDP growth rate has had the effect of depreciating the real exchange rate (RER). This result is at variance with the theoretical expectation. Also, the evidence from the estimation results of Cottani *et al* (1990), suggests that monetary and nominal exchange rate policies have important influences on the dynamics of observed RER in the Nigerian context. The influences of these two variables tend to dominate those of the RER determinants.

Related to Olopoenia is Obadan (1994), who examines the determinants of RERs, particularly, the roles of structural and monetary policy disturbances, the relationship of the RER with its fundamental determinants. This study unlike Olopoenia, investigates the effects of trade balance on RER. Obadan provides theoretical argument for linking the RER with its determinants and thus, distinguishes between structural factors and short run factors affecting RERs. The study argues that in an open economy that allows foreign capital inflows and does not use quantitative restrictions, structural or fundamental factors determine the RER over the medium and long terms. Such factors include international terms of trade, net flow of capital and trade policy. The study avers that, another factor that may also be important is technical progress. On the other hand, certain factors may alter the path of the RER in the short run independent of the directions dictated by the underlying structural factors. Such factors relate mainly to macroeconomic policy variables and other policy variables such as fiscal and monetary policies actions.

Obadan opines that the nominal exchange rate may also cause short run fluctuations in the RER. In this regard, the RER prevailing at any point in time is determined by both structural and short run factors. The study points to the fact that macroeconomic policies cause short run variations in the RER which tend to be temporary. For instance, the study argues that under a fixed exchange rate regime, expansionary monetary policy results in strong upward pressure on domestic prices, leading to temporary real appreciation. In the same way, a loose fiscal policy is reflected in excessive expansion of domestic credit. To this end, any monetary impact associated with an inconsistent set of macroeconomic policies will be short-termed because there will be an incipient pressure on the prevailing exchange rate.

In addition, the study is the only study among the studies reviewed that estimates a simultaneous equation model. The study estimates two different models using time series data, covering the periods of 1970 to 1988 and 1970 to 1990. The first model which covers the period of 1970 to 1988 being a simultaneous equation model was estimated using two stage least square estimation techniques while the second single equation model was estimated by the ordinary least square method for the period, 1970 to 1990. Two definitions of RER were used. REE was defined as the real effective exchange rate index (1980 = 100) computed with total trade weight and arithmetical average formula. BRE which is the alternative definitions is the bilateral RER index (1985 = 100) computed using the reciprocal nominal exchange rate concept of dollars per unit of naira. Balance of trade (BOT) was defined as the ratio of balance of trade to GDP in percentages.

Similarly, NCF is the ratio of net private capital inflow of GDP in percentages (NCP). It was alternatively defined as the ratio of the balance of payments on capital account to GDP in percentage (NCB). TOT is the international terms of trade index (1987 = 100). Two measures of the influence of import and export taxes were used, XMR and IXP while XMR was defined as the ratio of import duties plus export duties to GDP in percentages; IXP refers to the ratio of import

duty to export duty. The variables MSP and GFD represent the growth of money supply (per cent) and deficit - GDP ratio respectively. And, real money balance (RMB) is money supply ($M_1$) deflated by the CPI.

Obadan finds that two variables consistently performed very well in terms of expected signs and highly statistical significant. These are the external terms of trade (TOT) and nominal exchange rate (NER) variables. The results thus show that these two variables are the most important determinants of RER. Therefore, improvements/deteriorations in the TOT led to appreciations/depreciations of RER. In the same way, appreciations/depreciations of NER led to appreciations/depreciations of the RER.

The results show that the effect of money supply growth has been to depreciate the RER. This might not be unconnected with the fact that for most of the period covered, the percentage rate growth of money supply was higher than the rate of inflation, thus resulting in positive growth of the real money balance. The results further show that expansionary fiscal policy has similar effect to those of monetary policy on RER in Nigeria. These macroeconomic policies thus tended to be consistent with the objective of achieving real depreciations of the exchange rate under the structural adjustment programme (SAP), in order to enhance international competitiveness. The empirical results further show that net private capital inflow (NCP) had a depreciating effect on the RER. The variables, XMR and IXP, representing trade policies reveal that the effect of eliminating and/or reducing export and import duties is for the RER to appreciate. This result conforms with the *a priori* expectations that import duty elimination will appreciate the RER while export duty elimination appreciates it.

Obadan's second model which adapts the random walk hypothesis, was estimated by the OLS regression method, for the period 1970 to 1990. The result thus rejects the unit efficient and random walk hypothesis. It was found that, a consideration of the other explanatory variables

shows that sectoral factors and, to some extent, short run factors are the important determinants of changes in the RERs. The result further indicates that improvement in the TOT appreciates the RER while deterioration depreciates it. These confirm the results of first model introduced by the study. Moreover, as in the analysis of the result of the first model with respect to monetary policy variable; increases in the RMB led to depreciation in the RER. This result also conforms with the *a priori* expectation. Overall, the empirical results show that the RER rate equation is not a random walk. Rather, the prevailing RERs in Nigeria are influenced by structural factors such as terms of trade and net capital inflow and short run policy variables, particularly monetary policy. These findings are in line with other authors results (Olopoenia, Amin *et al* and Parikh (1997).

Daniel *et al* (1994) examine measures of RER using a structural modelling approach. The issues addressed in this study are closely related to the one addressed by Cotanni *et al*. Amin, *et al*, analyse the determinants of RER for Cameroon, Congo and Gabon. Since the RER is an indispensable variable for macroeconomic and sectoral performance, it was considered crucial to understand the RER in the short and long run, so as to better manage the RER and restore the economy to a path of rapid growth and sustained development. Therefore, the issues of concern in this study are related to that of Olopoenia, Obadan, Cottani, *et al* and Daniel, *et al*. Daniel *et al* based their study on the same theory of RER like that of Olopoenia, Cottani *et al* and Obadan. Despite the fact that their theoretical basis is alike, Daniel *et al* identify other economic fundamentals such as tariff, fiscal debts and credit rationing.

With respect to the definition of RER, Amin *et al* definition of RER is in line with that of Daniel *et al*. Amin *et al* define RER as the relative price of tradable to non-tradables in an economy and it measures the cost of domestically produced tradable goods. Thus, it determines the degree of competitiveness of the economy and its external performance. Also, capital flows in the form of external borrowing, grants and foreign aids also affect the RER. So, an increase in capital flows

causes the RER to appreciate since it increases the price of non-tradeable more than that of tradeables which are determined in the world market. Capital inflows may have a limited impact if they are directly tied to imports such that resources do not spill over into increased demand for non-tradeables. Further, the trade policy of a country also determines the RER. This depends on the degree of openness of the economy. However, in many developing countries, in order to correct for current account deficit there are numerous restrictions in the form of quotas, tariff and exchange controls. Trade liberalisation that reduces these restrictions often leads to RER depreciation since price of imports will fall in line with reduction of tariffs. Also, this increases competition and put downwards pressure on the price of non-tradeables relative to tradeables. Further, Daniel *et al* like Cottani *et al*, Olopoenia and Obadan , used ordinary least square to estimate the model using pooled cross-sectoral time series data including country-specific dummy variables; using a fixed-effect procedure for the following developing countries: Argentina, Brazil, Chile, Ivory Coast, Egypt, India, Indonesia, Kenya, Nigeria and Venezuela. Time series data from 1971 to 1988 were used in the estimation and were sourced from World Bank and the International Monetary Fund.

Daniel *et al* found the coefficient for technical progress to be positive but not statistically significant. A positive relationship was anticipated between technical progress and the RER on the basis of Balassa and Kravis as well as Heston and Summers differential technological progress hypothesis. According to their views, productivity gains are thought to occur more rapidly in the traded than in the non-traded good sector. Consequently, economic growth is associated with increases in the relative prices of non-tradables, that is, RER will appreciate when thee is technological progress or productivity gains. The coefficient of TOT was positive and significant, verifying theoretical expectations that a rise in the terms of trade leads to appreciation of RER.

A positive sign was anticipated and obtained for capital inflows. Therefore, an exogenous inflow of capital appreciates the RER. A negative sign was obtained for investment/GDP ratio but,

the way in which investment/GDP ratio affects the RER will depend on the composition of investment expenditures between tradeables and non-tradables. They anticipated a positive relationship between government consumption and appreciation of the RER because most government expenditures in contrast to household expenditures are made for non-tradeables. Consequently, both the price of non-tradeables and the foreign exchange price of the domestic currency was thought to increase with government expenditures. In addition, DCRE is found to be both positive and significant. Also, the devaluation variable (NOMDEV) is negative and significant as expected. The difference between the black market and official exchange rate was found to be negative and significant. These results are similar to that of other authors (Olopoenia; Amin *et al* and Parikh) in the sense that it confirms the theoretical expectations.

Another related methodology to that of Olopoenia was that of Amin *et al*, they use cointegration and error correction specification which allow them to capture the equilibrium relationship between non-stationary series as well as incorporating the short and long run information into the model. This helps to avoid the loss of information resulting from differencing non-stationary series. In addition, Olopoenia and Amin *et al* opine that the effect of technological progress on the RER could also be ambiguous, because when technological progress leads to increase in productivity in the tradable sector, price of tradeable sector falls in relationship to non-tradeables and an increase in the supply of tradeable goods leads to real appreciation of RER. On the other hand, technological progress may also increase the demand for non-tradeables through a real income effect. Government expenditure also affects the RER. If the government expenditure is mostly on tradeable sector, the RER will depreciate but if it consists mostly of non-tradable goods the RER will appreciate.

The two studies point out that, the starting point for RER analysis is to define RER as the relative price of tradables to non-tradables. This is for sustainable values of other variables such as

taxes, international TOT, trade policies, capital flows and technology, resulting in the simultaneous attainment of internal and external equilibria. Internal equilibrium is said to hold when present and future current balances are compatible with long run sustainable capital flows. According to the definition, the RER is a function of not only the present movement in fundamental determinants but also in anticipation of the future evolution of the variables. The RER therefore experiences movements in response to exogenous and policy induced shifts in its real fundamentals. Amin *et al* like other authors (Olopoenia; Obadan; and Daniel et al) identify TOT, external capital flows, trade policies, technological progress, capital controls and government expenditure as fundamental determinants of RER. It was made to believe that impact of changes in TOT on the RER could be ambiguous, because the changes in TOT depend on the sources of the change. If the income effects dominate the substitution effect, a rise in TOT depends on the sources of the terms of trade change. If the income effects dominate the substitution effect, a rise in TOT will lead to RER appreciation and vice versa. The empirical results of Amin *et al* reveal that the TOT tends to appreciate RER for the three countries (Cameroon, Congo and Gabon) in line with results obtained by other studies (Olopoenia; Amin *et al*; Obadan; and Parikh). On openness, the results show that an improvement in trade openness depreciates RER in Cameroon but appreciates it in Congo and Gabon.

The sign for government consumption is positive for Congo and negative for Cameroon and Gabon. In Congo where the sign is positive, it connotes that government consumption has depreciating effects on the RER. While the negative sign in Cameroon suggests that government consumption would induce appreciation of RER. The results also show that increases in gross domestic investment would induce depreciation in the RER. This finding is relevant to Cameroon and Gabon but in Congo there is a tendency for the appreciation of RER as gross domestic investment increases. The effect of money supply increases on RER suggests a positive effect in

equations specified for Cameroon and negative effects for Congo and Gabon. The positive effects reflect depreciation of RER and negative effects suggest appreciation of RER.

Also, Parikh examines the movement of RER in South African economy. This was done on the basis of short and long run behaviour of the RER of South African economy. In another development, Parikh based on the hypothesis of PPP approach is believed to be associated with RER movement. Therefore, his definition of RER is nothing but deviations from PPP. Parikh opines that, there are several counter arguments to the PPP hypothesis; some suggest that economic forces caused large and prolonged fluctuations in RERs over time. Other counter arguments point to economic forces that generate changes in the relative price of tradeable and non-tradeable goods, and, thus in RERs over the long run. It was noted that the validity of the long run PPP hypothesis might depend on whether it is taken to apply to the price levels of tradable goods alone or to general price levels for tradable and non-tradable together. Further, Parikh (1997), examines the short and long run movement of RER with two methodologies. The long run movement was explained using a structural approach and the short run movement is captured using a time series modelling strategy (a cointegration methodology). It was however, believed that, in the long run analysis, real factors will influence RER while in the short run monetary and other factors can also have influence.

Parikh empirical results suggest that an increase in gold prices or an improvement in the TOT or an improvement in productivity in South Africa or an increase in transport costs induces an appreciation of RER. Parikh, thus argues that, in South Africa context, long run exchange rates are determined by increase in transport cost, growth in productivity, increase in gold prices and improvement in TOT while in the short run, the terms of trade do not have any significant influence on RER when monetary factors are accounted for.

Ogun (1998) based on the theory propounded by scholars such as DeGrauwe (1988); Edwards (1987); Caballero and Corbo (1989); Ghura and Grennes (1992); and Savvides (1992) as

discussed earlier. Ogun like (Olopoenia; Amin *et al*; and Parikh) examines the time series properties of the data by conducting tests for stationarity and cointegration. The test for stationarity is designed to examine the order of integration of the variables while that for cointegration is to check for the existence of cointegrating relationship between non-stationary explanatory variables and the dependent variables. If cointegration is established, the relationship between the independent and the dependent variables will be most efficiently represented by an error-correction model. According to Ogun, the error-correction specification will not only facilitate the analysis of the short run impacts on the dependent variable but will also suggest the speed of adjustments to long run equilibrium. In addition, it will permit an equilibrium interpretation of the estimates.

The tests for stationarity and cointegration are conducted according to three tests, the Sargan-Bhargara Durbin-Watson (SBDW), the Dickey Fuller (DF) and Augmented Dickey Fuller (ADF). In the case of cointegration, the tests were conducted on the residuals from the cointegration regression. The findings from the study indicate that, restrictive trade practices produce a significantly appreciating effect on RER, confirming that sustaining a liberalisation process requires frequent exchange rate depreciation. Further, the coefficient of the real income variable appears to suggest that productivity improvement or technological progress are faster in the non-tradable goods sector of the country (Nigeria) thereby causing its RER to depreciate. The study avers that, the most potent determinants of short run movement in RER in the country are the nominal exchange rate, excess domestic credit and net capital inflow. However, nominal exchange rate devaluation appears to bear a relatively greater influence on RER.

Cottani *et al*, study is based on the theory of real exchange rate (RER) determinants propounded by Edwards who distinguishes between external and domestic RER determinants. According to them, policy affects RER through changes in the domestic price level, the nominal exchange rate or both. Therefore, the theory singled out the following fundamental determinants of

equilibrium RERs, vis, international TOT; international transfers or aids; trade policies; exchange and capital controls; the composition of government expenditure; and technological progress. Moreover, the authors estimate the relationship between the RER and its determinants, using a single equation model. The empirical results of the study are of interest for various reasons. First, the signs of the estimated coefficients are mostly according to theoretical expectations. In instances where this is not the case, the estimates with incorrect signs are insignificant even though a large number of observations were available for the estimations. This is especially true for coefficients that are related to the TOT and capital inflow variables. Second, it was found that, RERs in high-export and high-growth countries are more responsive to changes in the TOT than in low-export, low-growth countries. They opine that, this result may be deemed to be in line with Balassa and McCarthy's finding that export-oriented economies have adjusted more effectively to external shocks than closed economies, since coefficient of TOT can be interpreted as an indicator of macroeconomic adjustment (real depreciation) in response to adverse terms of trade. The estimation results make it possible for the authors to distinguish among several sources of RER variations. Two of these sources, foreign TOT and differential productivity changes accounting for the residual trend, are exogenous non-policy variables. The remaining three, excess domestic credit creation; net capital inflow; and income over trade ratio are affected by domestic policies in a way that may create "policy-induced misalignment".

Adebiyi basically applies the theory of intervention with more emphasis on the sterilised intervention hypothesis to determine whether foreign exchange intervention has effect on exchange rate in Nigeria. The overall finding from the study is that foreign exchange intervention in Nigeria is sterilised because the cumulative aid which constitute part of foreign exchange inflows and net foreign assets variables which are proxies for intervention, are found not to be significant. Thus, the

study concludes by recommending among others, the use of external reserves stock to support the exchange rate through increased funding of the foreign exchange market.

Chete in an attempt to evaluate Nigeria's experience with exchange rate depreciation applies a monetary approach to the theory of balance of payments. The study makes a tentative point that the envisaged salutary gains from exchange rate depreciation at that time are yet to materialise. Although, some surpluses were made especially in the trade account for some years but these surpluses have not translated into a consistent improvement in the balance of payments. The methodological approach adopted in an attempt to evaluate Nigeria's experience with exchange rate depreciation in the study involves the process of generating elasticities. These were generated by specifying two models - the trade flow and the reserve flow.

Related to Chete's approach is the theoretical basis explored by Ajakaiye (1994) to show the role of exchange rate in the determination of the sectoral prices of goods and services in Nigeria. Adebiyi employs an econometric framework involving the conduct of cointegration tests. The tests are based on the maximum likelihood procedure and provide a unified framework for testing of cointegrating relations in the context of vector autoregressive (VAR) error correction models. Quarterly time series data spanning 1986:1 to 2003:4 are used and a number of statistical tools are employed to test the study hypothesis. In order to avoid the problems associated with Johansen tests of cointegration, he employs the OLS based autoregressive distributed lag (ARDL) approach to cointegration, a more popular approach.

## *3.4 Exchange Rate Volatility and the Macroeconomy*

Despite the saturation of the literature with studies on exchange rate volatility and the macroeconomy, the literature is still scanty with respect to developing countries. The few studies are panel data in nature and have traced the effects of macroeconomic shocks on exchange rate

volatility. For instance, Crossby (2000) presents evidence on whether Hong Kong's currency board management, put in place since 1983, has affected the volatility of real macroeconomic variables. Simple evidence on the relative volatilities of relevant macroeconomic variables, pre and post, 1983 was presented, before a more formal econometric framework was utilised to examine the linkages between the exchange rate and the real economy. It was found that the currency board period had been one of relative stabilise era in Hong Kong, though it had also been a period where external factors had been relatively benign. Even after controlling for the external environment, the study notes that the currency board period was one of low macroeconomic volatility.

In a related study, Carrera and Vuletin (2003) seek to analyse the relationship between exchange rate regimes and short-term volatility of the effective RER. The study sets out the relative importance of these links, specifically by analysing the exchange rate regime influence on RER volatility using a dynamic panel data analysis. For this, a sample of 92 countries for the 1980 to 1999 period was considered. The study finds evidence on how other variables influence RER volatility and it also analyses the persistence of shocks in RER. The study further finds more evidence of more openness, acceleration in per capita GDP growth, reduction in volatility. Conversely, positive monetary shocks and growth in capital inflows and in public expenditure increase real volatility. Evidence from the study also support the view that the analysis of the dynamics of the exchange rate regimes needs to be differentiated between developed and developing countries.

Ito (2005) examines the pass-through effects of exchange rate changes on the domestic prices among the East Asian countries using the conventional pass-through equation and a VAR analysis. First, dynamics of pass-through from the exchange rate to import and consumer prices was analysed using the conventional model of pass-through based on the micro-foundations of the exporters' pricing behaviour. Both the short run and long run elasticities of the exchange rate pass-

through are estimated. Second, a VAR technique was applied to the pass-through analysis. A Choleski decomposition was used to identify structural shocks and to examine the pass-through of each shock to domestic price inflation by the impulse response function and variance decomposition analysis. The conventional and VAR analyses show that while the degree of exchange rate pass-through to import prices is quite high in the crisis-hit countries, the pass-through to CPI is generally low, with a notable exception of Indonesia. The VAR analysis shows that the size of the pass-through of monetary shocks is even larger in Indonesia. Thus, it was Indonesia's accommodative monetary policy as well as the high degree of CPI responsiveness to exchange rates that contributed to high domestic price inflation, resulting in the loss of its export competitiveness, even when the currency depreciated sharply in nominal terms in 1997 to 1998.

In a similar study, Supaat *et al* (2003) examines the characteristics of the Singapore dollar nominal effective exchange rate (SGD NEER) since 1980s and investigate whether the short-term movements in the currency has affected key real macroeconomic variables in the economy. The analysis of the study which utilises a GARCH framework shows an increase in the volatility of real macroeconomic variables. The authors adopted a flexible-price monetary model to assess the impact of the increase in exchange rate volatility on real macroeconomic variables. The analysis found little evidence of a relationship between exchange rate volatility and that of a number of key macroeconomic variables. In addition, the study also specifically assesses the effects of exchange rate volatility on bilateral trade flows using a standard "gravity" model as well as a multivariate error correction model and noted that the impact to be relatively small. The results of the analysis provide some support to the argument that volatility in the foreign exchange market may not be transferred to other parts of the economy.

Morana (2007) investigates whether there is a short- to medium-term linkage between macroeconomic and exchange rate volatility or not. The study provides a clear-cut framework by

pointing to the significant linkages and trade-offs between macroeconomic and exchange rate volatility, particularly involving output volatility. Evidence of bidirectional causality was also found, with macroeconomic volatility showing a stronger causal power than exchange rate volatility. According to the study, many tasks in finance, such as option pricing, risk analysis and portfolio allocation, rely on the availability of good forecasting models. The study also points to new directions for the construction of improved medium-term volatility models.

Benita and Lauterbach (2007), study the daily volatility of the exchange rate between the U.S. Dollar and 43 other currencies in 1990 to 2001. The study uses several macroeconomic variables that proxy for the domestic economy uncertainty, wealth and openness to international markets, as controls in the analysis. The well-known GARCH statistical behaviour of exchange-rate volatility was also accounted for. The main finding of the study was that exchange rate volatility was positively correlated with the real domestic interest rate and with the degree of central bank intervention. In the panel, the study finds *positive* correlations between exchange rate volatility, real interest rates and the intensity of central bank intervention. These positive correlations, however, most probably reflect a cross-country difference: countries with relatively high exchange rate volatility maintain higher real interest rates and employ more central bank intervention. Indeed, when the analysis was narrowed down to a specific country (Israel) real interest rates and central bank intervention restrain (i.e., are *negatively* correlated with) exchange rate volatility. It was noted that statistical and macroeconomic factors also help to explain exchange rate volatility. The study suggests that the positive correlation between exchange rate volatility and the levels of real interest rate as well as bank intervention may reflect the cross-country difference in the panel data used: in countries with high exchange rate volatility, real interest rates are higher and central banks intervene more frequently and vigorously.

Iwata and Wu (2005) empirically examine the sources of the volatility of the foreign exchange risk premia. By explicitly modelling the currency risk premia in the VAR system, the study offers a potential reconciliation for the seemingly contradicting observations from the previous VAR analysis of the exchange rate "overshooting" behaviour under exogenous monetary innovations. Exogenous shocks to the foreign exchange markets have a small, though not negligible impact on the foreign exchange risk premia. If the foreign exchange risk premia are time-varying and volatile, then a large fraction of the movement in the exchange rate must be attributed to the fluctuations in the risk premium. Therefore, knowing the behaviour of the risk premia may be crucial to understand the dynamics of the exchange rate movements in response to exogenous macroeconomic shocks. One important question that is left unanswered in the study is that, why the currency risk premium or the exchange rate is so volatile. Many studies have proposed various explanations based on structural models. The empirical results of this study provide some insight into the dynamic effects of different macroeconomic shocks as an intermediate step towards bridging the gap between economic theories and the empirical evidence.

In Nigeria, very scanty studies have been conducted to estimate exchange rate volatility and its response to macroeconomic shocks. Most of the studies on exchange rate volatility in Nigeria measure the impacts of trade shocks on exchange rate volatility with little attention to other internal macroeconomic variable shocks. For instance, Akpokodje explores the exports and imports effects of exchange rate volatility with specific reference to the non-Communaute Financiere Africaine (non-CFA) countries of Africa from 1986 to 2006. The countries chosen included Ghana, Lesotho, Malawi, Nigeria, Sierra Leone, South Africa, Uganda and Zambia. A GARCH approach was employed to generate on annual basis the RER volatility series for each country. The study reveals a negative effect of exchange rate volatility on exports and imports in selected African countries. The adverse effect of exchange rate volatility on exports in the sampled countries, as found in the study

suggests the need for policy interventions that will help to minimise and, where possible, eradicate exchange rate volatility.

In the same vein, Ogunleye (2009) investigates the relationship between exchange rate volatility and Foreign Direct Investments (FDI) inflows in Sub-Saharan Africa (SSA) using Nigeria and South Africa as case studies. By endogeneising exchange rate volatility, the study uses a two – stage Least Squares methodology. It finds that in Nigeria, there is a statistically significant relationship between the variables, with exchange rate volatility retarding FDI inflows and FDI inflows increasing exchange rate volatility. As revealed in the study, this relationship is however weak for South Africa. The possible reason adduced in the study is the sound capital flows management policy of the South African Reserve Bank.

Aliyu (2009) assesses the impact of oil price shock and RER volatility on real economic growth in Nigeria on the basis of quarterly data from 1986Q1 to 2007Q4. The empirical analysis starts by analysing the time series properties of the data, followed by examining the nature of causality among the variables. Further, the Johansen VAR-based cointegration technique was applied to examine the sensitivity of real economic growth to changes in oil prices and RER volatility in the long run while the short run dynamics was checked using a vector error correction model. Results from ADF and PP tests show evidence of unit root in the data and Granger pair wise causality test reveals unidirectional causality from oil prices to real GDP and bidirectional causality from RER to real GDP and vice versa. Findings further show that oil price shock and appreciation in the level of exchange rate exert positive impact on real economic growth in Nigeria. The study recommends greater diversification of the economy through investment in key productive sectors of the economy to guard against the vicissitude of oil price shock and exchange rate volatility.

Yinusa and Akinlo in their study investigate the empirical evidence of the response of exchange rate volatility and currency substitution to monetary policy shocks in Nigeria in a

multivariate setting. Both the impulse response and the forecast error variance decomposition were constructed. The results from the study suggest that exchange rate volatility respond to monetary policy with some lags. The study cited an instance that monetary policy will not affect exchange rate volatility until three quarters away. The findings from the study further reveal that a tightening shock leads to a persistent fall in domestic prices both in the short term and in the longer horizon. Therefore, according to the study, currency substitution is not an instant reaction to the slightest policy mistake rather; it is fallout from prolonged period of mismanagement and macroeconomic instability. The study concludes by proposing that exchange rate-based monetary policy would be more potent in reducing currency substitution than interest rate-based policy.

## *3.5 Implications of the Reviewed Literature for this study*

The review so far shows that there exists a dearth of research on the possible impact of macroeconomic policy shocks on the volatility of exchange rate in Nigeria, the focus of this research. It should be noted that the only related work to this study carried out by Yinusa (2004) and Yinusa and Akinlo, but failed to trace the channel through which macroeconomic policy shocks impact on the exchange rate volatility in Nigeria. Although, the two studies examined exchange rate volatility as it relates to currency substitution in Nigeria, but they failed to examine the possible consequences of macroeconomic policy shocks on exchange rate management in Nigeria. Besides, the studies failed to show how exchange rate volatility transmits into the economy and how macroeconomic policies aggravate or ameliorate the volatility of exchange rate in Nigeria. Moreover, the studies did not recognised the effects of regime shift on exchange rate behaviour, thereby assuming that regime shifts have no effects on the behaviour of exchange rate in Nigeria. In other words, the studies failed to take into cognisance or violate the phenomenon called "*the Lucas*

*Critique"* with the assumption that at the time of regime switch, the coefficients associated with policy variables remained on change.

This research however covers all these areas by measuring the impact of regime switch on exchange rate behaviour in Nigeria. Also, it traces the channels through which macroeconomic policy shocks impact on exchange rate volatility in Nigeria as well as the relative importance of these channels. This is the focus of this research.

Most of the studies undertaken relating to the focus of this research were carried out some decades ago, their outcomes may have been overtaken by the present developments. Therefore, the debate on the relationship between macroeconomic policies and exchange rate volatility remains inconclusive, given the conflicting results of current studies. It is in the light of this that this study examines the relationship between macroeconomic polices and exchange rate volatility to know where the results fall in the case of the Nigerian economy. This underscores the relevance of this research work.

**Table 3.1: Summary of Some Selected Studies Reviewed**

| S/N | Author and year | Issues Addressed | Scope | Methodology | Results/ Findings and conclusions |
|---|---|---|---|---|---|
| 1 | An and Sun (2008) | Analyse the interaction among monetary policy, foreign exchange intervention and exchange rate in a unifying model for Japan. | 1991 to 2004 | The analyses start from a set of rationally identifying assumptions which are consistent with Japan's economic structure. | 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. |
| 2 | Roca and Priale (1987) | Conduct a country specific study on both fiscal and monetary effects of exchange rate in Peru during the period of economic deregulation. | 1980 to 1985 | Applied an ordinary least square method. | They suggest that stabilisation programmes of which devaluation is a part, have led to a greater fiscal deficit as a percentage of GDP |
| 3 | Edwards (1989) | The relationship between real exchange rate and the behaviour of the fiscal variables in many developing countries. | 1971 to 1988 | Applied an ordinary least square method to test behavioural relations for these variables for sampled countries. | Shows a split results for sampled countries. Higher government spending led to an appreciation of the RER for Argentina, Cote d'Ivoire, Morocco and Zimbabwe and to depreciation for Chile, Colombia and Mexico. |
| 4 | Adebiyi (2007) | Investigate the impact of foreign exchange intervention in the Nigerian foreign exchange market. The study only determines whether foreign exchange intervention is sterilised or not. | 1986:1 to 2003:4 | An economic framework involving the conduct of cointegration tests. | Findings from the study shows that foreign exchange intervention in Nigeria is sterilised because the cumulative aid which constitute part of foreign exchange inflows and net foreign assets variables which are proxies for intervention, are not significant. |
| 5 | Adewuyi (2003) | Examines the dynamics of trade and exchange rate policies and their impacts on macroeconomic adjustments and economic performance in Nigeria. | 1991 to 1995 | Applies both probity regression analysis and the ordinary least square estimation technique. | The study results show that there exist some relationships between trade policy and exchange rate policy dynamics. Thus, it was found that trade policy changes induce exchange rate policy adjustments |
| 6 | Chete (1995) | Evaluates Nigerian's experience with exchange rate depreciation, particularly in relation to the objective of achieving external balance. | 1985 to 1994 | Applies a monetary approach to the theory of balance of payments. | From the study, a tentative point was made that the envisaged salutary gains from exchange rate depreciation at that time are yet to materialise. Although, some surpluses were made especially in the trade account for some years but these surpluses have not translated to a consistent improvement in the balance of payments |
| 7 | Ajakaiye (1994) | Assesses the contribution of exchange rate depreciation to increase in prices at the sectoral level in Nigeria. | 1986 to 1989 | The study measures the changes in sectoral producers' prices induced by exchange rate | The study findings show that changes in sectoral producer prices in Nigeria is induced by exchange rate depreciation between 1986 and |

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| | | | | depreciation between 1986 and 1989 using an input-output price model with 1985 base | 1989 |
| 8 | Olopoenia (1993) | Examines the extent to which observed movement in Nigeria's RER represent deviations from its equilibrium level.<br>The influence of monetary variables and macroeconomic instability on the actual RER in Nigeria<br>The effect of nominal exchange rate changes on the trend of observed RER movement | 1964 to 1990 | The estimated RER dynamics were annual data for the 1962 to 1990 for Nigeria. He estimated his model using cointegration and error correction mechanisms. | The study results suggest that monetary and nominal exchange rate policies have important influences on the dynamics of observed RER in the Nigerian context. |
| 9 | Obadan (1994) | Examines the determinants of RERs particularly the roles of structural and monetary policy disturbances, the relationship of RER with its fundamental determinants in Nigeria. It investigates the effects of trade balance of RER. | 1970 to 1988 and 1970 to 1990 | Two models were applied. A simultaneous equation model was estimated using two stage least square estimation techniques while the second single equation model was estimated by the ordinary least square method for the period 1970 to 1990. | The findings from the study show that the RER prevailing at any point in time is determined by both structural and short run factors. He points to the fact that macroeconomic policies cause short run variations in the RER which tend to be temporary. |
| 10 | Daniel *et al* (1994) | The measures of RER using a structural modelling approach | 1960 to 1983 | Used ordinary least square method to estimate a RER model using time series data. | Economic growth was found to be associated with increases in the relative prices of non-tradable, that is to say, RER will appreciate when there is technological progress or productivity gains. The coefficient of TOT was positive and significant, verifying theoretical expectations that a rise in the TOT leads to appreciation of RER. |
| 11 | Amin *et al* (1997) | Analyse the determinants of RER for Cameroon, Congo and Gabon | 1966 to 1993 | Used cointegration and error correction specification which allowed them to capture the equilibrium relationship between non-stationary series as well as incorporating the short and long run information into the model. | The study reveals that the TOT tend to appreciate the RER for the three countries (i.e. Cameroon, Congo and Gabon) in line with results obtained by other authors. |
| 12 | Parikh (1997) | Examines the movement of RER for South African economy | 1979 to 1994 | This was done on the basis of short and long run behaviour of | It was however believed that, in the long run analysis, real factors will influence RER while |

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| | | | | the RER of the South African economy. The long run was explained using a structural approach and the short run was captured using a time modelling strategy. | the short run monetary factors can also have influence. |
| 13 | Yiheyis (2000) | Analyses the relationship between exchange rate and its fiscal consequences among selected countries. Basically, he examines the relationship between exchange rate, revenue and expenditure. | 1990 to 1999 | He explores an economical model to show the relationships between exchange rate and the two fiscal variables. A three-equation model which endogenises the three variables are specified. | The fiscal effects of devaluation depend on the size of the real devaluation, the share of traded goods in government and aggregate expenditure and on the output effect of devaluation. |
| 14 | Ndung'u (1999) | Assesses whether the exchange rate in Kenya is affected by monetary policy and whether these effects are permanent or transitory. | 1970 to 1994 | Decomposes the RER into cyclical and permanent components.<br>Causality tests are performed between several measures of monetary shocks and the cyclical component of the RER | The study results 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 RER volatility, the cointegrating vectors and the shocks. |
| 15 | Cottani *et al* (1990) | Since the RER is an indispensable variable for macroeconomic and sectoral performance, it was considered crucial to understand the RER in the short and long run, so as to better manage RER and restore the economics on a path of rapid growth and sustained development. | 1970 to 1988 | The study is based on the theory of RER determinants propounded by Edwards (1989) who distinguishes between external and domestic RER determinants. | Findings show that RERs in high-export and high-growth countries are more responsive to changes in the TOT than in low-export, low-growth countries. |
| 16 | Crosby (2000) | Presents evidence on whether Hong Kong's currency board management, in place since 1983, has affected the volatility of real macroeconomic variables | 1980 to 1990 | Simple evidence on the relative volatilities of relevant macroeconomic variables, pre and post 1983 was presented, before a more formal econometric framework was utilised to examine the linkages between the exchange rate and the real economy | It was found that the currency board period had been one of relative stable era in Hong Kong, though it had also been a period where external factors had been relatively benign. Even after controlling for the external environment, the study finds that the currency board period was one of low macroeconomic volatility. |
| 17 | Carrera and Vuletin (2003) | The study seeks to analyse the relationship between exchange rate regimes and short- | A sample of 92 countries for the | A panel data analysis using VAR framework. | The study finds evidence on how other variables influence RER volatility and it also analyses the |

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| | | term volatility of the effective RER | 1980 to 1999 was considered | | persistence of shocks in RER. |
| 18 | Ito (2005) | The pass-through effects of exchange rate changes on the domestic prices among the East Asian countries. | 1995 to 2004 | The conventional pass-through equation and a VAR analysis was applied. | Both the conventional analysis and VAR analysis show that while the degree of exchange rate pass-through to import prices is quite high in the crisis-hit countries, the pass-through to CPI is generally low, with a notable exception of Indonesia. |
| 19 | Supaat et al (2003) | The study examines the characteristics of the Singapore dollar nominal effective exchange rate (SGD NEER) since 1980s and investigates whether the short-term movements in the currency has affected the movement of key real macroeconomic variables in the economy. | 1980 to 2002 | The analysis of the study utilises a GARCH framework. The authors adopted a flexible price monetary model to assess the impact of the increase in exchange rate volatility on real macroeconomic variables in Singapore. | The analysis found little evidence of a relationship between exchange rate volatility and that of a number of key macroeconomic variables. |
| 20 | Morana (2007) | The study investigates whether there is a short- to medium-term linkage between macroeconomic and exchange rate volatility or not | 1980 to 2006 | Pair-wise Granger causality. | Evidence of bidirectional causality was also found, with macroeconomic volatility showing a stronger causal power than exchange rate volatility. |
| 21 | Benita and Lauterbach (2007) | The study examines the daily volatility of the exchange rate between the US Dollar and 43 other currencies in 1990 to 2001. | 1990 to 2001 | GARCH statistical method of analysis was applied | The main finding of the study was that exchange rate volatility was positively correlated with the real domestic interest rate and with the degree of central bank intervention. |
| 22 | Akpokodje (2009) | Explores the exports and imports effects of exchange rate volatility with specific reference to the non-Communaute Financiere Africaine (non-CFA) countries of Africa during the period | 1986 to 2006 | A GARCH approach was employed to generate on annual basis the RER volatility series for each country | The study reveals a negative effect of exchange rate volatility on exports and imports in selected African countries. The adverse effect of exchange rate volatility on exports in the sampled countries, as found in the study suggests the need for policy interventions that will help to minimise and, where possible, eradicate exchange rate volatility. |
| 23 | Ogunleye (2009) | Investigates the relationship between exchange rate volatility and FDI's inflows in Sub- Saharan Africa using Nigeria and South Africa as case studies | 1970 to 2005 | A two-stage Least Squares methodology was applied | The study finds that in Nigeria, there is a statistically significant relationship between the variables, with exchange rate volatility retarding FDI inflows and FDI inflows increasing exchange rate volatility. |

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| 24 | Aliyu (2009) | The study seeks to assess the impact of oil price shock and RER volatility on real economic growth in Nigeria. | 1986 to 2007 | Johansen VAR-based cointegration technique was applied to examine the sensitivity of real economic growth to changes in oil prices and real exchange rate volatility in the long run while the short run dynamics was checked using a vector error correction model. | Findings show that oil price shock and appreciation in the level of exchange rate exert positive impact on real economic growth in Nigeria. |
| 25 | Mallick (2010) | Investigates the role of nominal exchange rate and macroeconomic shocks in influencing monetary policy, long-term interest rate and fiscal policy in a structural vector-autoregressive (SVAR) model of the Indian economy. | 1980 to 2009 | The author examines the impact of monetary and fiscal policy shocks on the macroeconomy of the India economy. The author develops a theoretical setting and a model to identify structural shocks along with carrying out variance decomposition of different shocks. | The findings further reveal that exchange rate, supply and monetary policy shocks influence inflation more than the demand shocks. In order to further validate these results, the study identifies monetary and exchange rate shocks separately within a sign-restriction based VAR to demonstrate the case of exchange rate targeting by restricting it not to appreciate which in part explains the persistent inflation at high single-digit levels in India. |
| 26 | Khamfula (2004) | The study examines the macroeconomic goals and policies introduced in Growth, Employment and Redistribution (GEAR) strategy and how these have been fulfilled in South Africa. | 1990 to 2003 | A simultaneous equation system was applied. Statistical methods for systems of simultaneous equations capture the mutual dependence among the variables in the model. | The results from the study indicate that both monetary and fiscal policy shocks are not important in determining the long run course of economic growth in South Africa. |
| 27 | Gauthier *et al* (2004) | The study empirically determine how the dynamics of nominal bond yields is related to domestic macroeconomic fundamentals in a small open economy like Canada | 1980 to 2002 | A VAR framework was employed to determine the impact of unexpected movements—basically the structural shocks—and not an estimate of the systematic component of the variables in the model. | The study provides evidence regarding the importance of monetary shocks in the dynamics of nominal variables, thereby confirming the impact of monetary policy on the inflationary component of nominal interest rates in Canada. The study further stresses that in the long run, supply shocks is found to have no significant impact on long-term nominal interest rates. |

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| 28 | Pericoli and Taboga (2009) | The study analyses the joint dynamics of bond yields, macroeconomic variables and the exchange rate in USA and Germany. | 1980 to 2008 | The study introduces a two-country no-arbitrage term-structure model to analyse the joint dynamics of bond yields, macroeconomic variables and the exchange rate in USA and Germany. | Estimating the model with US and German data, the authors obtain an excellent fit of the yield curves and they are able to account for up to 75 per cent of the variability of the exchange rate. The study findings show that time-varying risk premia play a non-negligible role in exchange rate fluctuations, due to the fact that a currency tends to appreciate when risk premia on long-term bonds denominated in that currency rise. |
| 29 | Cagliarini and McKibbin (2009) | The study explores the potential role of three major shocks – to productivity, risk premia and US monetary policy – to explain the large global movements in relative prices between 2002 and 2008. The study considers a stylised representation of three major shocks affecting the global economy from 2002 to 2008 | 2002 to 2008 | The study uses 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 from 2002 to 2008. | An interesting conclusion of the simulations exercise carried out 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. |
| 30 | Iwata and Wu (2005) | The study empirically examines the sources of the volatility of the foreign exchange risk premia. | | The study adopts a structural nonlinear VAR model based on no-arbitrage condition to identify various macroeconomic shocks and the foreign exchange risk premia. | The findings from the study reveal that more than 80% of the volatilities of the currency risk premia can be accounted for by the standard macroeconomic shocks that drive output and inflation. The empirical results of this study provide some insight into the dynamic effects of different macroeconomic shocks as an intermediate step towards bridging the gap between economic theories and the empirical evidence. |
| 31 | Yinusa and Akinlo (2008) | The study investigates the empirical evidence of the response of exchange rate volatility and currency substitution to monetary policy shocks in Nigeria in a multivariate setting. | 1986 – 2005 | The study adopts the unrestricted portfolio balance model of currency substitution, incorporating exchange rate volatility within the framework of the Vector Error Correction (VEC) technique. | Results from both impulse response and the forecast error variance decomposition functions of the study suggest that exchange rate volatility and currency substitution responds to monetary policy with some lags meaning that monetary policy may be effective in dampening exchange rate volatility and currency substitution in the medium horizon. |

# CHAPTER 4

# THEORETICAL FRAMEWORK AND METHODOLOGY

## *4.1 Introduction*

In this chapter, the theoretical framework and the research methods employed in the process of carrying out this study are discussed. The study first presents the theoretical framework. The main issues are discussing the main theories that have been applied in literature. These various models are reviewed with a view to gaining insight into various theoretical constructs that have influenced the current state of knowledge in this area. This was followed by the analytical framework and model specification. Based on the former, the study constructs a VAR model to determine the dynamic responses of all the variables in the VAR to a one – time standard innovation to any of the variables in the system. Tests for volatility of exchange rate were also presented. Sources of data and measurement of variables are presented at the latter part of this chapter. The chapter concludes with a discussion of the analytical techniques employed in this study, under which tests for stationarity and cointegration are considered.

## *4.2 Theoretical Framework*

This study adopts an abridge version of several exchange rate determination theories. These theories include the purchasing power parity (PPP), interest rate parity (IRP), the Mundell –Fleming model, the Balassa – Samuelson model, Monetary Exchange Rate model with price flexibility, the Dornbusch Overshooting model and the Obstfeld and Rogoff model. The reason for the adoption of several versions of these models is that a single model cannot adequately capture the issues raised and to be addressed by this study. Therefore, the

salient features of several theories of exchange rate determination provide the framework for this study.

### 4.2.1 Exchange Rate Theories

The recent movement of exchange rates in a flexible rate system has baffled many economists. Exchange rates have exhibited considerable volatility and with commodity prices have failed to conform to predictions of PPP theory and other theories of exchange rate determination. Frequently, exchange rate changes have failed to follow contemporary economic theories and existing studies have produced a number of different views about factors responsible for the exchange rate changes. Evidences have shown that the reason behind the difference is that different theories, data and econometric methods are used. It is clear that not all the theories that are actually used are suitable for explaining the movement of exchange rate. Thus, it is important to create micro foundations from divergent theories for an empirical study. In this section we review existing theories of exchange rate determination as their implications will be helpful for modelling our study before the empirical analysis.

Exchange rate theories surveyed in this part can be classified into three categories: ***partial equilibrium, general equilibrium and disequilibrium or hybrid models***. Partial equilibrium models include relative PPP and absolute PPP, which only consider the goods market; covered interest rate parity (CIRP) and uncovered interest rate parity (UCIRP) which only considers the assets market; the external equilibrium model which states that exchange rate is determined by the balance of payments. General exchange rate equilibrium models include the Mundell-Fleming model which deals with the equilibrium of the goods market, money market and balance of payments but lacks micro-foundations to some extent; the Balassa-Samuelson model, built on the maximisation of firms profit; the Redux model which was developed by Obestfeld and Rogoff and the PTM (Pricing to Market) model, created on

the maximisation of consumer's utility. A simple monetary model with price flexibility and the Dornbusch model (or Mundell-Fleming-Dornbusch model), are actually obtained by combining the monetary equilibrium with the adjustment of price and output toward their long run equilibrium and can be called hybrids of monetary equilibrium with PPP or UCIRP.

#### 4.2.1.1 Purchasing Power Parity

The starting point of exchange rate theory is PPP, also called the ***inflation theory of exchange rates***. PPP can be traced back to 16th century Spain and early 17th century England but Swedish economist, Cassel (1918), was the first to name the theory PPP. Cassel once argued that without it, there would be no meaningful way to discuss over-or-under valuation of a currency. If the prices of each good are equalised between the two countries and if the goods' baskets and their weights in the two countries are the same, then absolute PPP holds as follows:

$$P = SP^* \tag{4.1}$$

Under this model, $P_i$ and $P_i^*$ denote, respectively, the price level of good $i$ in the home currency and foreign currency. Letter "$S$" denotes the nominal exchange rate that expresses the price in foreign currency in terms of the domestic currency. According to the "law of one price," the price of one good should be equal at home and abroad, connoting that: $P_i = SP_i^*$.

Absolute PPP theory was first presented to deal with the price relationship of goods with the value of different currencies and it requires very strong preconditions. Generally, absolute PPP holds in an integrated, competitive product market with the implicit assumption of a risk-neutral world, in which the goods can be traded freely without transportation costs, tariffs, export quotas and so on. However, it is unrealistic in a real society to assume that no

costs are needed to transport goods from one place to another. In the real world, each economy produces and consumes tens of thousands of commodities and services, many of which have different prices from country to country because of transport costs, tariffs and other trade barriers.

Absolute PPP is generally viewed as a condition of goods market equilibrium. Under it, both the home and foreign markets are integrated into a single market. Since it does not deal with money markets and the balance of international payments, we consider it to be only a partial equilibrium theory, not general. Perhaps because absolute PPP requires many strong impractical preconditions, it fails in explaining practical phenomenon and signs of large persistent deviations from absolute PPP have been documented.

A more general version of PPP, called the relative PPP, was introduced to describe the relationship between prices and the exchange rate in different economies. Generally, relative PPP can be derived by assuming that transaction costs are proportionately related to price level. For example, assuming that a commodity's home price at time t is $P_t$ and the transport cost is $kP_t$ where $k$ is constant, the foreign price of the commodity is equal to the price of foreign currency multiplied by the exchange rate $(1+k)P_t$ in terms of home currency, that is:

$$(1+k)P_t = S_t P_t^* \tag{4.2}$$

By taking the logarithm and then carrying out a differential operation on each side of equation (4.2) with regard to time t, we get relative PPP expressed as:

$$\frac{\Delta E_t}{E_t} = \frac{\Delta P_t}{P_t} - \frac{\Delta P_t^*}{P_t^*} \tag{4.3}$$

Equation 4.3 states that the relative change of the exchange rate equals the difference in inflation rate between the two economies. Assuming that $\frac{\ln S_t}{S_t} = s_t$, $\frac{\ln P_t}{P_t} = p_t$, $\frac{\ln P_t^*}{P_t^*} = p_t^*$, the equation 4.3 can be re-expressed as:

$$s_t = p_t - p_t^* \qquad (4.4)$$

The equation 4.3 can also be derived by taking the logarithm and differential operation directly from (4.1). If the real exchange rate (RER) is denoted by the ratio of national price levels, $q_t = \frac{S_t P_t^*}{P_t}$, if absolute PPP holds, the RER equals one. If relative PPP holds, the RER should be a constant but is not necessarily equal to one.

If an economy adopts a fixed exchange rate regime, the relative PPP model forecasts that the home prices change at the same speed as foreign prices. Conversely, if the inflation rates in the two economies are the same, according to relative PPP, the exchange rate should be constant. It is clear that absolute PPP is built on the assumption of a perfect market setting with high information efficiency in both foreign exchange and goods' markets. Allowing for transport costs, tariffs and trade barriers, absolute PPP may not hold. Many empirical studies show that neither absolute nor relative PPP holds in the short run, since the adjustment is a time-consuming process. Though controversies over PPP remain, it seems that only relative PPP can hold in the long run (Cote, 1994). This may explain why PPP was thought by some to be a long run equilibrium condition, instead of a casual relationship (Pericoli and Taboga). Relative PPP implies that the RER is constant. However, this theory does not explain why the RER should remain constant over a particular period of time. Theoretically, deviations of the PPP from its practical value may also be caused by differences in production technology and consumers' preferences toward risk and uncertainty.

### 4.2.1.2 Interest Rate Parity

During the period of the gold standard, monetary policymakers found that exchange rates were influenced by changes in monetary policy. A rise in the home interest rate was usually followed by the appreciation of the home currency and a fall was followed by a depreciation of the home currency. This suggests that the price of assets plays a role in exchange rate variations. The interest rate parity condition was developed by Keynes (1923), to link the exchange rate, interest rate and inflation. The theory also has two forms: covered CIRP and uncovered UCIRP. CIRP describes the relationship between the spot market and forward market exchange rates with interest rates on bonds in two economies. UCIRP dwells on relationship between the spot and expected exchange rate with nominal interest rates on bonds in two economies.

#### *4.2.1.2.1 Covered Interest Rate Parity (CIRP)*

The covered interest rate parity (CIRP) assuming the home country Nigeria is denoted by NG and the foreign country is denoted by US. The nominal interest rate at time $t$ in NG is $i_t$ and in the US is $i_t^*$, the spot exchange rate is $S_t$ and the forward exchange rate at time $t+1$ is $S_{t+1}$. If an investor in the NG deposits one naira in Nigerian currency, he will get a return of $i_t$ at time $t+1$ and the sum of his/her principal and interest rate at time $t+1$ is $1+i_t$. If this investor exchanges his/her one naira into USD at time $t$ and then deposits it in a US bank with interest rate $i_t^*$, the sum of his principal and interest rate is $S_{t+1}$, this sum of the principal and interest in naira terms is $\left(1+i_t^*\right)S_{t+1}/S_t$. In a perfectly competitive market, it is generally recognised that it is less likely for the gap between naira's yield and that of the USD to persist for any length of time. In other words, the return from depositing naira in

Nigeria must be the same as the return from depositing USD in US. This relation can be expressed using the CIRP condition:

$$(1+i_t) = \left(1+i_t^*\right) S_{t+1} / S_t$$

(4.5)

Or

$$1+i_t/1+i_t^* = S_{t+1}/S_t \qquad (4.6)$$

Equation 4.6 is the precise form of the CIRP condition. It can also be derived directly from the Fisher condition and PPP. Under the Fisher condition, the real interest rates at home and abroad are respectively

$$\left(1+i_t\right)P_{t+1}/P_t = \left(1+r_t\right)$$

$$\left(1+i_t^*\right)P_t^*/P_{t+1}^* = \left(1+r_t^*\right)$$

Since the real interest rates are equal, the following formula holds:

$$\left(1+i_t\right)P_{t+1}/P_t = \left(1+i_t^*\right)P_t^*/P_{t+1}^*$$

Assuming $P_t = S_t P_t^*$ or PPP holds, we again obtain the CIRP condition

$$\left(1+i_t\right) = \left(1+i_t^*\right) S_{t+1} / S_t$$

To simplify the model, we introduce the sign:

$$1+ f_{t+1} = S_{t+1}/S_t \,, \qquad (4.7)$$

Where $f_{t+1}$ is defined as the forward premium (discount), the proportion by which the forward exchange rate exceeds (falls below) its spot rate. Using (4.7), (4.6) can be rewritten as

$$1+i_t = \left(1+i_t^*\right)\left(1+ f_{t+1}\right) = 1+ f_{t+1} + i_t^* + i_t^* f_{t+1} \qquad (4.8)$$

Since $i_t^* f_{t+1}$ is such a small number that it can be omitted, expression 4.8 can be written approximately as:

$$i_t = f_{t+1} + i_t^* \quad (4.9)$$

This is the normal form of the CIRP which states that the domestic interest rate must be higher than the foreign interest rate by an amount equal to the forward premium (discount) on domestic currency. According to CIRP, if the exchange rate of, say, the naira against the USD is fixed, the interests of the two countries should be equal. Thus, a small country with a pegged exchange rate regime cannot carry out monetary policy independently. Levi (1990) indicates that deviations from CIRP might occur due to four major reasons: transaction costs; political risk; potential tax advantages; and liquidity preference.

#### *4.2.1.2.2 Uncovered Interest Rate Parity*

However, investors face uncertainty over future events. In a rational expectation framework, the forward exchange rate may be strongly influenced by the market expectations about the future exchange rate if new information is taken into consideration. In an uncertain environment, an un-hedged interest rate parity condition may hold. Given that all other variables' symbols do not change but that the forward exchange rate $S_{t+1}$ is substituted by the expected exchange rate $E(S_{t+1})$, the UCIRP condition can be written as:

$$(1+i_t)/(1+i_t^*) = E\left(S_{t+1}/S_t\right) \quad (4.10)$$

This is the precise form of uncovered interest rate parity. Like PPP, the UCIRP does not allow for investor's preferences. In other words, expression (4.10) is derived under the condition that investors are risk neutral. This means that agents are indifferent between an investment yielding a completely secure return, on the one hand and one offering the prospect of an identical return on average, but with the possibility of a much higher or lower return, on the other hand. In other words, they are concerned only with average returns.

Similarly, using the following approximate expression:

$$ES_{t+1}/S_t = 1 + \Delta s_t^e \qquad (4.11)$$

where $\Delta s_t^e$ is the expected rate of appreciation of foreign currency and then substituting (4.11) into (4.10) and ignoring the smaller number as we did previously, we get the formal UCIRP condition:

$$i_t = i_t^* + \Delta s_t^e \qquad (4.12)$$

Equation 4.12 states that the domestic interest rate must be higher than the foreign interest rate by an amount equal to the appreciation rate of foreign currency. As with PPP, uncovered and covered interest rate parity conditions are derived under the assumption of no transaction barriers, a perfectly competitive capital market and no arbitrage opportunities at equilibrium. Obviously, this kind of equilibrium is still partial because only the assets market is considered. Few empirical studies support UCIRP. For example, using a K-step-ahead forecasting equation and overlapping techniques on weekly data of seven major currencies, Hansen and Hodrick (1980) reject the market efficiency hypothesis for exchange.

We have indicated earlier that the Fisher open condition can be a basis for CIRP. This condition implies that the expected real interest rates are equal in different countries, with the real interest rate defined as the nominal interest rate divided by the sum of one plus the expected inflation rate. The Fisher open condition implies approximately that the difference of nominal interest rates equals the difference of expected inflation rate between two countries. Empirically, little evidence supports the Fisher open hypothesis (Cumby and Obstfeld 1981, 1984). When the Fisher open hypothesis is denied, real interest rate parity cannot hold.

#### 4.2.1.3 The Mundell-Fleming Model

Money is important because it serves as a medium of exchange, measure of value and means of storage. As a modern invention, paper money or currency plays an important role in reducing transaction costs. However, the effect on the nominal exchange rate of monetary policy is not clear from previous models. The Mundell-Fleming model is developed by extending the IS-LM model to the case of an open economy and thus provides understanding of how the exchange rate is determined. The IS-LM model considers three markets: goods, money and assets and is mainly used to analyse the impacts of monetary and fiscal policies. When the goods' market is not in full employment equilibrium level, it shows how to use fiscal and monetary policies to adjust an economy to new full employment equilibrium. Since only two of the three markets are independent, the IS-LM model only establishes a linkage between the money market and goods market. In the Mundell-Fleming model, the balance of international payments is considered another equilibrium condition in addition to the money and goods' market.

Let us first define the goods' market equilibrium as the IS curve

$$Y = C + I + G + (X - M) \tag{4.13}$$

Where $Y$ denotes domestic national income; $C = C(Y)$ denotes consumption, a function of income; $I = I(i)$ denotes investment which is a decreasing function of national interest rate $i$; $G$ denotes government spending; $X = X(Y^*, q)$ denotes exports, an increasing function of foreign national income and RER. $M = M(Y, q)$ denotes imports, an increasing function of domestic income and decreasing function of the RER. The RER is defined by $q = \frac{SP^*}{P}$, where $S$ is the nominal exchange rate; $P$ and $P^*$ denote, respectively domestic and foreign prices.

Second, we define the money market equilibrium through the LM curve. Let $M^d/P = L(Y, i)$ represent money demand, an increasing function of domestic income and decreasing function of the interest rate and $M^s$ represent money supply. The money market equilibrium condition can be expressed as:

$$M^s/P = L(Y, i) \tag{4.14}$$

Finally, the external equilibrium is denoted by the balance of payment (BP) equation:

$$BP = CA + KA = 0 \tag{4.15}$$

Where, current account is expressed as

$$CA = PX - SP^* M$$

and capital account as

$$KA = K(i - i^* - \Delta s^e)$$

One of the most important issues addressed by the model is the so-called trilemma which states that perfect capital mobility, monetary policy independence and a fixed exchange rate regime cannot be achieved simultaneously. Specifically, it argues that a country cannot sustain monetary policy independence in a fixed exchange rate regime with perfect capital mobility. The model also forecasts that the exchange rate level is perfectly correlated with the level of monetary supply in the long run and thus that monetary policy may only play a marginal role. Another important implication is that devaluation may lead to further devaluation if fiscal discipline, inflation and balance of payments are not well-managed or if the assets' market produces a self-fulfilling bubble. Finally, the impact of devaluation on the improvement of the current account may be weakened if an economy is heavily reliant on the re-export processing industry.

#### 4.2.1.4 Exchange Rate and Productivity: The Balassa-Samuelson Model

From our discussion thus far, we conclude that PPP and CIRP (and UCIRP) only express forms of partial equilibriums and do not clearly relate producer behaviour to consumer behaviour. Meanwhile, price levels are determined by the interaction between supply and demand. Since the supply of and demand for products are associated with producers' and consumers' behaviour, a starting point for studying the determinants of the RER is to investigate producers' behaviour and consumers' behaviour, associated with the microeconomic foundations of exchange rate theory. In this section, from the angle of producer behaviour, we study the Balassa-Samuelson (B-S) model (Balassa, 1964; Samuelson, 1964). It allows us to see the role that productivity plays in the RER.

The standard version of the B-S model is presented using a single-factor aggregate production function in Obstfeld and Rogoff (1996). For simplicity, this model assumes that the production functions of tradable (T) and non-tradable (N) goods take the following form:

$$Y_T = A_T L_T$$

$$Y_N = A_N L_N$$

$$Y_T^* = A_T^* L_T^*$$

$$Y_N^* = A_N^* L_N^*$$

where, $Y$ is production, $A$ is a constant describing technology and $L$ is labour force. Foreign economies employ the same kind of technology as the domestic economy but may differ from it in the value of the technological parameter; $A$. the subscript $T$ denotes the tradable sector and the subscript $N$ the non-tradable sector.

This model also *assumes that the law of one price holds for tradable commodities and that the world price of tradable commodities is equal to one without a loss of generality. In addition, perfect labour mobility is assumed between sectors within an individual economy, but zero mobility of labour is assumed between economies*. The mobility of labour ensures

that the wage rates *w* are equal in other sectors of the same economy. We define the price index as the weighted geometric average of prices of tradable and non-tradable goods:

$$P = (p_T)^{\gamma}(p_T)^{1-\gamma} = (p_T)^{1-\gamma} = \left(\frac{A_T}{A_N}\right)^{1-\gamma}$$

where, $\gamma$ is the share of tradable goods in total outputs. If this share is the same at home and abroad, the relative price vis-a-vis the outside world is:

$$\frac{P}{P*} = \left(\frac{A_T/A_N}{A_T^*/A_N^*}\right)^{1-\gamma}$$

the nominal GDP per employee can be expressed as

$$GDP_{nom} = A_T$$

Therefore, the relative price can be transformed into

$$\frac{P}{P*} = \left(\frac{GDP_{nom}}{GDP_{nom}^*}\right)^{1-\gamma}\left(\frac{A_N^*}{A_N}\right)^{1-\gamma} \qquad (4.16)$$

This formula states that the relative price is determined by relative GDP and the relative technological level or productivity in non-tradable sector of the two economies. Given a level of productivity at home and abroad; a higher nominal GDP growth at home than abroad leads to an appreciation of the RER. On the other hand, given an economic growth rate, higher productivity of non-tradable in the home country than the foreign country will lead to depreciation of the real exchange rate. This simplified model can be easily extended to a more general one that includes two production factors: labour and capital. Let us consider a small economy that produces two composite goods: tradables and non-tradables. We assume that the production functions are functions of capital and labour with constant return to scale:

$$Y_T = A_T f(K_T, L_T),$$

$$Y_N = A_N f(K_N, L_N),$$

where $K$ denotes capital. The other variables are the same as above. Through some manipulation, the log-differentiation of the relative price of tradable goods and non-tradable goods can be expressed as:

$$\hat{P} - \hat{P}^* = (1-\gamma)\left(\frac{\mu_{LN}}{\mu_{LT}}\left(\hat{A}_T - \hat{A}_T^*\right) - \left(\hat{A}_N - \hat{A}_N^*\right)\right) \tag{4.17}$$

where $\mu_{LT} = wL_T/Y_T$ and $\mu_{LN} = wL_N/pY_N$ are respectively the labour share of the income generated in the tradable and non-tradable goods sectors. Provided that non-tradable are relatively labour-intensive, meaning $\frac{\mu_{LN}}{\mu_{LT}} \geq 1$, the model forecasts that the domestic economy will experience real appreciation if its productivity-growth advantage in tradable exceeds its productivity growth advantage in non-tradables.

The B-S model is one of the cornerstones of the traditional theory of the real equilibrium exchange rate. The key empirical observation underlying the model is that countries with higher productivity in tradables compared with non-tradables tend to have high price levels. *The B-S model hypothesis states that productivity gains in the tradable sector allow real wages to increase commensurately and, since wages are assumed to link the tradable to the non-tradable sector, wages and prices also increase in the non-tradable sector. This leads to an increase in the overall price level in the economy which in turn results in an appreciation of the real exchange rate.*

The shortcomings of this model are clear. First, it assumes that the tradable price at home is the same as that abroad. This is clearly an unrealistic special form of PPP but for tradable goods only. Under this setting, how the prices of tradables are determined remain unknown. Second, since it states nothing about the demand side, it is criticised by the Keynesian school which regards price to be rigid or sticky. Third, without considering the behaviour of consumers or the demand side, it is difficult to interpret how market prices are

formed. Last and most importantly, this model does not deal with the role of money; it can at best explain partly how the RER is determined.

Integrating the model with a model of accumulation of capital and with the demand side of the economy, Tomâš Holub and Martin Ĉihâk (2003) claim that that the predictions of their model are generally consistent with empirical findings of Central and Eastern European countries. But the extended model still does not have room for money and the nominal exchange rate. This implies that money is assumed out of this kind of model and that prices are assumed to be flexible enough to adjust to supply and demand.

#### 4.2.1.5 A Simple Monetary Exchange Rate Model with Price Flexibility

Unlike the Mundell-Fleming model which involves the balance of international payment, a simple monetary model was originally created in a frictionless world with only one good and one bond (Mussa, 1976, Frenkle, 1976) in which money market equilibrium, PPP and UCIRP are reached. This model includes three blocks.

The first is the money market equilibrium equation given as:

$$m_t - p_t = -\eta i_t + \phi y_t \qquad (4.18)$$

Where: $p$ is the log price level, $i$ is nominal interest rate, $y$ is the log of real output and $m$ is the log of money supply.

The second is PPP. Let $e$ be the log of the nominal exchange rate, defined as the price of foreign currency in terms of home currency; $p*$, $p$ denote the log of the world foreign currency price of the goods basket and the log of the home currency price level. The PPP in log terms is:

$$\ell_t = p_t - p_t^* \qquad (4.19)$$

The third is UCIRP which can be approximation and expressed in log form as:

$$i_t = i_t^* + E_t \ell_{t+1} - \ell_t \qquad (4.20)$$

Substituting (4.19) and the UCIRP approximation equation 4.20 into money market equilibrium equation 4.18, we have

$$\ell_t = \frac{1}{1+\eta}\sum_{s=t}^{\infty}\left(\frac{\eta}{1+\eta}\right)^{s-t} E_t\left\{m_s - \phi y_s + \eta i_t^* - p_s^*\right\} \qquad (4.21)$$

Given money supply, foreign interest rate and price, this simple monetary model demonstrates that the exchange rate depends on both current values as well as expected future values of related variables; that an increase in the domestic money supply and foreign interest rate raises both the domestic price level and nominal exchange rate level; and that changes in real domestic income and the foreign price level have a negative effect on the domestic level and nominal interest rate.

In the extreme case of a fixed exchange rate regime, the domestic interest rate and price level are equal to their foreign counterparts. The money supply is endogenously determined by domestic output, the foreign interest rate and foreign price level: $m_t = \phi y_t - \eta i_t^* + p_s^*$

#### 4.2.1.6 The Dornbusch Overshooting Model

Many studies document the fact that deviations from the law of one price are highly correlated with nominal exchange rate changes (for example, Giovannini, 1988). Evidence also shows that RERs always seem much less volatile when nominal exchange rates are fixed than when they are floating (Mussa, 1986). During the Bretton Woods period up until December 1971, the nominal exchange rate of the Italian lira to the French franc was relatively fixed and RER volatility was fairly low. During the periods when the relative value of the two currencies was not effectively fixed (the early 1970s through 1987), real exchange rate movements were much more volatile and short run real changes virtually mirrored short

run changes in the nominal exchange rate. This indicates that the choice of exchange rate regime can have important effects on real variables.

Such forms of evidence motivate a sticky price extension of the flexible exchange rate monetary model above, namely the Dornbusch Overshooting model, presented in the influential masterpiece "Expectations and exchange rate dynamics" by Dornbusch (1976) (Kenneth Rogoff, 2002).

Under the Dornbusch model, UCIRP and the money equilibrium of the simple monetary model are retained. However, the assumption of flexible prices is replaced by sticky prices. Similarly, the first condition in Dornbusch's model is monetary equilibrium:

$$m_t - p_t = -\eta i_{t+1} + \phi y_t \qquad (4.22)$$

Where $m$ is the money supply, $p$ is the domestic price level and $y$ is domestic output, all in logarithms; $\eta$ and $\phi$ are positive parameters. Equation 4.22 implies that higher interest rates raise the opportunity cost of holding money and thereby lower the demand for money; on the other hand, a higher interest rate also means high costs of speculation which lowers the demand of money as well. Conversely, an increase in output raises the transaction demand for money. Finally, the demand for money is positively related to the level of prices.

The second condition is UCIRP which can be rewritten as

$$i_{t+1} = i^* + E_t\left(\ell_{t+1} - \ell_t\right) \qquad (4.23)$$

Where $\ell$ is the logarithm of the exchange rate (home currency price of foreign currency) and $E_t$ denotes market expectations based on information at time $t$. $i_{t+1} = \log\left(1 + i_{t+1}\right)$ and $i^* = \log\left(1 + i^*\right)$ are approximately correct. The foreign interest rate $i^*$ is taken as a given exogenous variable. In accordance with UCIRP, the home interest rate must be equal to the foreign interest rate *i** plus the expected depreciation rate of the home currency, $E_t\left(e_{t+1} - e_t\right)$.

Unlike under the perfectly flexible price model, the prices of goods are sticky and cannot adjust immediately to clear the market in the Dornbusch model. With sticky prices, an adjustment mechanism is needed for an economy to converge on its equilibrium path in which full employment is realised. Given the magnitude of the real exchange rate's departure from its long-term equilibrium, the force to pull it back to equilibrium will increase. Dornbusch assumes that if the RER rises over its long-term equilibrium level or if the foreign currency is overvalued or the domestic currency is undervalued, the demand for domestic goods will increase; contrarily, if the RER falls below its long-term equilibrium level, or the foreign currency is undervalued or domestic currency is overvalued, then the demand of domestic goods will fall. In this connection, the third condition is an adjustment mechanism of the demand for domestic goods which can be expressed as

$$y_t^d = \bar{y} + \delta(\ell_t + p^* - p_t - \bar{q}) = \bar{y} + \delta(q_t - \bar{q}), \tag{4.24}$$

where: $p$ and $p^*$ are, respectively, logarithms of the domestic price level $P$ in domestic currency and foreign price levels $P^*$ in foreign currency, $\delta$ is a constant greater than zero,

$$q_t = \log(E_t P^*/P) = e_t + p^* - p_t \tag{4.25}$$

is the real exchange rate at time $t$, $\bar{y}$ and $\bar{q} = \log(EP^*/P) = e + p^* - p$, respectively, denoting the exogenous long-term equilibrium output and RER, at which full employment is realised. The last or fourth condition is the price adjustment equation. Keynes assumed that the domestic price level $p$ does not move instantaneously in response to unanticipated monetary disturbances but adjusts only slowly over time. Notably, under Dornbusch's model, the feature of sticky prices is different from that in the Mundell-Flemming model where the domestic price level is basically assumed to be fixed. Using the price adjustment mechanism proposed by Mussa (1982) which is better suited than Dornbusch's original formulation to dealing with more complex exogenous shocks, the sticky-price adjustment process can be described as:

$$p_{t+1} = p_t + \psi\left(y_t^d - \bar{y}\right) + \left(e_{t+1} - e_t\right) \tag{4.26}$$

The Dornbusch model is well-known for its overshooting phenomenon which states that one permanent change in the money supply must lead to a proportionate change in the price level and the exchange rate in the long run. But in the short run, the price level is fixed and the nominal exchange rate must overshoot its long run equilibrium. That is, any initial disturbance of money supply will cause an even larger unanticipated rise in the instant exchange rate than in the long-term exchange rate.

Another significant conclusion of the Dornbusch model is that the impact on the exchange rate of a monetary shock is greater when prices are sticky than when they are flexible. The third conclusion is that the exchange rate converges on its flexible-price equilibrium value following an initial overshooting after a shock and that the nominal exchange rate is more volatile than the RER when $\psi\delta < 1$. Fourth, the Dornbusch model tells not only a story of overshooting but it has important policy implications for the exchange rate regime. A central conclusion of the model is that with sticky prices and flexible exchange rates, purely monetary shocks will be significant for the real economy, leading to large changes in prices and output and prolonged adjustment. If the exchange rate is fixed, the real effects of money demand shocks can be eliminated by setting money supply to money demand (so-called non-sterilised foreign exchange intervention).

The model also states that the exchange rate policy is to some extent inconsistent with the independence of monetary policy. When a real shock occurs, such as a long run rise in the RER, buffeting the economy, the model forecasts that a new full employment equilibrium adjustment will occur immediately under a floating exchange rate regime and need not change the price level. If the exchange rate were fixed, in order to recover the real economy to equilibrium, the entire burden would have to be borne by the prices of goods. But because these prices are sticky, it is a time-consuming process for the economy to reach equilibrium.

Dornbusch's model is not without deficiencies. For example, it is unable to deal adequately with the current account and fiscal policy dynamics or, more fundamentally, with welfare issues because it lacks a micro foundation. In addition, it is premised on the assumption that capital is perfectly mobile and the market is clear. In cases where capital mobility is imperfect or where capital control is stringent, as it is in Nigeria and other developing countries, there is a lot of room for the model to be improved. Finally, a fixed exchange rate regime may not be a viable option in the long run, given the limited ability of an economy to endure pervasive speculative attacks on it.

It is worth mentioning that the above arguments are obtained in the context of a small country model. For a big economy, further studies are needed to determine whether these conclusions are applicable.

#### 4.2.1.7 The Obstfeld and Rogoff Model

Probably from the awareness that previous models have an inadequate micro foundation and are unable to deal adequately with current accounts and balances of international payments, economists have made considerable efforts to explore a new set-up for exchange rate determination.

The modern models of Obstfeld and Rogoff were set-up based on simple PPP which implicitly assumes that nominal prices are producers' currency of production (PCP). As a result, the exchange rate changes "pass-through" one hundred per cent to consumer prices and a flexible exchange rate is a perfect substitute for flexible goods price. In their pioneering work, based on PCP, Obstfeld and Rogoff (1995) develop a perfect-foresight for two-country equilibrium monetary model with preset prices.

Their model assumes that the world is inhabited by a continuum of individual monopolistic producers, indexed by $z \in [0,1]$, each of which produces a single differentiated

good, also indexed by *z*. All producers reside in one of two countries, home or abroad. The home consists of producers on the interval [0,*n*] whereas foreign producers are on interval (*n*,1]. But this model revolves around the endogeneity of output of good *z* , *y* (*z*) *t* .

One of the important contributions of the model is that it introduces a utility consumer function: j, $j \in [0,1]$ which depends on the consumption index, real money balance and effort made in production:

$$U_i^j = \sum_{s=t}^{\infty} \beta^{s-t} \left[ \log C_s^j + \chi \log \frac{M_s^j}{P_s} - \frac{k}{2} y_s(j)^2 \right], \tag{4.27}$$

Here, the real consumption index for individual j is defined as:

$$C^j = \left[ \int_0^1 c^j(z)^{\frac{1-\theta}{\theta}} dz \right]^{\frac{\theta}{1-\theta}} \tag{4.28}$$

where: $C^j(z)$ is the j-th domestic individual's consumption of good $z$ and $\theta > 1$.

Let $p(z)$ be the domestic-currency price of good $z$. Then the home money price level is

$$p = \left[ \int_0^1 p(z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}} \tag{4.29}$$

Let $p^*(z)$ be the domestic-currency price of good z. Then the foreign money price level is:

$$p^* = \left[ \int_0^1 p^*(z)^{1-\theta} dz \right]^{\frac{1}{1-\theta}} \tag{4.30}$$

The law of one price holds for individual goods and the home and foreign price levels are related by PPP. That is $P = \varepsilon P^*$

In an individual's budget constraint:

$$P_t B_{t+1}^j + M_t^j = P_t(1+r_t) B_t^j + M_{t-1}^j + p_t(j) y_t(j) - P_t C_t^j - P_t \tau_t, \tag{4.31}$$

where: $r_t$ denotes the real interest rate on bonds between t-1 and t, $y_t(j)$ is the output good j

and $p_t(j)$ is its domestic currency price. Because there is production differentiation, $p_t(j)$ need not be the same for all $j$. The $M_t^j$ is agent j's holdings of nominal money balances entering period t and $\tau_t$ denotes lump-sum taxes.

Compared with the Dornbusch model, the Obstfeld and Rogoff model has four advantages. First, it was developed on a firm micro foundation that maximises the welfare of consumers. Second, though money the demand functions in the Dornbusch model and Obstfeld and Rogoff model have similar forms; the output variable in the former was substituted by consumption in the later. Third, a good's differential is allowed in the Obstfeld and Rogoff model but Dornbusch's model revolves around the market structure and the endogeneity of output. Fourth, in the Obstfeld and Rogoff model, a comparison of the impact of external shocks on consumers' welfare is allowed but it is not in Dornbusch model.

According to Obstfeld and Rogoff (1998, 2000a), the flexibility of the exchange rate is desirable in the PCP setting, because: (1) flexible exchange rates are a perfect substitute for flexible nominal prices. Relative price adjustment is achieved by exchange rate flexibility under PCP pricing; (2) the policy that achieves the flexible price allocation is a constrained Pareto optimum; (3) this optimal policy is completely self-oriented. No policy coordination across countries is required or desirable. In this sense, perfectly flexible exchange rates are optimal (Engle, 2002).

#### 4.2.1.8 Price to Market and Exchange Rate Regime

The modern models of Dornbusch and Obstfeld and Rogoff are based on simple PPP which implicitly assumes that nominal prices are PCP. As a result, the "pass-through" of exchange rates to consumer prices is one hundred per cent and flexible exchange rates are a perfect substitute for flexible goods prices. However, a number of empirical studies indicate that in the short run, nominal exchange rate changes only partly pass through to consumer

prices. To reflect this phenomenon, Devereux and Engle (2003) put forward another type of price-stickiness: prices are preset in the consumers' currency (denoted by local currency pricing or LCP).

Under LCP, the short run responses of consumer prices to exchange rate changes are very small. When prices are not very responsive to exchange rate changes, the monetary policymaker cannot rely on the exchange rate to provide the necessary adjustment to real shocks. Since consumers do not interpret exchange rate changes as relative price changes in the short run, it is not easy to control the relative demand for domestic goods and foreign goods through exchange rate changes. In the absence of strong expenditure switching effects, the benefits of floating exchange rate are diminished. This implies that an optimum monetary rule would not utilise exchange rate movements at all and that welfare-maximising monetary policies may entail a fixed exchange rate (Devereux and Engle, 2003). This theoretical framework can be viewed as a major challenge to the Friedman case for exchange rate flexibility, according to which floating exchange rates are helpful in cushioning national economies from real idiosyncratic shocks and one that is applicable to industrial rather than emerging economies.

Obstfeld (2004) improved on the model of Devereux and Engle in two ways. First, he modelled the monetary policy as a choice of the nominal interest rate rather than a monetary aggregate. Second, he introduces non-traded goods in the LCP framework. However, his conclusion challenges that of Devereux and Engle. He declares that even when the exchange rate plays no role, countries may wish to have flexible exchange rates in order to free the domestic interest rate as a stabilisation tool.

### 4.2.2 Theoretical Implications of the Theories for the Study

In this section, we provide a brief review of exchange rate determination theories and their policy implications. This review demonstrates that each theory holds in a particular setting and explains some macroeconomic phenomena. No single theory contains all the factors that may have an impact on foreign exchange rates or exchange rate volatility. Purchasing power parity (PPP) theory, classified into two types (absolute PPP and relative PPP) is covered in this review as a starting point for understanding how exchange rates are determined in the goods' market. It builds linkage between the exchange rate and prices of goods in two economies. This is why it is called the "inflation theory of exchange rates." Since it deals only with the goods market and not the assets market, it is a partial equilibrium theory. The minimum preconditions for absolute PPP include: (i) same production technology for individuals; (ii) neutral-risk preferences; (iii) perfectly competitive goods markets in two different economies, (iv) no trade barriers such as transport costs, tariffs and trade quotas and so on. It is established on the "law of one price." Actually, the preconditions for absolute PPP do not hold since transport costs, tariffs and technological as well as preferential differences exist at all times and places. Absolute PPP is rejected by most empirical surveys. Relative PPP allows exchange rates to deviate from absolute PPP. It is equivalent to the RER being constant. Empirically, both absolute PPP and relative PPP in the short run are rejected but some studies find that relative PPP seems to hold in the long run.

Another popular partial equilibrium exchange rate theory, interest rate parity, examines how the exchange rates are determined in financial markets. Since interest rates change frequently in the short run, interest rate parity is thought of as "short run exchange rate theory." Interest rate parity also is of two types, CIRP and UCIRP, both are based on the assumption that asset markets are frictionless and that there is no arbitrage. A lot of evidence supports CIRP as a forward exchange rate pricing model. However, variations in monetary

policy, degree of risk aversion, political risks, barriers to capital mobility and microstructure variations in the market may cause persistent variations in the risk premium over time. UCIRP and the Fisher open condition are also covered in this review but both lack support from empirical studies.

Three monetary models are presented to introduce the impact of monetary factor and real factor shocks on the exchange rate. The first model, known as the simple monetary model in the setting of flexible prices, forecasts how the exchange rate and price level change with current and expected future values of related variables, such as money supply, foreign interest rate and income level.

The second model, the Mundell-Fleming model, is extended from a closed IS-LM model. Unlike the simple monetary model, in which prices are viewed as flexible, it assumes that prices are preset in the short run. In addition to the internal monetary market equilibrium, goods market equilibrium and external equilibrium condition, the balance of payments is also considered in the Mundell-Fleming model. Thus, it can be viewed as a general equilibrium model. One of the most important forecasts of the model is the so called trilemma which states that perfect capital mobility, monetary policy independence and a fixed exchange rate regime cannot be achieved simultaneously. In the long run, the exchange rate level is perfectly correlated with the level of monetary supply and monetary policy may only play a marginal role in economic growth. Another important forecast is that devaluation may lead to further devaluation if fiscal discipline, inflation and the balance of payments are not well-managed because a self-fulfilling bubble may be produced. Finally, the impact of devaluation on current account improvement may be weakened if an economy is heavily dependent on the re-export processing industry.

The third monetary model, Dornbusch model, loosens the condition that prices must be preset but allows for slow price adjustments. A famous insight into policy implication of

this model is the overshooting of the nominal exchange rate over its long run equilibrium when an economic system is shocked with monetary supply. This character is regarded as an advantage of a fixed exchange rate regime over a floating one. This model shows that once a real economic shock happens, markets may move to equilibrium either through a flexible exchange rate or change of prices. The difference between the two is mainly that in the latter, adjustment may consume more time and be less risky than in the former. If prices are relatively flexible and inflation can be controlled in a moderate range, a fixed change rate regime is desirable. These models were criticised frequently for their lack of micro foundations and for their failure to elucidate the effect of the balance of payment on the determination of the exchange rate. However, their clear implications for policymakers should not be underestimated.

The Ballasa-Samulson model partly addressed the issue of the lack of a micro foundation in modelling work by incorporating productivity differentials or technological changes in production into a one-factor production technology model which was then extended to a two-factor model. The main contribution of this kind model is that they built linkages between productivity, output and the RER (terms of trade) through the rational behaviour of producers. However, they fail to incorporate paper money or nominal exchange rate and the behaviour of the demand side that might have important impacts on the exchange rate.

The latest important development in exchange rate studies is the pioneering work in 1995 of Obstfield and Rogoff whose model incorporates the demand side. However, this model still relied on PPP and price presetting. Though it allows the welfare effects of different shocks to be compared, it merely seems to be a Dornbusch model based on maximisation behaviour. There are still many deficiencies in the model. First, it does not

consider investment and producers' behaviour; second, it regards absolute PPP as a precondition, but this has not been supported by empirical studies.

To address the unsuitability of PPP, recent modelling efforts have been formulated in the setting of consumers' currency pricing or LCP. In the LCP setting, some implications are found to be different from that in the PCP setting, especially regarding the choice of the exchange rate regime. In PCP, perfectly flexible exchange rates are to some extent optimal. However, some economists argue that the LCP setting is more practical than PCP, at least in the short run. In the LCP setting, an optimum monetary rule does not utilise exchange rate movements at all and welfare-maximising monetary policies may entail a fixed exchange rate. Otstfeld argues that substituting interest rate for aggregate money demand in LCP when the exchange rate plays a marginal role affords some countries to have flexible exchange rates in order to free the domestic interest rate as a stabilisation tool.

Existing exchange rate models have done little regarding the role of fiscal policy and income policy in dealing with trade surpluses and deficits. For a perfect market economy, this may not be a problem, because fiscal policy and income policy are usually regarded as non-market measure and may cause distortions of the market. But for a country that is undergoing reform and marketisation, structural factors may play a key role in the balance of trade and payments.

## *4.3 Theoretical Model*

The theoretical model of exchange rate determination in Nigeria based on the strands of theories in the previous section is provided here in order to build a theoretical foundation for the empirical analysis in subsequent chapters. The shortcomings of existing theories in explaining the phenomenon occurring in Nigeria provide impetus to build a more general framework. To analyse the macroeconomic factors that influence the exchange rate, a general

equilibrium model which includes "domestic" and "foreign" countries and three sectors, goods, money and asset markets was developed.

The absolute version of PPP presented to deal with the price relationship between goods with the value of different currencies is based on the "law of one price". The law states that the price of one good should be equal at home and abroad, such that:

$$P = SP* \tag{4.32}$$

where: $P_i$ and $P_i^*$ denote respectively, the price level of good $i$ in the domestic currency and foreign currency. "$S$" denotes the nominal exchange rate that expresses the price in foreign currency in terms of the domestic currency, that is:

$$S = \frac{P_t}{P_t^*} \tag{4.33}$$

The absolute PPP only holds based on its (unrealistic) preconditions that the prices of each goods are equalised between two countries and the goods baskets and their weights in the two countries are the same. Also, goods are traded freely without transaction costs, tariffs and quotas.

However, a more extended and general version of PPP, called the relative PPP is incorporated to build up the micro foundation of the general equilibrium model from the goods' market. The relative PPP is derived by assuming that transaction costs are proportionately related to price level. Under this version, a commodity's home price at time t is $P_t$ and the transport cost is $kP_t$, where *k* is constant, the foreign price of the commodity is equal to the price of foreign currency multiplied by the exchange rate $(1+k)P_t$ in terms of home currency, that is:

$$(1+k)P_t = S_t P_t^* \tag{4.34}$$

By taking the logarithm and then carrying out a differential operation on each side of equation 4.33 with regard to time t, we get relative PPP expressed as:

$$\frac{\Delta s_t}{s_t} = \frac{\Delta P_t}{P_t} - \frac{\Delta P_t^*}{P_t^*} \qquad (4.35)$$

where, $\frac{\Delta s_t}{s_t}$ = e

Equation 4.35 states that the relative change of the exchange rate equals the difference of the inflation rate between the two economies. Assuming that $\frac{\ln S_t}{S_t} = s_t$, $\frac{\ln P_t}{P_t} = p_t$, $\frac{\ln P_t^*}{P_t^*} = p_t^*$, then equation 4.35 can be re-stated as:

$$s_t = p_t - p_t^* \qquad (4.36)$$

If the RER is denoted by the ratio of national price levels, $q_t = \frac{S_t P_t^*}{P_t}$, if absolute PPP holds, the real exchange rate equals one. If relative PPP holds, the RER should be a constant but is not necessarily equal to one.

Keynes (1923) argues that changes in monetary policy are relevant in explaining exchange rate fluctuations ($q_t$). That is, the rise of the home interest rate is followed by depreciation of the home currency. This indicates that the price of assets plays a role in exchange rate variations. Keynes (Ibid) tries to link exchange rate, interest rate and inflation rate under the covered and uncovered interest rate parity based on bonds investment in two economies, home and foreign. It is recognised that it is less likely for the gap between domestic and foreign currencies to persist for any length of time. That is, the return from depositing the home currency must be the same as the return from depositing foreign currency in the foreign country. This implies that interest yield in the home and foreign countries must be equal. This relation is expressed using the CIRP condition as:

$$(1+i)/(1+i*) = S_{t+1}/S_t \qquad (4.37)$$

where the interest rate at time $t$ in the domestic economy is $i_t$ and the foreign economy at time $t$ is $i_t^*$, the spot exchange rate is $S_t$ and the forward exchange rate at time $t+1$ is $S_{t+1}$. If an investor in the domestic economy deposits one unit of the domestic currency, he/she will get a return of $i_t$ at time $t+1$ and the sum of his principal and interest rate at time $t+1$ is $1+i_t$.

Equation 4.37 is conceived under Fisher open condition, if real interest rate at home and abroad is incorporated, respectively, the equation can be re-stated as:

$$(1+i_t)P_{t+1}/P_t = (1+r_t) \tag{4.38}$$

$$(1+i_t^*)P_t^*/P_{t+1}^* = (1+r_t^*) \tag{4.39}$$

Given that the real interest rates are equal, that is, $(1+r_t) = (1+r_t^*)$, the following expression holds by equating (4.38) and (4.39), to have:

$$(1+i_t)P_{t+1}/P_t = (1+i_t^*)P_t^*/P_{t+1}^* \tag{4.40}$$

Empirical evidences has shown that the CIRP hardly holds, we considered a rational expectation framework that investors face uncertainty over future events and future exchange rate may be strongly influenced by the market expectations about the future exchange rate if new information is taken into consideration. This is referred to as uncovered interest rate parity by Keynes.

The relationship under the UCIRP is expressed as:

$$(1+i_t)/(1+i_t^*) = E(S_{t+1}/S_t) \tag{4.41}$$

Under this condition, investors are risk neutral and are concerned only with average returns. Using the following approximate expression:

$$E(S_{t+1}/S_t) = 1+\Delta s_t^e \tag{4.42}$$

where: $\Delta s_t^e$ is the expected rate of appreciation of foreign currency and then substituting 4.42 into 4.41, the UCIRP condition is expressed as:

$$i_t = i_t^* + \Delta s_t^e \tag{4.43}$$

In extending the PPP and interest rate parity of partial equilibrium which explain the micro foundation of the sequential model specification for this study to a more general equilibrium framework, we incorporate the Mundell-Fleming and monetary exchange rate theoretical models.

Under the Mundell-Fleming model, exchange rate is determined through the extension of IS-LM model for open economy like Nigeria. The Mundell-Fleming model is established based on the linkage created by the IS-LM model in the independent money and goods market. Equilibrium in the goods market through the IS curve is defined as:

$$Y = C + I + G + (X - M) \tag{4.44}$$

where C is Consumption, I is investment, G is government Spending, X is Export and M is Import. while, $X = X(Y^*, q)$ denotes export which is an increasing function of foreign national income and real exchange rate (RER). $M = M(Y, q)$ denotes import, an increasing function of domestic income and decreasing function of the RER. The RER is defined by $q = \frac{SP^*}{P}$.

Further, equilibrium in the money market through the LM curve is defined as:

$$M^s / P = L(Y, i) \tag{4.45}$$

Thus, $M^d = M^s$

Although, the $M^s$ (money supply) is taken to be endogenously determined following the monetary exchange rate model as:

$$m_t = \phi y_t - \eta i_t^* + p_s^* \tag{4.46}$$

Expression (4.46) shows that money supply is endogenously determined by domestic output, foreign interest rate and price level; with $m_t$ defined as

$$m_t = \log M^s .$$

In the simple monetary model, RER is determined where money market equilibrium, PPP and UCIRP are reached by substituting both

$$s_t = p_t - p_t^* \tag{4.47}$$

and

$$i_t = i_t^* + E_t s_{t+1} - s_t \tag{4.48}$$

Following Mundell-Fleming model, this was transformed into the money market equilibrium equation (4.46), we have simple monetary theoretical model after substitution (Macdonald, 2000), expressed as:

$$\ell_t = \frac{1}{1+\eta} \sum_{s=t}^{\infty} \left( \frac{\eta}{1+\eta} \right)^{s-t} E_t \left\{ m_s - \phi y_s + \eta i_t^* - p_s^* \right\} \tag{4.49}$$

Unlike the simple monetary model, in the Mundell-Fleming model, the balance of payment is considered as another equilibrium condition in addition to the money and goods' markets. Where the external equilibrium is denoted by the balance of payment equation:

$$BP = CA + KA = 0 \tag{4.50}$$

where, BP is the balance of payment, CA is the current account and KA is the capital account. The current account is further expressed as

$$CA = PX - SP^* M + NFI$$

Therefore, $PX - SP^* M = nx$

where $P$ is domestic price, $SP^*$ is foreign price expressed in domestic currency[1], $PX$ is value of domestic exports of goods and services, $SP^* M$ is value of imports of goods and

[1] Recall from [4.32], the "law of one price" state that the price of one good should be equal at home and abroad , that is, $P = SP^*$

services, NFI is net foreign investment income and $nx$ is net export; while capital account can be expressed as

$$KA = K\left(i - i^{*} - \Delta s^{e}\right)$$

According to Macdonald, the standard balance of payments equilibrium condition holds under floating exchange rates in the absence of intervention in the foreign exchange market. Thus given

$$ca_t = nx_t + nfa_t \tag{4.51}$$

Equation (4.50) can be re-stated as:

$$nx_t + nfa_t + ka_t = 0 \tag{4.52}$$

where $nx_t$ denotes net exports and $nfa_t$ represents net foreign assets.

This model does not assume PPP to be true in all cases but assumes that the RER or term of trade as a measure of competitiveness have an impact on net exports and the current account. It also assumes that a rise in domestic income worsens net exports through its effect on imports while a rise in foreign income improves the net export position through its influence on domestic exports. Though, the incomes effect does not have direct and high relevant implications on exchange rate volatility for a developing country like Nigeria via net trade. Thus, net exports are determined by a standard relationship such that:

$$nx_t = \alpha_1\left(s_t + p_t^{*} - p_t\right) \tag{4.53}$$

where: $s_t$ is the log of the spot exchange rate; $p_t$ is the log of the domestic price level; $p_t^{*}$ is the log of the foreign price level and $\alpha's$ are elasticities.

In practice, the international capital markets are not necessarily perfect and thus the uncovered interest rate parity (UCIRP) may not hold everywhere. However, when the capital markets are not in equilibrium, a mechanism for adjusting the flows of capital will take effect. In other words, if other things are equal, a rise in the domestic interest rate raises

capital inflow while a rise in the foreign interest rate lowers capital inflow, leading to a rise in the expected exchange rate (domestic currency depreciation) which will encourage capital outflow. This also indicates that domestic and foreign interest can play capital flows adjustments mechanism but not necessarily simultaneously. Also, considering the peculiarity of developing countries (such as Nigeria) capital market sensitivity to foreign interest rate which this framework is based, the foreign interest rate is regarded to be more effective for capital flows adjustment mechanism to attain market equilibrium(Mallick,2010).

$$ka_t = \mu\left(i_t - i_t^* - \Delta s_{t+k}^{\ell}\right) \tag{4.54}$$

where: $i_t$ denotes an interest rate yield of domestic deposits and $i_t^*$ an interest rate yield of foreign deposits and $\Delta s_{t+k}^{\ell}$ is the expected change in exchange rate. The $\Delta s_{t+k}^{\ell}$ is exogenously determined by fiscal and monetary policy shocks. Also, market fundamental as the differential between foreign exchange demand and supply has been identified as a determinant of expected changes in exchange rate. Based on the Mundell-Fleming model, in the long run, the expected exchange rate level is perfectly correlated with the level of monetary policy rate and monetary policy may only play a marginal role in economic growth. Another important aspect is that devaluation may lead to further devaluation if fiscal discipline in terms of domestic credit management is not properly managed.

Mallick argued that monetary policy is accommodative in helping finance growing fiscal imbalance (fiscal deficit) and often lead to increase in interest rate and stem inflationary pressure via increase in demand for funds. He further proposed that the more accommodation of higher fiscal deficit by monetary policy will result to both short-and long-rate declines to meet higher government financing needs, which later becomes a channel for monetary policy transmission and eventual lead to currency depreciation (via expansionary monetary policy).

Also, for an oil-dependent economy like Nigeria where crude oil production is the main sustenance of the economy and the major channel of economic globalization through

trade, variability of crude oil price is a significant lead indicator of expected changes in exchange rate. The price of oil is an increasing function of expected changes in exchange rate (currency depreciation). Increase in crude oil price can increase expected changes in exchange rate via interest rate and import channels.[2] Therefore, the exogenously determined expected change in exchange rate is defined as:

$$\Delta s_{t+k}^{\ell} = \lambda\left(fd_t + op_t + + dsg\right) \tag{4.55}$$

Where $fd$ is fiscal deficit; $op$ is world crude oil price and $\lambda$ is the elasticity.

Substituting 4.53, 4.54 and 4.55 into 4.52 to obtain:

$$\alpha\left(s_t + p_t - p_t^*\right) + nfa_t + \mu\left[i - i_t^* - \lambda\left(fd_t + op_t + dsg_t\right)\right] = 0 \tag{4.56}$$

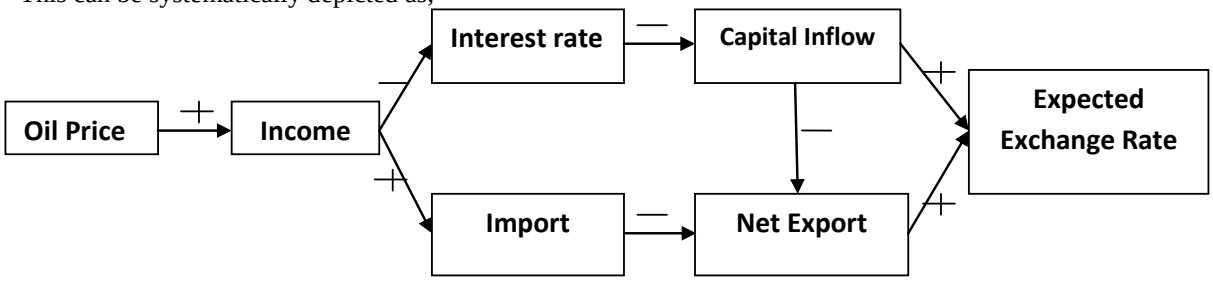
By simplification and expansion of (4.56), we obtain the general equilibrium exchange rate equation

$$\alpha_{11}s_t = -\alpha_{12}p_t + \alpha_{13}p_t^* - nfa_t - \mu_1 i_t + \mu_2 i_t^* + \mu_{31}\lambda_1 fd_t + \mu_{32}\lambda_2 op_t + \mu_{33}\lambda_3 dsg_t \tag{4.57}$$

Dividing both sides by $\alpha_{11}$ yields:

$$s_t = -\left(\frac{\alpha_{12}}{a_{11}}\right)p_t + \left(\frac{\alpha_{13}}{a_{11}}\right)p_t^* - \left(\frac{1}{a_{11}}\right)nfa_t - \left(\frac{\mu_1}{a_{11}}\right)i_t + \left(\frac{\mu_2}{a_{11}}\right)i_t^* + \left(\frac{\mu_{31}\lambda_1}{a_{11}}\right)fd_t + \left(\frac{\mu_{32}\lambda_2}{a_{11}}\right)op_t + \left(\frac{\mu_{33}\lambda_3}{a_{11}}\right)dsg_t \tag{4.58}$$

[2] This can be systematically depicted as;



with

$\alpha_1 = \alpha_{11} + \alpha_{12}$

$\mu = \mu_1 + \mu_2 + \mu_3$

$\mu_3 = \mu_{31} + \mu_{32} + \mu_{33}$

The equation 4.58 usually conceived to be a general expression of an equilibrium exchange rate in that it satisfies the balance of payments equilibrium under floating exchange rates and covers the money, goods and asset markets. It is clear that $\mu \to \infty$ means that uncovered interest rate parity (UCIRP) is satisfied and $\alpha_1 \to \infty$ means that PPP is satisfied.

## *4.4 Model Specification and Analytical Techniques*

In this section, all the models employed are clearly specified. These models are adapted from Mallick(2010) and An and Sun(2008) after taking into consideration the structural characteristics of the Nigerian economy as an oil producing economy.

In order to achieve the objectives of the study and to have a holistic picture of the relationship between macroeconomic policy shocks and the movement of exchange rate in Nigeria, two models are applied. First, the Autoregressive Conditional Heteroskedasticity (ARCH) model introduced by Engle (1982) and the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model by Bollerslev (1986). They are applied to estimate the degree and severity of exchange rate volatility in the economy. Second, a Structural Vector Autoregressive Model (SVAR) is applied to measure the effects of macroeconomic policy shocks on exchange rate volatility in Nigeria as well as the response of exchange rate volatility to both internal and external macroeconomic shocks.

### 4.4.1 Specification of ARCH and GARCH Models

In the literature (Kenen and Rodrik, 1986; Peree and Steinherr, 1989; Cote 1994; McKenzie and Brooks, 1997), various measures of exchange rate volatility have been employed to examine the variability of pair-wise cross-country exchange rate based on the observation that exchange rate time series are typically heteroskedastic, leptokurtic and exhibit volatility clustering, that is, varying variance - over a specified period of time. On this basis and in line with the research objective of this study, the study examines the degree and the severity of exchange rate volatility between the end of fixed currency era which marks the inception of the IMF prompted Structural Adjustment Programme (SAP) in 1986 and 2009. Like other empirical studies, the ARCH and GARCH models were used to capture the extent and severity of exchange rate volatility in Nigeria. The choice of this model is based on its empirical use in various areas of econometric modelling, especially in financial time series analysis (Engle 1982; Bollerslev 1986; Bollerslev, Chou and Kroner 1992; Bollerslev, Engle and Nelson 1994; Yinusa 2004; Yinusa and Akinlo and Akpokodje) and its approach in modelling financial time series with an autoregressive structure in that heteroscedasticity observed over different periods may be autocorrelated.

In developing an ARCH model, we considered two distinct specifications-one for the conditional mean and the other for conditional variance. Generalising this, the standard GARCH (p, q) specification is expressed as;

$$y_t = \alpha + \sum_{i=1}^{k} \eta_i x_{t-i} + \varepsilon_t \tag{4.59}$$

$$\varepsilon_t \approx N\left(0, \sigma_t^2\right) \tag{4.60}$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i \sigma_{t-i}^2 \tag{4.61}$$

The mean equation given in equation 4.60 is expressed as a function of a constant $\alpha$ - (taken as a mean if other exogenous variables are assumed to be zero), exogenous

variable(s) $x_{t-i}$ -(majorly in autoregressive (AR) structure of order k) and with an error term $\varepsilon_t$. Note, $y_t$ is the first difference in the log of the exchange rate at time $t$. Since $\sigma_t^2$ is the one-period ahead forecast variance based on past information, it is called conditional variance. Equation (4.60) expresses the normal distribution assumption (*white noise*) of the error term. The conditional variance equation specified in 4.61 is a function of three components, namely:

- The mean: $\omega$
- The news about volatility from the previous period, measured as the lag of the squared residual from the mean equation: $\varepsilon_{t-i}^2$ (the ARCH term); and
- Last period's forecast variance: $\sigma_{t-1}^2$ (the GARCH term).

In equation 4.59, k is the order of the AR term while in equation 4.61, p is the order of the ARCH term and q is the order of the GARCH term. According to Gujarati (2004), a GARCH (p, q) model is equivalent to an ARCH (p+q). That is, in our specification ARCH (k), where k = p + q. For instance, a standard GARCH (1, 1) refers to the presence of a first-order ARCH term (the first term in parentheses-- p, lagged term of the squared error term) and a first order GARCH term (the second term in parentheses—q, lagged of the conditional variance).

According to Yinusa and Akinlo (2008), the GARCH specification is often interpreted in financial context, where an agent or asset holder predicts this period's variance by forming a weighted average of a long-term (constant), information about volatility observed in the previous period (the ARCH term) and the forecast variance from the last period (the GARCH term). If the exchange rate changes were unexpectedly large in either the upward or the downward direction, then the agent will increase the estimate of the variance for the next

period. The GARCH model is also consistent with the volatility clustering often seen in financial returns data where large changes in returns are likely to be followed by further large changes. In the mean equation, the presence of volatility means that volatility in the current period is related to its values in the previous periods (k) plus a white noise error term.

For the purpose of this study, the presence of volatility clustering is determined by the significance of the lagged volatility series parameters- $y_t$. The extent or degree of exchange rate volatility is determined by the autoregressive root which governs the persistence of volatility shocks. This is the sum of $\alpha + \beta$ and the indications of volatility degree are expressed as follows:-

- If $\alpha + \beta \to 1$ i.e. is close to one, it indicates that volatility is present and persistent;
- If $\alpha + \beta > 1$ i.e. is greater than 1, it indicates overshooting volatility(which implies that the volatility is very high and may not be managed; and
- If $\alpha + \beta < 0.5$ i.e. is less than 0.5, it indicates no volatility.

### 4.4.2 Specification of the VAR Model

In order to study the interrelationship between macroeconomic policy and exchange rate, we adopt the VAR model framework used by Kim (2003) and extended and applied to Japan by An and Sun (2008). Thus, this study employs a restricted VAR model to measure the true structural effects of macroeconomic policy shocks on the movement of exchange rate in Nigeria. As VAR models have become more tuned to the data, some of the "puzzles" created by the results they produce in the literature have been resolved. Therefore, open economy VAR models now seem to explain certain key elements of macroeconomic movement tolerably well (Brischetto and Voss 1999). These models are now starting to yield useful insights about the transmission mechanism and how it differs through time.

To be able to capture the response of exchange rate to various incorporated macroeconomic shocks, we re-specify the general equilibrium model (4.58) within the VAR framework. The model used is an unrestricted VAR model that includes cointegrating relationships among variables of the model to capture the long run characteristics of the variables and incorporate an error correction mechanism to track their short run dynamics before imposing restrictions to examine the contemporaneous shocks relationship between macroeconomic policy and exchange rate in Nigeria based on formulated restricted or structural VAR model. The framework developed by Sims (1992), Bernanke (1986), Bernanke and Blinder (1992), Dale and Haldane (1993) and An and Sun, are adopted in formulating the structural VAR model. Therefore, to examine the effect of macroeconomic shocks (monetary, fiscal and external) on the movement of exchange rate in Nigeria, the unrestricted VAR models that assume interdependence among internal and external shock mechanism components-(monetary policy shock, fiscal policy shock, market fundamental shock and external shock)-and exchange rate are presented as follows.

From the theoretical formulated general equilibrium model (4.58) for analysing the effect of fiscal, monetary and external policies as macroeconomic components on exchange rate in Nigeria is expressed as:

$$s_t = -\left(\frac{\alpha_{12}}{a_{11}}\right)p_t + \left(\frac{\alpha_{13}}{a_{11}}\right)p_t^* - \left(\frac{1}{a_{11}}\right)nfa_t - \left(\frac{\mu_1}{a_{11}}\right)i_t + \left(\frac{\mu_2}{a_{11}}\right)i_t^* + \left(\frac{\mu_{31}\lambda_1}{a_{11}}\right)fd_t + \left(\frac{\mu_{32}\lambda_2}{a_{11}}\right)op_t + \left(\frac{\mu_{33}\lambda_3}{a_{11}}\right)dsg_t \quad (4.62)$$

Its reduced form is obtained by setting

$$\frac{\alpha_{12}}{\alpha_{11}} = \theta_1; \frac{\alpha_{13}}{\alpha_{11}} = \theta_2; \frac{1}{\alpha_{11}} = \theta_3; \frac{\mu_1}{\alpha_{11}} = \theta_4; \frac{\mu_2}{\alpha_{11}} = \theta_5 \qquad \frac{\mu_{31}\lambda_1}{\alpha_{11}} = \theta_6; \qquad \frac{\mu_{32}\lambda_2}{\alpha_{11}} = \theta_7 \text{ and}$$

$$\frac{\mu_{33}\lambda_3}{\alpha_{11}} = \theta_8$$

Incorporating the approximate parameters, we have the exchange rate general equilibrium equation as:

$$s_t = -\theta_1 p_t + \theta_2 p_t^* - \theta_3 nfa_t - \theta_4 i_t + \theta_5 i_t^* + \theta_6 fd_t + \theta_7 op_t + \theta_8 dsg_t \qquad (4.63)$$

The reduced exchange rate general equilibrium equation (4.63) shows the theoretical relationship between exchange rate and incorporated macroeconomic factors based on signs. For the purpose of empirical analysis and estimation, constant and stochastic terms are incorporated in equation (4.63) to have:

$$s_t = \theta_0 + \theta_1 p_t + \theta_2 p_t^* + \theta_3 nfa_t + \theta_4 i_t + \theta_5 i_t^* + \theta_6 fd_t + \theta_7 op_t + \theta_8 dsg_t + u_t \qquad (4.64)$$

Equation (4.64) is the empirical model emanating for the theoretical model of exchange rate general equilibrium equation for this study.

Assuming the economy can be described by the following structural form model:

$$x_t = A(L)x_{t-1} + u_t \qquad (4.65)$$

where: $x_t$ is an $n \times 1$ vector matrix incorporating $s_t, p_t, p_t^*, nfa_t, i, i_t^*, fd_t\ op_t$, and $dsg_t$ variables; $A(L)$ is a matrix polynomial for the lag operator of considered variables; and $u_t$ is a vector of unestimated shocks for each of the macroeconomic variables and it is assumed serially uncorrelated structural disturbance for Var ($u_t$) = Ω. where Ω is a diagonal matrix, so the structural disturbances are assumed to be mutually uncorrelated.

Therefore, the structural unrestricted VAR model for this study is specified as:

$$s_t = \Psi_1 + \sum_{i=1}^{a} \eta_{1i} s_{t-i} + \sum_{i=1}^{b} \theta_{11i} p_{t-i} + \sum_{i=1}^{c} \theta_{12i} p^*_{t-i} + \sum_{i=1}^{d} \theta_{13i} nfa_{t-i} + \sum_{i=1}^{e} \theta_{14i} i_{t-i}$$
$$+ \sum_{i=1}^{f} \theta_{15i} i^*_{t-i} + \sum_{i=1}^{g} \theta_{16i} fd_{t-i} + \sum_{i=1}^{h} \theta_{17i} op_{t-i} + \sum_{i=1}^{l} \theta_{j8i} dsg_{t-i} + u_{1t} \quad (4.66)$$

$$x_t = \Psi_1 + \sum_{i=1}^{a} \eta_{ji} s_{t-i} + \sum_{i=1}^{b} \theta_{j1i} p_{t-i} + \sum_{i=1}^{c} \theta_{j2i} p^*_{t-i} + \sum_{i=1}^{d} \theta_{j3i} nfa_{t-i} + \sum_{i=1}^{e} \theta_{j4i} i_{t-i}$$
$$+ \sum_{i=1}^{f} \theta_{j5i} i^*_{t-i} + \sum_{i=1}^{g} \theta_{j6i} fd_{t-i} + \sum_{i=1}^{h} \theta_{j7i} op_{t-i} + \sum_{i=1}^{l} \theta_{j8i} dsg_{t-i} + u_{jt} \quad (4.67)$$

Therefore, $\underset{2}{\overset{8}{j}} \rightarrow 8$

where $x_t$ is a vector (8 x 1) matrix of other endogenous variables excluding real exchange rate $s_t$.

$$x_t = \begin{bmatrix} p_t \\ p^*_t \\ nfa_t \\ i_t \\ i^*_t \\ fd_t \\ op_t \\ dsg_t \end{bmatrix} \quad (4.68)$$

where:

$s_t$ is the real exchange rate of naira vis-à-vis US dollar;

$p_t$ is the domestic price measured by consumer price index (CPI);

$p^*_t$ is the foreign price level measured by US wholesale price index (WPI);

$nfa_t$ is Nigeria's net foreign asset;

$i_t$ is the monetary policy rate proxy as domestic interest rate;

$i^*_t$ is the foreign interest rate proxy by the US Fed interest rate;

$fd_t$ is the fiscal deficit proxy by the difference between government revenue and total expenditure;

$op_t$ is crude oil price;

$dsg_t$ is foreign exchange demand and supply gap as a measure of market fundamentals;

$x_t$ is the extension of other macroeconomic variables excluding $s_t$ incorporated in the VAR model above;

$\eta_{ij}$ and $\theta_{ij}$ are parameters to be estimated in each system of equations;

$\psi_{ij}$ is the intercept;

$u_{it}$ is the innovation term that tends to propel shocks in the interdependence equation system (4.66) to (4.67); ,

$t$ is time; and

$i$ is the lag length to be determined by the Akaike and Schwarz information criteria.

In re-specifying the VAR system model 4.66 to 4.67 in matrix form, the matrix (9 x 9) is expressed as:

$$\begin{bmatrix} s_t \\ p_t \\ p_t^* \\ nfa_t \\ i_t \\ i_t^* \\ fd_t \\ op_t \\ dsg_t \end{bmatrix} = \begin{bmatrix} \eta_1 & \theta_{11} & \theta_{12} & \theta_{13} & \theta_{14} & \theta_{15} & \theta_{16} & \theta_{17} & \theta_{18} \\ \eta_2 & \theta_{21} & \theta_{22} & \theta_{23} & \theta_{24} & \theta_{25} & \theta_{26} & \theta_{27} & \theta_{28} \\ \eta_3 & \theta_{31} & \theta_{32} & \theta_{33} & \theta_{34} & \theta_{35} & \theta_{36} & \theta_{37} & \theta_{38} \\ \eta_4 & \theta_{41} & \theta_{42} & \theta_{43} & \theta_{44} & \theta_{45} & \theta_{46} & \theta_{47} & \theta_{48} \\ \eta_5 & \theta_{51} & \theta_{52} & \theta_{53} & \theta_{54} & \theta_{55} & \theta_{56} & \theta_{57} & \theta_{58} \\ \eta_6 & \theta_{61} & \theta_{62} & \theta_{63} & \theta_{64} & \theta_{65} & \theta_{66} & \theta_{67} & \theta_{68} \\ \eta_7 & \theta_{71} & \theta_{72} & \theta_{73} & \theta_{74} & \theta_{75} & \theta_{76} & \theta_{77} & \theta_{78} \\ \eta_8 & \theta_{81} & \theta_{82} & \theta_{83} & \theta_{84} & \theta_{85} & \theta_{86} & \theta_{87} & \theta_{88} \\ \eta_9 & \theta_{91} & \theta_{92} & \theta_{93} & \theta_{94} & \theta_{95} & \theta_{96} & \theta_{97} & \theta_{98} \end{bmatrix} + \begin{bmatrix} u_s \\ u_p \\ u_{p*} \\ u_{nfa} \\ u_{i*} \\ u_{ms} \\ u_{fd} \\ u_{op} \\ u_{dsg} \end{bmatrix} \quad (4.69)$$

We therefore proceed with the endogenous variables n=9 and we assume that the structure of the model is consistent with the class of dynamic linear stochastic models. The matrix form of the VAR model is presented in (4.69).

There are several approaches to recover the parameters in the structural form equation (4.66 to 4.67) from the estimated parameters in the reduced form equation (4.69). One way is to use recursive approach by assuming Wold-chain ordering in which some variables cannot respond to other variables contemporaneously (An & Sun; Mallick). However, there is no clean consensus about the ordering and some ordering may not be justified by the economic structure. Nigeria is a country in which monetary policy and exchange rate might respond to each other contemporaneously. As Glick and Hutchison (1994) point out, efforts to influence the exchange rate have had an impact on domestic monetary control. Thus, it is essential to use identification scheme that allows a contemporaneous response of monetary policy to the exchange rate shocks. So we employ the recursive contemporaneous restrictions in that they allow contemporaneous simultaneity among the variables incorporated in equation 4.69 based on the theoretical postulations, following Mallick (2010), Kim (2003), Kim and Roubini (2000) and An and Sun (2008).

The main purpose of structural VAR (SVAR) estimation is to obtain structural orthogonalisation of shocks for impulse response analysis to determine in-sample effects of shock mechanism. The recursive Cholesky orthogonalisation approach requires re-arrangement of incorporated variables and imposing restrictions on theoretical basis to identify the orthogonal (structural) components of the error terms. The macroeconomic variables integrated in the previous specified structural VAR model (4.66 to 4.67) are re-arranged as follows for the purpose of structural shocks identifications:

$$s_t = \alpha_0 + \sum_{i=1}^{a} \kappa_{11i} i^*_{t-i} + \sum_{i=1}^{b} \kappa_{12i} p^*_{t-i} + \sum_{i=1}^{c} \kappa_{13i} op_{t-i} + \sum_{i=1}^{d} \kappa_{14i} p_{t-i} + \sum_{i=1}^{e} \kappa_{15i} nfa_{t-i}$$
$$+ \sum_{i=1}^{f} \kappa_{16i} fd_{t-i} + \sum_{i=1}^{g} \kappa_{17i} i_{t-i} + \sum_{i=1}^{h} \kappa_{18i} dsg_{t-i} + \sum_{i=1}^{k} \kappa_{19i} s_{t-i} + u_{1t} \quad (4.70)$$

Following, theoretical assertions and empirical studies, the following restrictions are applied to the contemporaneous structural parameters in models (4.66) and its extension as described in vector (4.67). All the zero restrictions are some of the structural parameters which cannot respond to other variables contemporaneously and the parameters in the main diagonal of matrix are estimated to capture the response of exchange rate to macroeconomic shocks in the past. Therefore, the non-unitary diagonal matrix for the short run restrictions for both external and internal shocks is shown below:

$$\begin{bmatrix} u_{i*} \\ u_{p*} \\ u_{op} \\ u_{p} \\ u_{nfa} \\ u_{fd} \\ u_{i} \\ u_{dsg} \\ u_{s} \end{bmatrix} = \begin{bmatrix} \kappa_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \kappa_{21} & \kappa_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \kappa_{31} & \kappa_{32} & \kappa_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ \kappa_{41} & \kappa_{42} & \kappa_{43} & \kappa_{44} & 0 & 0 & 0 & 0 & 0 \\ \kappa_{51} & \kappa_{52} & \kappa_{53} & \kappa_{54} & \kappa_{55} & 0 & 0 & 0 & 0 \\ \kappa_{61} & \kappa_{62} & \kappa_{63} & \kappa_{64} & \kappa_{65} & \kappa_{66} & 0 & 0 & 0 \\ \kappa_{71} & \kappa_{72} & \kappa_{73} & \kappa_{74} & \kappa_{75} & \kappa_{76} & \kappa_{77} & 0 & 0 \\ \kappa_{81} & \kappa_{82} & \kappa_{83} & \kappa_{84} & \kappa_{85} & \kappa_{86} & \kappa_{87} & \kappa_{88} & 0 \\ \kappa_{91} & \kappa_{92} & \kappa_{93} & \kappa_{94} & \kappa_{95} & \kappa_{96} & \kappa_{97} & \kappa_{98} & \kappa_{99} \end{bmatrix} + \begin{bmatrix} \varepsilon_{i*} \\ \varepsilon_{p*} \\ \varepsilon_{op} \\ \varepsilon_{p} \\ \varepsilon_{nfa} \\ \varepsilon_{fd} \\ \varepsilon_{i} \\ \varepsilon_{dsg} \\ \varepsilon_{s} \end{bmatrix} \quad (4.71)$$

Equation 4.71 shows the reduced matrix form of the restricted structural VAR model after re-arrangement of variables as opposed to the specified unrestricted VAR model (4.69) that its incorporated variables are not rank since they are theoretically formulated and not meant to analysis the shock mechanism response of exchange rate to macroeconomic policy in Nigeria. The $u$ (9 x 1) matrix is the vector of estimated (unrestricted) VAR residuals, $\kappa_{ij}$ (9 x 9) is the parameters of identified short-run restrictions, and $\varepsilon_t$ (9 x 1) is the vector of structural shocks.

From the equation (4.69) we allow Nigeria's monetary policy to respond to the foreign monetary policy contemporaneously. Kim (2003) shows that an expansionary foreign monetary policy tends to decrease the real interest rate of developing countries instantaneously. By imposing non-zero, we assume that monetary policy in Nigeria pays special attention to the exchange rate. It is a custom in the literature too. The monetary aggregate equation is specified as a standard money demand equation, dependent upon real income, opportunity cost of holding money, that is, the domestic interest rate, domestic inflation rate and exchange rate. $M_2$ as a measure of monetary aggregate is used which is consistent with its use in a cross-country study by An and Sun (2008), Kim and Roubini (1999), Viseth (2001) for Cambodia and Adebiyi (2007) for Nigeria.

The exchange rate equation is treated as dependent on all innovations of the model. This reflects the fact that the exchange rate is a financial variable and reacts quickly to all information. Aside from this, the exchange rate is an indirect tool of monetary policy especially in a free market economy where exchange rates are allowed to float. A similar argument was employed by Cushman and Zha (1997) and also, by Brischetto and Voss (1999).

## *4.5 Estimation Procedures*

In this section, the study presents how the objectives of the study were achieved through the estimation of the models employed that were discussed in the earlier section. Generally, the two models employed were used to achieve the five objectives of the study. Objective one of this study which is on establishing the depth/degree severity of exchange rate volatility in Nigeria is captured through the estimation of both ARCH and GARCH models. Objectives two which involve the estimation of the impacts of both internal and external macroeconomic policy shocks on exchange rate volatility in Nigeria is captured

through the estimation of the vector error correction(VEC) model. The estimation of the VEC model clearly shows the direction of the impacts (either positive or negative) and the magnitude of the impacts of each of the macroeconomic variables on exchange rate volatility.

Objective three which is on the response of exchange rate volatility to macroeconomic shocks is captured through the computation of the impulse response function as well as the variance decomposition obtained from the SVAR model results. Both the ARCH and GARCH and the SVAR were computed across the different exchange rate regimes in Nigeria to capture objective four which aims to ascertain the impact of regime shift on volatility of exchange rate in Nigeria. The last objective of the study is captured through SVAR granger causality tests to show the causal relationship between the exchange rate volatility and macroeconomic policy shocks in the economy. A detail discussion of the estimation procedures are presented in what follows.

### 4.5.1 Estimation of ARCH and GARCH Models

In order to precisely capture the degree and severity of exchange rate volatility in Nigeria, this study employed the ARCH approach developed by Engle (1982) and the GARCH approach developed by Bollerslev (1986). Several measures of volatility have been employed in the literature. These can be broadly divided into:

(i) those that use various modifications of standard deviations and

(ii) the ones that use different versions of the ARCH and GARCH techniques.

One of the major criticisms of the different variants of standard deviation as a measure of exchange rate volatility is that they ignore the stochastic process generating the exchange rates. They are unconditional measures of volatility that ignore relevant information on the random process generating the exchange rate (Engle, 1982 and Ogunleye, 2009). In addition, the standard deviation measure of volatility is characterised by skewed distribution.

Exchange rates are typified by volatility clustering, implying that future exchange rate changes are not independent of the past and current changes. To correct for these apparent deficiencies, the ARCH was introduced by Engle (1982) and later modified by Bollerslev (1986) as GARCH.

One basic advantage of ARCH and GARCH models and its variants over standard deviation measures is their ability to distinguish between predictable and unpredictable elements in RER formation process and are, therefore, not prone to overstating volatility (Arize, *et al*, 2000; Darrat and Hakim, 2000 and Ogunleye, 2009).

However, the appropriate number of ARCH term p and GARCH term q in the conditional variance equation (4.61) are determined based on the minimum Akaike and Schwarz Information criteria. The number of lag for the autoregressive components AR(k) that is, lag of exchange rate volatility-is determined by the minimum Akaike and Schwarz Information criteria and also, the significance nature of the parameters in order to detect the presence of volatility clustering in the exchange rate series from the GARCH mean equation (4.59). The degree or extent of exchange rate volatility in Nigeria is indicated by the sum of the ARCH and GARCH term parameters, that is, $\alpha + \beta$.

### 4.5.2 Examining the Time Series Properties of the Series

Prior to all the estimation, the time series properties of the incorporated variables in the models were examined using the ADF unit root test. The time series properties of all the variables were examined in order to have a reliable result. The exercise was carried out using Augmented Dickey-Fuller (ADF) test as articulated in Engle and Granger (1987). Conventionally, testing for unit roots in data always precedes cointegration analysis. These tests were used to determine the degree of integration of variables. That is, how many times a variable should be differenced to attain stationarity.

The ADF test is based on the following system of equations:

***Intercept***

$$\Delta X_t = \varphi_0 + \varphi_1 X_{t-1} + \sum_{i=1}^{m} \vartheta_i \Delta X_{t-i} + \omega_t \quad (4.72)$$

***Trend***

$$\Delta X_t = \varphi_0 + \varphi_1 X_{t-1} + \varphi_2 t + \sum_{i=1}^{m} \vartheta_i \Delta X_{t-i} + \omega_t \quad (4.73)$$

where: $\omega_t$ is the residual term and $X_t$ is the time series variable.

The Augmented Dickey Fuller (ADF) unit root test is used to determine number of differencing; the backward moving average is incorporated in the model. Further, the cross-correlation is used to determine the number of lag of the explanatory variables to be incorporated.

### 4.5.3 Conducting Johansen Cointegration Test

Therefore, the Johansen (1997) method will be used to examine the existence of a long-term relationship among the variables. The relationships among the variables are based on the following model:

Consider a VAR of order *p*

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + B x_t + \varepsilon_t \quad (4.74)$$

where $y_t$ is a *k*-vector of non-stationary I(1) variables, $x_t$ is a *d*-vector of deterministic variables and $\varepsilon_t$ is a vector of innovations. We can rewrite this VAR as:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-1} + B x_t + \varepsilon_t \quad (4.75)$$

where: $\Pi = \sum_{i=1}^{p} A_i - \mathrm{I}, \qquad \Gamma_i = -\sum_{j=i+1}^{p} A_j$

Granger's representation theorem asserts that if the coefficient matrix $\Pi$ has reduced rank $r < k$, then there exist $k \times r$ matrices $\alpha$ and $\beta$ each with rank $r$ such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is I(0). Where: $r$ is the number of cointegrating relations (the cointegrating rank) and each column of $\beta$ is the cointegrating vector and $\alpha$ represents the speed of adjustment parameters. Johansen developed two likelihood ratio tests for testing the number of cointegration vectors ($r$): the trace and the maximum Eigenvalue test. The trace statistics test the null hypothesis of $r = 0$ (i.e. no cointegration) against the alternative that $r > 0$ (i.e. there is one or more cointegration vector). The maximum Eigenvalue statistics test the null hypothesis that the number of cointegrating vectors is $r$ against the alternative of $r + 1$ cointegrating vectors. The cointegration test was applied using selected lag-lengths based on minimum AIC and SIC in the VAR.

### 4.5.4 Non-Stationary Series and Cointegrated VAR: Error Correction Analysis Procedure

There is a general contention in econometric literature that a cointegrated VAR with non-stationary time series is best estimated with VEC model to determine the short-run dynamic interaction among set of macroeconomic variables from the cointegrating (long-run) VAR equation (4.69). The major distinct between VAR and VEC models is the incorporation of error correction mechanism (ECM) term that tries to explaining the speed of convergence or divergence to a long-run equilibrium from a short-run disequilibrium since the cointegrated times series could not converge to their individual mean in the long-run ( that is, non-stationary).

Therefore, the estimation procedure involves estimation of the specified VAR model [4.69] and test for cointegration using Johansen Cointegration test as expressed in equation [4.74] and [4.75]. The series are found to exhibit at least one-cointegrating equation, we then

proceed to estimate a vector error correction (VEC) model with the incorporation of a error correction mechanism term from the estimated VAR model expressed as:

$$\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{17i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{18i} \Delta dsg_{t-i} + \varepsilon_{1t} \quad (4.76)$$

For essence of robustness, several estimation scenarios can be considered to examine the precise contemporaneous link between exchange rate volatility and macroeconomic policy in Nigeria, determine the speed of long-run equilibrium adjustment and analyze the differential effect of internal and external macroeconomic policy variables on exchange rate in Nigeria.

### 4.5.5 Estimating the SVAR Model

Further, this study adopted a restricted structural vector autoregression SVAR model. The choice of this model is based on its level of strength over other models (especially unrestricted VAR) in measuring structural effects of a policy change. As argued by Bernanke and Blinder (1992,), ". . . it is extremely risky to make structural inferences from unrestricted VAR which after all are only reduced forms. If we want to measure the true structural effects of a policy change, there are only two alternatives". First, we can specify and estimate a structural economic model, such as the restricted VAR model employed by Bernanke (1986). The second alternative is to find a proper measure of macroeconomic policy variables. Thus, the chosen variables must have a good reduced-form predictor of major macroeconomic activities (Bernanke and Blinder, 1992). Besides, several other studies even on Nigeria acclaimed that VAR models are the best method for investigating shock transmission among variables because they provide information on impulse responses (Adrangi and Allender, 1998; Zellner and Palm, 1974; Zellner, 1979; Palm, 1983; Adebiyi and Lawanson, 2006;

Yinusa and Akinlo, 2008; Ogunleye, 2009). Thus, a VAR model represents a reduced form of any wide variety of simultaneous structural models.

Following the above assertion, this study relies on a simple restricted SVAR technique to estimate the transmission mechanisms and to exhibit broad stylised facts. *The VAR methodology popularised by Sims (1980) are structural models in the sense that variables bear intuitive relation with economic theory. In particular, this relationship may be so complicated that it is more enriching to allow the data rather than the scholar determining the dynamic structure of the model*. This is where the VAR approach has its attraction in contrast to other models such as the Box Jenkins or ARIMA.

Under the SVAR procedure, only two things are needful:

(i) the set of endogenous variables (and exogenous variables if considered essential) that are germane to the system; and

(ii) the appropriate lag length or the largest number of lags that will capture the interactions between the variables which can be determined by minimum Akaike and Schwarz information criteria.

Subsequently, each endogenous variable is regressed on its lagged values and those of other variables in the system. However, in order to avoid the multicollinearity problems that may arise from the individual regressors, an Impulse Response Functions (IRF) and Variance Decomposition Analysis (VDA) were carried out. The impulse response function is employed to determine the response of exchange rate volatility to accumulated one-standard deviation shock exerted on the incorporated macroeconomic policy variables.

### 4.5.6 Macroeconomic Shocks Estimation

The short-run restriction parameters [$\kappa_{ij}$ (9 x9)] in the structural vector autoregressive model (4.76) is estimated by first estimating the residuals [$u$(9 x 1)]of each considered

macroeconomic policy variables and exchange rate volatility in the unrestricted VAR in (4.69). While the extracted structural shocks [$\varepsilon_t$ (9 x 1)] (i.e. macroeconomic policy shocks) from the estimated SVAR model is used for Impulse Response Function (IRF) that describes the in-sample effect of a typical shock to the system and also for the variance decomposition that assess the importance of different shocks by determining the relative share of variance that each structural shock (that is, macroeconomic shocks) contributes to the total variance of each variable (that is, exchange rate volatility).

### 4.5.7 Estimating the Impulse Response Function and the Variance Decomposition

Innovation accounting such as the impulse response function and forecast error variance decomposition (FEVD) is used in analysing the interrelationships among the variables chosen in the system of equation condensed. The impulse response functions are responses of all variables in the model to a one unit structural shock to one variable in the model. The impulse responses are plotted on the Y-axis with the period from the initial shock on the X-axis. Formally, each $\phi_{jk}(i)$ is interpreted as the time specific derivatives of the VDA ($\infty$) function (Engle, 1982):

$$\phi_{jk}(i) = \frac{\partial X_{jk}}{\partial \ell_k} \qquad (4.77)$$

Equation 4.77 measures the change in the $j^{th}$ variable in period *t* resulting from a unit shock to the $k^{th}$ variable in the present period. The FEVD measures the proportion of movement in a sequence attributed to its shock to distinguish it from movements attributable to shocks to another variable (Ender, 1982). In the FEVD analysis, the proportion of Y variance due to Z shock can be expressed as:

$$\frac{\sigma_z^2\left[\delta_{12}(0)^2+\delta_{12}(1)^2+.....+\delta_{12}(m-1)^2\right]}{\sigma_y(m)^2} \qquad (4.78)$$

One can see that as *m* period increases the $\sigma_y(m)^2$ also increases. Further, this variance can be separated into two series: $y_t$ and $z_t$ . Consequently, the error variance for *y* can be composed of $\ell_{yt}$ and $\ell_{zt}$. If $\ell_{yt}$ approaches unity it implies that $y_t$ series is independent of $z_t$ series. It can be said that $y_t$ is exogenous relative to $z_t$. On the other hand, if $\ell_{yt}$ approaches zero (indicates that $\ell_{zt}$ approaches unity) the $y_t$ is said to be endogenous with respect to the $z_t$ (Engle, 1982).

### 4.5.8 Estimation of the Pair-wise Granger Causality Test

In order to examine whether there are lead-lag relationships between the macroeconomic policy shocks and exchange rate volatility in Nigeria, the study conducted the Granger-causality test. The procedure is such that if the time series of a variable is non-stationary, I(1) and is not cointegrated, the variable is converted into I(0) by first differencing and Granger-causality test can be applied as follows:

$$\Delta X_t = \vartheta_x + \sum_{i=1}^{k}\rho_{x,i}\Delta X_{t-1} + \sum_{i=1}^{k}\psi_{x,i}\Delta Y_{t-1} + \varepsilon_{x,t}\,, \qquad (4.79)$$

$$\Delta Y_t = \vartheta_y + \sum_{i=1}^{k}\rho_{y,i}\Delta Y_{t-1} + \sum_{i=1}^{k}\psi_{y,i}\Delta X_{t-1} + \varepsilon_{y,t}\,, \qquad (4.80)$$

where, $\Delta X_t$ and $\Delta Y_t$ are the first difference of time series variable while the series is non-stationary. However, if a variable is non-stationary and cointegration, the Granger-causality test will be run based on the following equations:

$$\Delta X_t = \vartheta_x + \sum_{i=1}^{k}\rho_{x,i}\Delta X_{t-1} + \sum_{i=1}^{k}\psi_{x,i}\Delta Y_{t-1} + \varphi_x ECT_{x,t-1} + \varepsilon_{x,t}\,, \qquad (4.81)$$

$$\Delta Y_t = \vartheta_y + \sum_{i=1}^{k} \rho_{y,i} \Delta Y_{t-1} + \sum_{i=1}^{k} \psi_{y,i} \Delta X_{t-1} + \varphi_y ECT_{y,t-1} + \varepsilon_{y,t}, \qquad (4.82)$$

where: $\varphi_x$ and $\varphi_y$ are the parameters of the ECT term, measuring the error correction mechanism that drives the $X_t$ and $Y_t$ back to their long run equilibrium relationship. The null hypothesis for the equation (4.79) and (4.81) is $H_o : \sum_{i=1}^{k} \psi_{x,i} = 0$, suggesting that the lagged item $\Delta Y_t$ do not belong to the regression. Conversely, the null hypothesis for the equations (4.80) and (4.82) is $H_0 : \sum_{i=1}^{k} \psi_{y,i} = 0$, that is the lagged term $\Delta X_t$ do not belong to the regression. These hypotheses are tested using the F-test.

### 4.5.9 Statistical Packages

The Econometric view (E-View) version 7.1 is the statistical package that will be employed to carry out the various tests mentioned above.

## *4.6 Data Requirements, Measurements and Sources*

The study used quarterly series from 1986 to 2009. Specifically, the data used in this study are quarterly time series on exchange rate of the naira vis-à-vis US dollar, money supply, CPI, interest rate, net foreign assets, United State Federal Reserve Fund interest rate, foreign price, foreign exchange demand and supply gap, fiscal deficit as a ratio of GDP (measures fiscal imbalances) and world oil price.

It should be noted that the trade-weighted exchange rate as against the bilateral exchange rate is not significantly different from the bilateral exchange rate. This study adopts a bilateral exchange rate which is in line with other studies in this area. Such studies include

Olopoenia, Obadan, An and Sun and Mallick. Besides, in most cases, trade-weighted exchange rate reduces the predictive ability of a model.

The quarterly data of CPI, broad money supply, interest rate, fiscal deficit and exchange rate are extracted from the CBN statistical bulletin, Volume 20, 2009. The data on United State whole price index, net foreign asset, world oil price and United State federal fund interest rate are sourced from *World Bank Development Indicator CD-Rom* (April, 2011).

# CHAPTER 5

# PRESENTATION AND DISCUSSION OF RESULTS

## *5.1 Introduction*

In this chapter, the study presents the data analysis, estimation and discussion of results of various specified models in the previous chapter. Specifically, the objectives and research questions raised in chapter one, are addressed using the methodological approaches and techniques discussed in chapter four. The results are also interpreted along the various theoretical lines of exchange rate determination presented in the previous chapters of this study.

## *5.2 Descriptive Statistical and Time Series Properties Analysis of the Data*

### 5.2.1 Descriptive Statistics Analysis

In this subsection, the study presents a brief statistical and summary description of all the macroeconomic time series data used for the analysis including the exchange rate. This allows us to relate the empirical results obtained from the models to the statistical results of the data and see if there is any divergence or convergence in the results. In addition, the time series properties of the variables are also examined. This is important because the ways the variables enter the models depend significantly on their time series properties.

Table 5.1 presents the average, minimum and maximum value of each of the incorporated macroeconomic time series data. The Table shows that the quarterly average of exchange rate of naira to a US dollar has been ₦64.0015 between the inceptions of the IMF adopted SAP - 1986 and 2009. While, the quarterly exchange rate series reached a peak and minimum of ₦152.3017 in 2009 third quarter and ₦21.8861 in 1993:1 - 1998:4 to $1 US respectively. The peak, minimum and time series trend is shown in Figure 5.1. The deteriorating trend of the exchange rate of naira vis-a-vis US dollar between third quarter of

2008 and last quarter of 2009 is necessitated as result of the global financial crisis that engulfed major economies and depleting foreign reserves. Also, the least exchange rate of naira vis-a-vis US dollar which stood at ₦21.8861 is recorded during regulated financial system era in Nigeria between first quarter of 1993 and last quarter of 1988.

Table 5.1 indicates that quarterly averages of real GDP in Nigeria, net foreign asset, broad money supply and fiscal deficit have been ₦94,040.13 million, ₦467,755.9 million, ₦172,2580 million and -₦ 30,690.43million respectively between 1986:Q1 and 2009:Q4. Also, the quarterly macroeconomic series -real gross domestic product in Nigeria, net foreign asset, broad money supply and fiscal deficit peaked at ₦185,824.4 million in 2009:Q4, ₦2,495,756 million in 2009:Q3, ₦10,767,378 million in 2009:Q4, -₦232,772.5 million in 2009:Q3 respectively. While the minimum quarterly value of the same macroeconomic time series stood at ₦50,564.33 million in 1987:Q2, - ₦3,944.307 million in 1994:Q2, ₦26,110 million and -₦308.03 million in 1995:2 respectively.

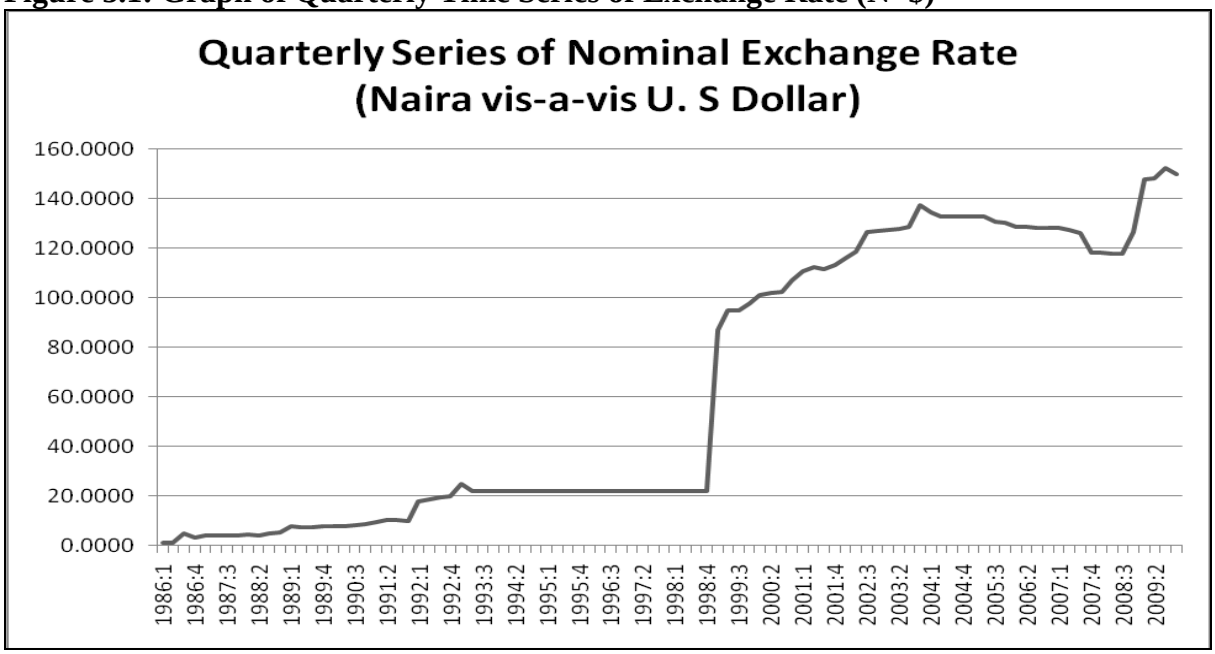
Likewise, the quarterly average of CPI and US whole price index is 48.28833 and 84.22083 basis points. These series peaked at 144.6999 in 2009 and 122.6708 in 2008:Q3. Likewise, there quarterly minimum stood at 1.38328 in 1986:Q1 and 63.25738 in 1986:Q3. All the incorporated macroeconomic time series - US real gross domestic output quarterly average stood at $2,233,205 million, peaked at $3,024,248 million in 2009:Q2 and hits its all time low of $1,537,299 million in 1986:Q1. The average market world oil price stood at $34.54 per barrel of crude oil between 1986:Q1 and 2009:Q4. The price peaked and recorded over two decade's low of $97.25 in 2009:Q4 and $2.27in 1998:Q2 respectively. The corresponding decades low in the second quarter of 1998 reflected the period of excess supply of crude oil beyond OPEC quota. Comparing the time seris trend of domestic income and foreign income as shown in Figure 5.2, there tends to be very wide gap in quarterly outputs of both country indicating the level of economic growth disparity.

**Table 5.1: Summary Statistics of Incorporated Macroeconomic Data**

| | S | P | P* | Y | Y* | NFA | I | I* | MS | OP | FD |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mean** | 64.00150 | 48.28833 | 84.22083 | 94040.13 | 2233205. | 467755.9 | 19.77292 | 7.345417 | 1722580. | 34.54333 | -30690.43 |
| **Median** | 21.88610 | 40.37924 | 80.53192 | 76687.39 | 2212478. | 49128.41 | 19.39521 | 8.043682 | 448887.3 | 22.26000 | -20481.17 |
| **Maximum** | 152.3017 | 144.6999 | 122.6708 | 185824.4 | 3024248. | 2495756. | 33.78671 | 11.16256 | 10767378 | 97.25000 | -232772.5 |
| **Minimum** | 1.001600 | 1.383280 | 63.25738 | 50564.33 | 1537299. | -3944.3 | 9.317732 | 2.906840 | 26110.00 | 2.720000 | -308.0265 |
| **Std. Dev.** | 55.43442 | 43.72388 | 14.72638 | 39109.40 | 459997.7 | 738355.4 | 4.331823 | 1.975659 | 2607972. | 25.17204 | 43904.43 |
| **Skewness** | 0.229852 | 0.655628 | 0.912610 | 0.888332 | 0.173795 | 1.606729 | 0.526046 | -0.4442 | 1.974908 | 1.188808 | -2.797467 |
| **Kurtosis** | 1.216902 | 2.217540 | 3.029365 | 2.393257 | 1.704692 | 4.154871 | 4.575802 | 2.403208 | 5.987722 | 2.950587 | 12.45694 |
| | | | | | | | | | | | |
| **Jarque-Bera** | 13.56307 | 9.326542 | 13.32917 | 14.09870 | 7.194568 | 46.64015 | 14.36019 | 4.582035 | 98.11013 | 22.62201 | 482.9483 |
| **Probability** | 0.001135 | 0.009436 | 0.001275 | 0.000868 | 0.027398 | 0.000000 | 0.000762 | 0.101163 | 0.000000 | 0.000012 | 0.000000 |
| | | | | | | | | | | | |
| **Sum** | 6144.144 | 4635.680 | 8085.200 | 9027852. | 2.14E+08 | 44904569 | 1898.200 | 705.1601 | 1.65E+08 | 3316.160 | -2946282 |
| **Sum Sq. Dev.** | 291932.6 | 181618.9 | 20602.29 | 1.45E+11 | 2.01E+13 | 5.18E+13 | 1782.645 | 370.8067 | 6.46E+14 | 60194.98 | 1.83E+11 |
| | | | | | | | | | | | |
| **Observations** | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 | 96 |

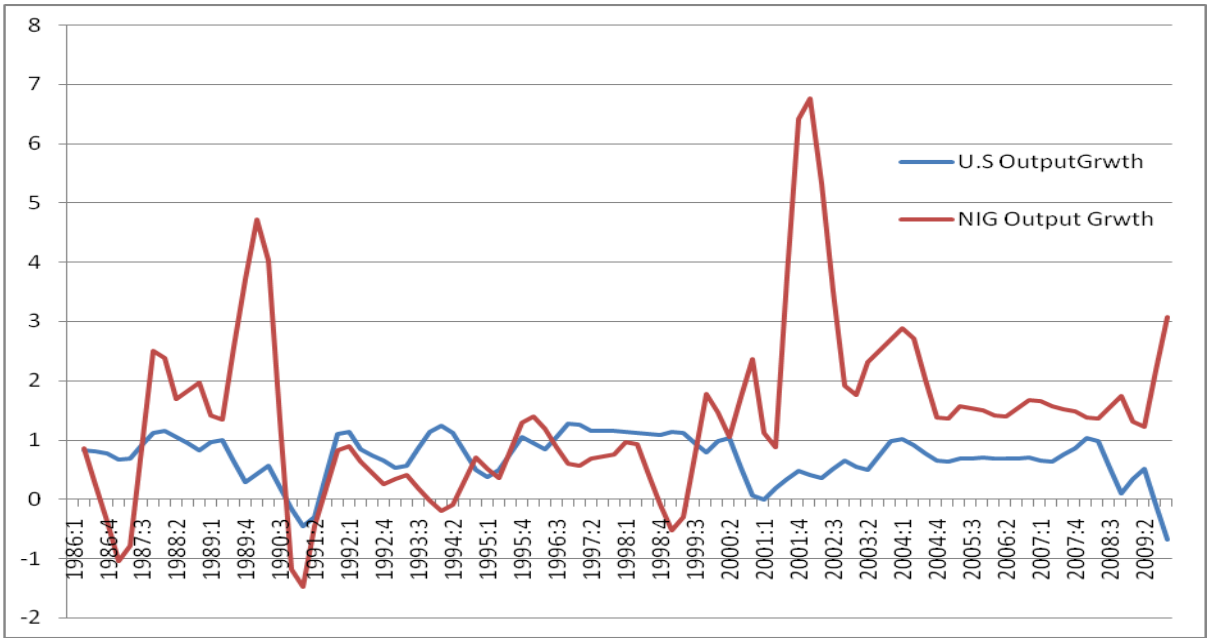
***Source: Author's computation.***

**Figure 5.1: Graph of Quarterly Time Series of Exchange Rate (₦=$)**




*Source: CBN Statistical Bulletin, various Issues*

**Figure 5.2: Graph of Quarterly Time Series of U.S.A and Nigeria's Outputs Growth**



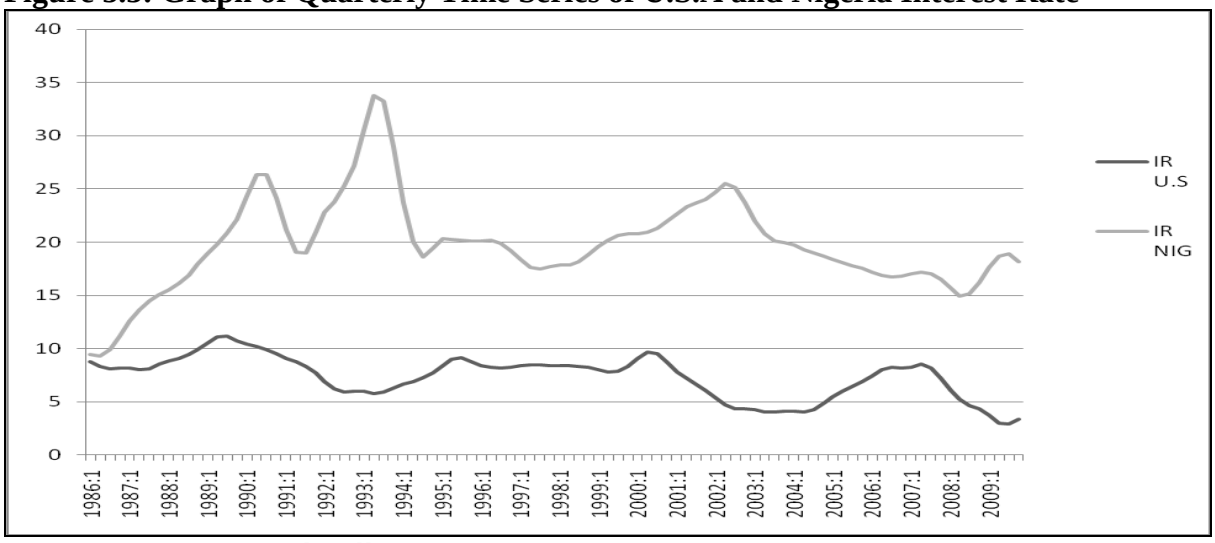

*Source: CBN Statistical Bulletin, various Issues*

For the other time series, the quarterly average value of domestic interest rate and US fed interest rate is 19.7729% and 7.3454% respectively. These series hit its all time quarterly high of 33.7877% in 1993:Q2 and 11.1626% in 1989:Q3. While their reported all time

quarterly low are 9.31773% in 1986:Q2 and 2.90684% in 2009:Q3. The statistical results show a high disparity between the domestic and foreign interest rate as shown in Figure 5.3. This may be adduced to ineffective monetary policy management that characterised developing nations like Nigeria.

However, the differences in the maximum and minimum periods of the series could be associated with different applications as well as the effects of the macroeconomic policies of the government at different points in time. For instance, in 1993 when the domestic interest rate was highest, this era corresponded to the period when there was failure of government attempts to restore fiscal and monetary stability which finally brought about the reversal of most important aspect of Nigeria's reform process. This era saw the end of the liberalisation of Nigeria's foreign exchange regime, that is, towards the end of 1993. The effect of this policy failure was the wide divergence of the naira exchange rates between the official and parallel markets that was astronomically high reaching 283 per cent between 1993 and 1994. Notably, since this period, exchange rate has been very volatile.

**Figure 5.3: Graph of Quarterly Time Series of U.S.A and Nigeria Interest Rate**




*Source: CBN Statistical Bulletin, various Issues*

Generally and clearly, the descriptive statistic of times series variables presented in Table 5.1 reveals that over time, there is no stability in the movement of macroeconomic

policies in maintaining favourable pattern of the indicators in Nigeria which resulted in large random value of the series most especially the variable of interest in this study – exchange rate. In other words, unstable macroeconomic policies could be a contributory factor to fluctuations of exchange rate in Nigeria.

### 5.2.2 Unit Root Test

Since the data set employed is a time series data, the unit root properties of the data were examined. This is to ascertain the stationarity or otherwise level of the data set before proceeding to the estimations of the models. It is a common practice in an empirical analysis like this for time series data to demonstrate signs of non-stationarity especially when both the mean and the variance of macroeconomic variables trend tend upwards over time or following consistent average pattern. Therefore, it is important to test explicitly for manifestations of non-stationarity because its presence often has important statistical and economic implications in analysis and model estimation. In particular, it can lead to an unacceptable and spurious result. It has been shown in a number of theoretical literatures that the statistical properties of regression analysis using non-stationarity time series data are likely to be spurious (Phillips, 1997; Yinusa, 2004; Yinusa and Akinlo, 2008 and Adebiyi, 2007).

The ADF unit root test result presented in Table 5.2 reveals that the incorporated time series variable-first difference measure of exchange rate volatility (SVF), coefficient of variation measure of exchange rate volatility (SVC) and domestic interest rate (I) reject the null hypothesis of no stationary at level of different lag length selected using Akaike and Schwarz information criteria. This implies that these macroeconomic variables are integrated of order zero.

For the other macroeconomic time series variables such as exchange rate (S), domestic price (P), foreign wholesale price index (P*), log of net foreign asset (LNFA), foreign interest rate (I*), log of broad money supply (LMS), fiscal imbalance (FD) and world oil price (OP) accept the null hypothesis "no stationary" at level and could not be rejected. This implies that the non-stationary series do not have a long-run mean which the series converge and the variance is dependent upon over time and tend to infinity as the sample period increases. However, the mean increase over time of the series is more evident in Figure 5.4.

But after first differencing and iteration based on a number of lags, the other time series variables are found to reject the hypothesis of no stationary at first difference with varying lags. This implies that all the first difference time series variables are integrated of order one. The result indicates that the incorporated time series variables are unstable and non-mean reverting and this might render the model estimations structurally unstable at levels.

### 5.2.3 Johansen Multivariate Cointegration Test

The non-stationary nature of the macroeconomic series of interest reported in Table 5.2 prompted the test for cointegration of the series in order to determine the choice of estimation techniques between VAR and VEC models for examining the dynamic effect of macroeconomic policy shocks on exchange rate volatility in Nigeria.

The Johansen's Trace and Maximum Eigen-value tests' results are shown in Tables 5.3 and 5.4 for linear deterministic model with intercept only and linear deterministic model with trend respectively. The cointegration test result indicates that there exist seven cointegrating equations among the exogenous variables considering the restriction of deterministic trend with intercept and linear trend which are based on the maximum Eigen statistic. This implies that there exist long run relationship between exchange rate volatility

and the macroeconomic variables incorporated in the estimated VAR model. The results indicated a strong evidence of that the exchange rate volatility had an equilibrium condition with macroeconomic policies which kept them in proportion to each other in the long-run and that at least one direction of long-run causal relation can be established among any pair of the series.

**Table 5.2: Unit Root Test Results**

| Variable | ADF Tau Statistics | | Order of Integration |
|---|---|---|---|
| | Intercept | Trend | |
| **S** | -8.6203* (0) | -8.5949* (0) | 1 |
| **SVF** | -10.7834* (0) | -11.0848* (0) | 0 |
| **SVC** | -10.7834* (0) | 11.0848* (0) | 0 |
| **P** | -2.5994*** (3) | -5.3452* (0) | 1 |
| **P*** | -6.9890* (2) | -7.1299* (2) | 1 |
| **LY** | -5.8686* (1) | -6.2771* (1) | 1 |
| **LY*** | -4.3468* (1) | -4.4820* (1) | 1 |
| **LNFA** | -5.7780* (1) | -5.7430* (1) | 1 |
| **I** | -2.9887** (11) | -3.4399*** (11) | 0 |
| **I*** | -5.2388* (9) | -5.1948* (9) | 1 |
| **LMS** | -10.6656* (0) | -10.6295* (0) | 1 |
| **FD** | -4.7985* (3) | -4.9154* (3) | 1 |
| **OP** | -5.4605* (2) | -5.6517* (2) | 1 |
| **DSG** | -2.8593***(11) | -4.3343* (11) | 0 |

*Source:* Author's computation.

Notes: *Significant at 1% level, **Significant at 5% and ***Significant at 10% McKinnon critical level. The value in parenthesis is the lag length based on the minimum Akaike and Schwarz information criteria.

**Table 5.3: Johansen Cointegration Rank Test Result - Linear Deterministic Trend Model with Intercept**

| Trend assumption: Linear deterministic trend | | | | |
|---|---|---|---|---|
| **R=No. Of CE(s)** | **Trace Statistic** | **Prob.**** | **Max-Eigen Statistic** | **Prob.**** |
| **R=0** | 1938.333* | 1.0000 | 504.4487* | 0.0001 |
| **R≤1** | 1433.885* | 1.0000 | 299.9054* | 0.0001 |
| **R≤2** | 1133.979* | 0.0001 | 283.1955* | 0.0000 |
| **R≤3** | 850.7837* | 0.0001 | 261.1746* | 0.0001 |
| **R≤4** | 589.6091* | 0.0001 | 207.9411* | 0.0001 |
| **R≤5** | 381.6680* | 0.0001 | 175.8790* | 0.0001 |
| **R≤6** | 205.7891* | 0.0001 | 122.4746* | 0.0001 |
| **R≤7** | 83.31440* | 0.0000 | 79.87353* | 0.0000 |
| **R≤8** | 3.440877 | 0.0636 | 3.440877 | 0.0636 |

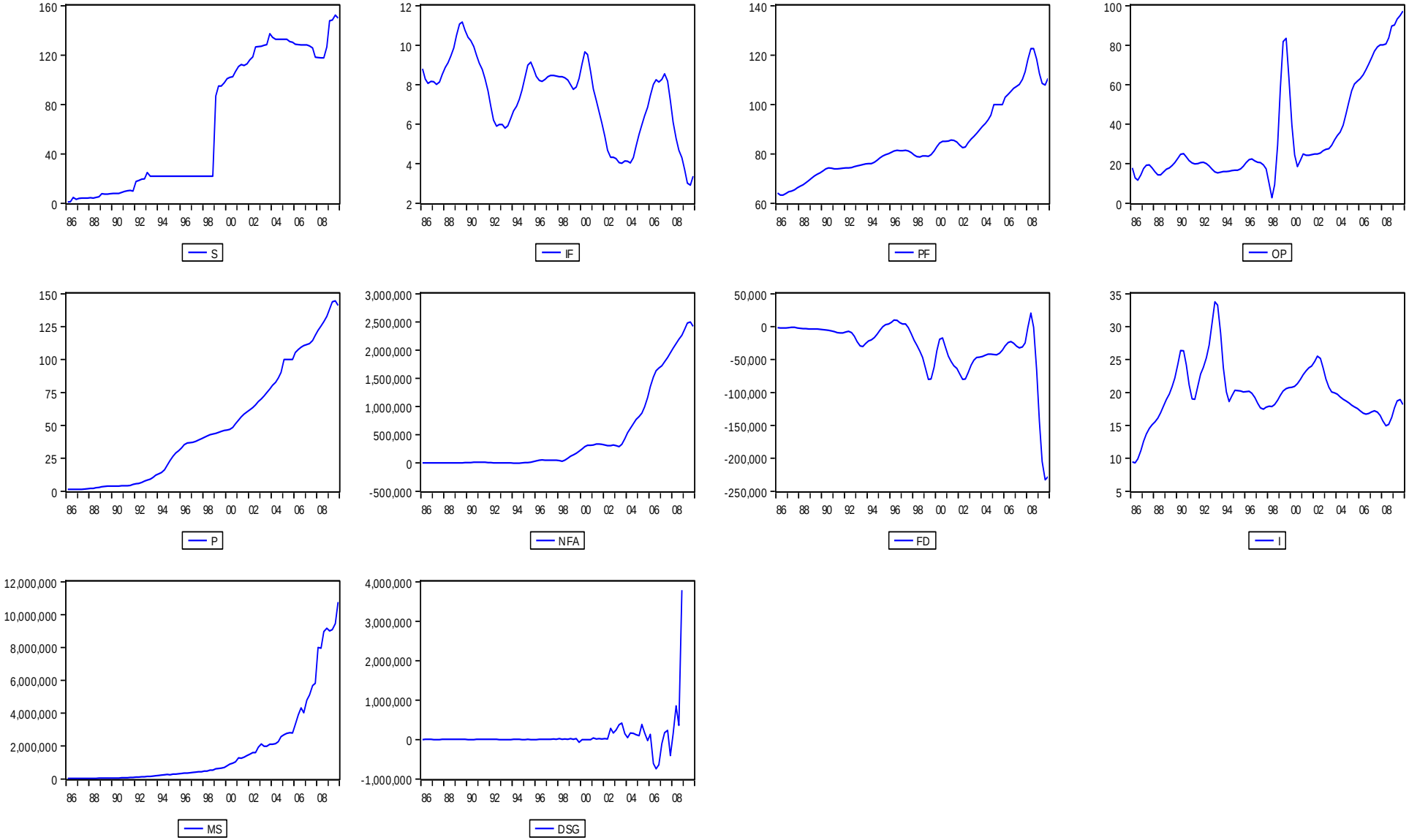
** denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values*
**Source:** *Author's computation*

**Table 5.4: Johansen Cointegration Rank Test Result -Linear Deterministic Trend Model with Intercept & Linear Trend**

| Trend assumption: Linear deterministic trend (restricted) | | | | |
|---|---|---|---|---|
| **R=No. Of CE(s)** | **Trace Statistic** | **Prob.**** | **Max-Eigen Statistic** | **Prob.**** |
| **R=0** | 2632.857* | 1.0000 | 711.6828* | 0.0001 |
| **R≤1** | 1921.174* | 0.0000 | 499.4122* | 0.0001 |
| **R≤2** | 1421.762* | 1.0000 | 295.6141* | 0.0001 |
| **R≤3** | 1126.147* | 0.0001 | 282.4905* | 0.0000 |
| **R≤4** | 843.6569* | 0.0001 | 261.0352* | 0.0001 |
| **R≤5** | 582.6217* | 0.0001 | 207.7521* | 0.0000 |
| **R≤6** | 374.8696* | 0.0001 | 175.0802* | 0.0001 |
| **R≤7** | 199.7895* | 0.0000 | 119.9314* | 0.0001 |
| **R≤8** | 79.85802* | 0.0000 | 79.85802* | 0.0000 |

** denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values*
**Source:** *Author's computation*

**Figure 5.4: Time Series Plot of Macroeconomic Series**



## *5.3 Testing for the Presence and Severity of Exchange Rate Volatility*

### 5.3.1 Exchange Rate Volatility Tests for the whole sample period

The exchange rate volatility of naira vis-a-vis US dollar is examined using the two volatility series variants generated, that is, first difference measure of exchange rate volatility (SVF), and the coefficient of variation measure of exchange rate volatility (SVC). The appropriate fitted GARCH model to the exchange rate volatility series is selected based on structural stability tests using the significance of z-statistic, coefficient of determination (R-Squared) and minimum Akaike and Schwarz information criteria. The results of the GARCH model results are presented in Table 5.5.

The estimated GARCH (1, 1) model result presented in Table 5.5 is divided into two parts – panels A and B. Panel A provides the standard output for the mean equation, that is, the ARCH parameters which signify the presence of volatility clustering and effect of previous volatility on the current. Panel B on the other hand tagged "Variance Equation" contains the coefficient, standard errors, z-statistics, p-values for the coefficient of the variance equation. In arriving at the AR(2) for the mean equation, other lower and higher orders ARCH models were examined but only the ARCH(2) model turned out to be significant and has the minimum Akaike and Schwarz information criteria.

The estimated mean equation in Table 5.5 reveals that first measure of exchange rate volatility (SVF) in the current period is significantly related to its first previous quarter of volatility ($SVF_{t-1}$). Since the coefficients of the first quarter lagged term of exchange rate volatility is highly significant (*p-values* of nearly zero), it implies the presence of volatility clustering. The volatility swings between the current and previous quarter of exchange rate volatility in Nigeria is depicted in Figure 5.5. Likewise, the normality test analysis on the

generated volatility series is presented in Figure 5.6. Figure 5.6 shows that the first difference exchange rate volatility is normally distributed based on its significant Jarque-Bera statistic.

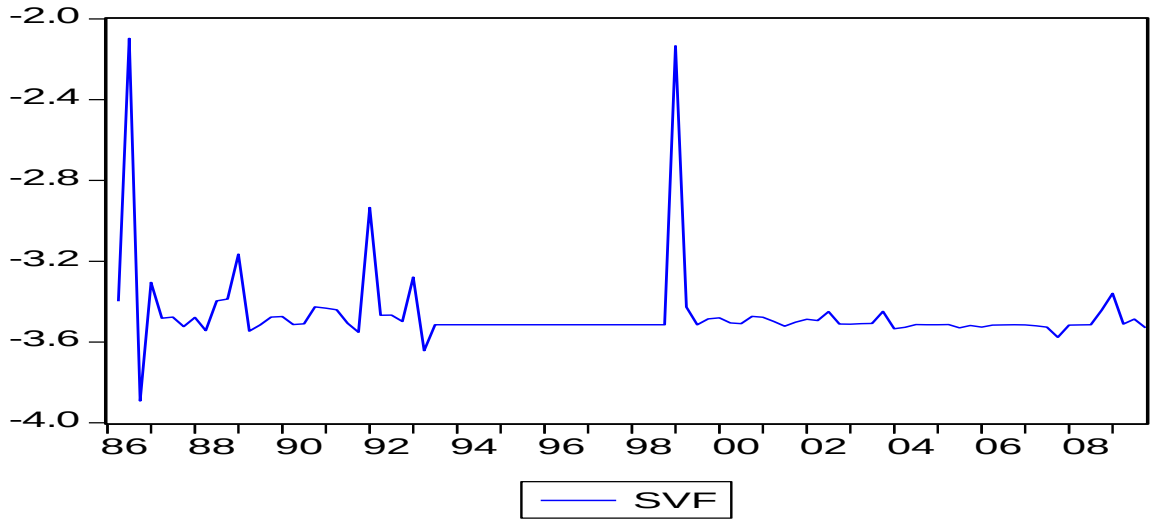
**Table 5.5: ARCH and GARCH Model Results of Exchange Rate Volatility**

| **PANEL A Mean Equation** | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C | -3.708264 | 0.187113 | -19.81830 | 0.0000 |
| SVF(-1) | -0.056938 | 0.011571 | -4.920674 | 0.0000 |
| SVF(-2) | -0.000301 | 0.042395 | -0.007095 | 0.9943 |
| **PANEL B Variance Equation** | | | | |
| C | 1.65E-05 | 8.32E-06 | 1.983324 | 0.0473 |
| ARCH (-1) | -0.022745 | 0.000951 | -23.92601 | 0.0000 |
| GARCH(-1) | 1.012420 | 0.001142 | 886.2598 | 0.0000 |
| R-squared | -0.019256 | Mean dependent var | | -3.476519 |
| Adjusted R-squared | -0.077834 | S.D. dependent var | | 0.168488 |
| S.E. of regression | 0.174922 | Akaike info criterion | | -1.683435 |
| Sum squared resid | 2.662011 | Schwarz criterion | | -1.520042 |
| Log likelihood | 84.27974 | Durbin-Watson stat | | 1.788809 |

***Source:*** *Author's computation.*

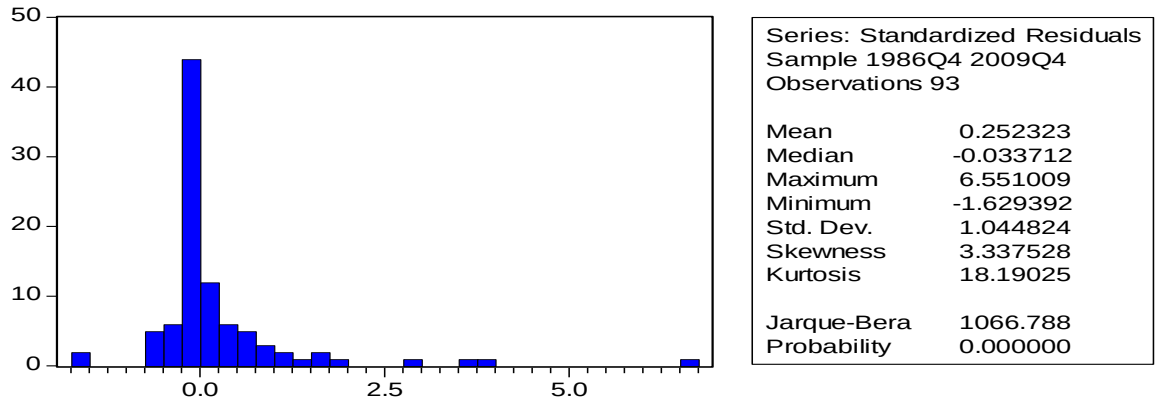
In ascertaining the degree and severity of exchange rate volatility in Nigeria based on exchange rate first difference measure series, the components (ARCH and GARCH terms) of the estimated variance equation presented in the lower part of Table 5.5 are summed. The sum of the ARCH and GARCH coefficients ($\alpha + \beta$) is 0.989675 which is close to one and greater than 0.5. This clearly indicates that volatility shocks are present and quit persistent in the exchange rates of the Nigerian naira against the US dollar. Therefore, the sum of the square error term and conditional variance coefficients in the estimated GARCH (1, 1) model result reveals that exchange rate in Nigeria had been volatile and persistent during the period under review. This result also conforms to other earlier empirical studies (Yinusa, 2004; Yinusa and Akinlo, 2008 and Akpokodje, 2009) on exchange rate volatility in Nigeria.

**Figure 5.5: Graph of Exchange Rate Volatility**




*Source: Extracted from the computed results*

***Figure 5.6: Normality Test of Exchange Rate Volatility***




*Source: Extracted from the computed results*

To further confirm the existence of significant exchange rate volatility, the coefficient of variation measure was also explored. It should be noted that there are some sceptics who argued that exchange rate volatility is affected by the way it is measured. In order to ensure that the measurement errors do not affect the result presented in this study, we extend the analyses to other measures of exchange rate volatility such as the coefficient of variation. The results obtained from the coefficient of variation measures are not different from that of the first difference measures of exchange rate volatility. The study analysis therefore stitches to the first difference measures of exchange rate volatility in this study. However, this measure of exchange rate volatility has been used extensively in several studies such as Kenen and

Rodrick (1986), Polak (1988), Chowdhury (1993), McKenzie (1999), Arize, Osang and Slottje (2000) and Gerardo and Felipe (2002) and Ogunleye (2009). On this basis, the first difference measure of exchange rate volatility (SVF) series is employed in subsequent estimation of our empirical model.

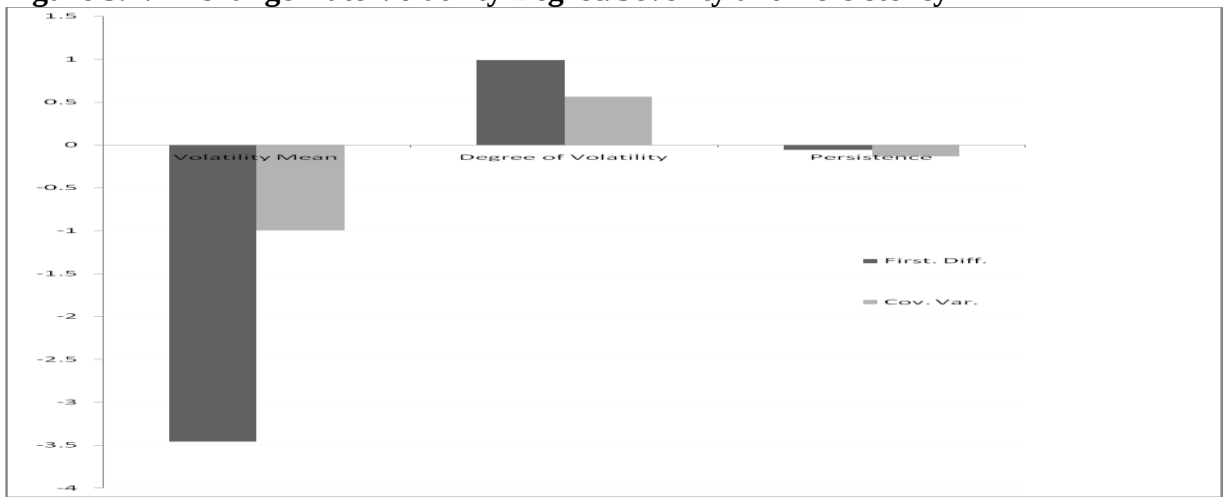
The main extract of findings of the mean[3], degree and persistence of exchange rate volatility is depicted in Figure 5.7 and values shown in Table 5.6. The average volatility as reported in Table 5.6 indicates long-run swings in exchange rate fluctuations in Nigeria. Likewise, there is persistency of exchange rate volatility in Nigeria going by the result. The result shows that the degree of volatility is significantly higher that the baseline value of 0.5. The degree which is measured by the covariance is negative and almost 1.0 (0.99992).

**Table 5.6: Structure of Exchange Rate Volatility in Nigeria**

| | **First. Diff.** | **Cov. Var.** |
|---|---|---|
| **Volatility Mean** | -3.4612 | -0.9992 |
| **Degree of Volatility** | 0.989675 | 0.561499 |
| **Persistency** | -0.05694 | -0.13618 |

*Source:* Author's Computation

**Figure 5.7: Exchange Rate Volatility Degree/Severity and Persistency**




*Source: Extracted from the computed results*

[3] The volatility mean is calculated based on the generated volatility series integrated in the estimation of the GARCH model.

### 5.3.2 Exchange Rate Volatility Tests for Different Exchange Rate Regimes

The volatility of exchange rate in different exchange rate policy regime is also examined using the similar method used for the whole sample periods. The detailed discussion of the nature of volatility in the nominal exchange rate of naira vis-a-vis US dollar based on the estimated ARCH and GARCH models for each of the era is presented in what follows.

#### *5.3.2.1 SAP Era (1986-1993)*

The volatility generated series of the exchange rate volatility are presented in Table 5.7. The results as depicted in Table 5.7 revealed that the previous volatility has significant effect on the current, suggesting presence of volatility clustering between the current and immediate previous volatility. This suggests that there is volatility clustering during the SAP era that marks the period of flexible exchange rate system.

In ascertaining the degree of exchange rate volatility in Nigeria the components of the variance equation, that is, the ARCH and GARCH terms are summed. Under the first difference measure of exchange rate volatility, the sum of the ARCH and GARCH ($\alpha + \beta$) is 1.047528 which is greater than one. This precisely indicates that during the flexible exchange rate regime under the SAP framework, there is presence of overshooting volatility in the exchange rate of naira vis-a-vis US dollar as depicted in Figure 5.8. This also suggests that the CBN finds it difficult to stabilise and manage volatility in the exchange rate of naira vis-a-vis US dollar during the flexible exchange rate regime and this has consequently affected the behaviour and movement of the exchange rate with difficulty in restoring it back to its original equilibrium point before the reform. The end results was the continuous adoption of different exchange rate management approaches which have proved ineffective. According to

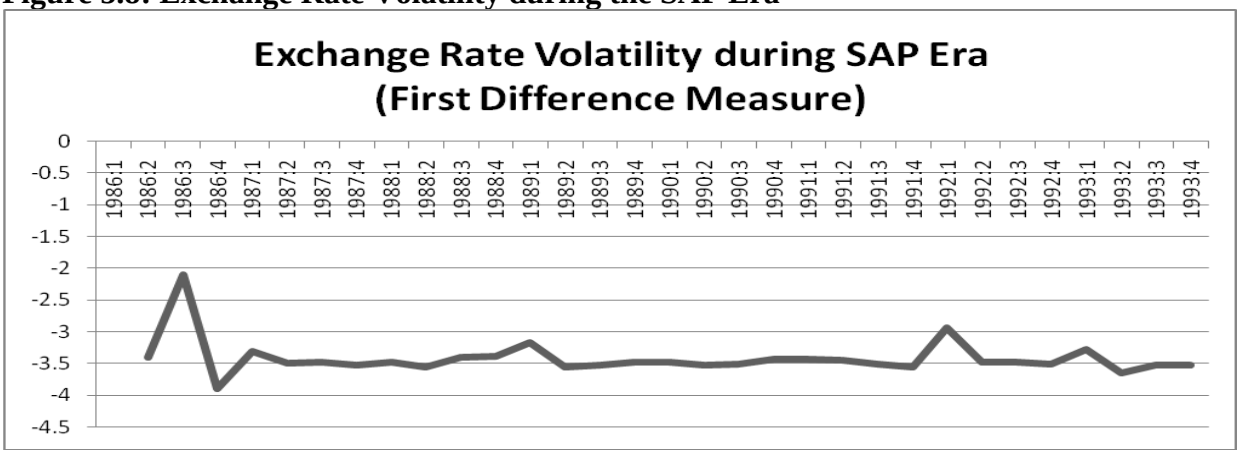
Balogun (2007), this period laid the foundation for exchange rates devaluation and the emergence of multiple exchange rate system in Nigeria.

**Table 5.7: Exchange Rate Volatility results during SAP Era**

| **Volatility** | **First Difference Measure** | |
|---|---|---|
| | **Mean Equation** | |
| | **Co-eff.** | **Prob.** |
| **C** | -4.496566 | 0.0000 |
| **SV(-1)** | -0.306522 | 0.0137 |
| **SV(-2)** | 0.008642 | 0.9499 |
| | **Variance Equation** | |
| | **Co-eff.** | **Prob.** |
| **C** | 0.000386 | 0.7389 |
| $\alpha$ **:ARCH(-1)** | -0.143207 | 0.0483 |
| $\beta$ **:GARCH(-1)** | 1.190735 | 0.0000 |
| | **Degree** | |
| | 1.047528 | |
| | **Residual Test** | |
| **Jarque Bera** | 9.121891 | |
| **Prob.** | 0.010452 | |
| | **ARCH Test** | |
| **F-Stat** | 0.228211 | |
| **Prob.** | 0.636845 | |
| | **Wald Test** | |
| | **Test Value** | **Prob.** |
| **F-Stat** | 24.65680 | 0.0001 |
| **Chi-square** | 24.65680 | 0.0000 |

**Source:** *Author's Computation*

**Figure 5.8: Exchange Rate Volatility during the SAP Era**




*Source: Extracted from the computed results*

*5.3.2.2 Post-SAP Era/Reform Lethargy Period (1994-2003)*

The ARCH (1) and GARCH (1, 1) are found fitted to the generated volatility series based on lag length iterations performed, employing the Akiake and Schwarz information criteria to examine the presence, persistence and degree of exchange rate volatility of naira vis-a-vis US dollar during the reform lethargy regime. The result of the estimated GARCH (1, 1) models and diagnostic tests are presented in Table 5.8.

From Table 5.8, the estimated mean equations revealed that first autoregressive (AR (1)) series of exchange rate volatility has no significant effect on current exchange rate volatility which indicates no volatility clustering during the reform lethargy exchange rate regimes. Also, the results under the variance equation reveal that the degree of exchange rate volatility based on the sum of the ARCH and GARCH terms is 0.550112. The sum of the ARCH and GARCH terms ($\alpha + \beta$) is greater than 0.5 and this indicates that there is presence and persistence of volatility in the exchange rate of naira vis-a-vis US dollar during the post-SAP era. However, when compared with what obtains during SAP era, it is glaring that exchange rate was relatively stable during the reform lethargy and NEEDS era than the SAP era. That is, the degree of volatility in the nominal exchange rate was higher during SAP compared to the reform lethargy era. The time series graph of the exchange rate volatility during the Post-SAP era is captured in Figure 5.9.

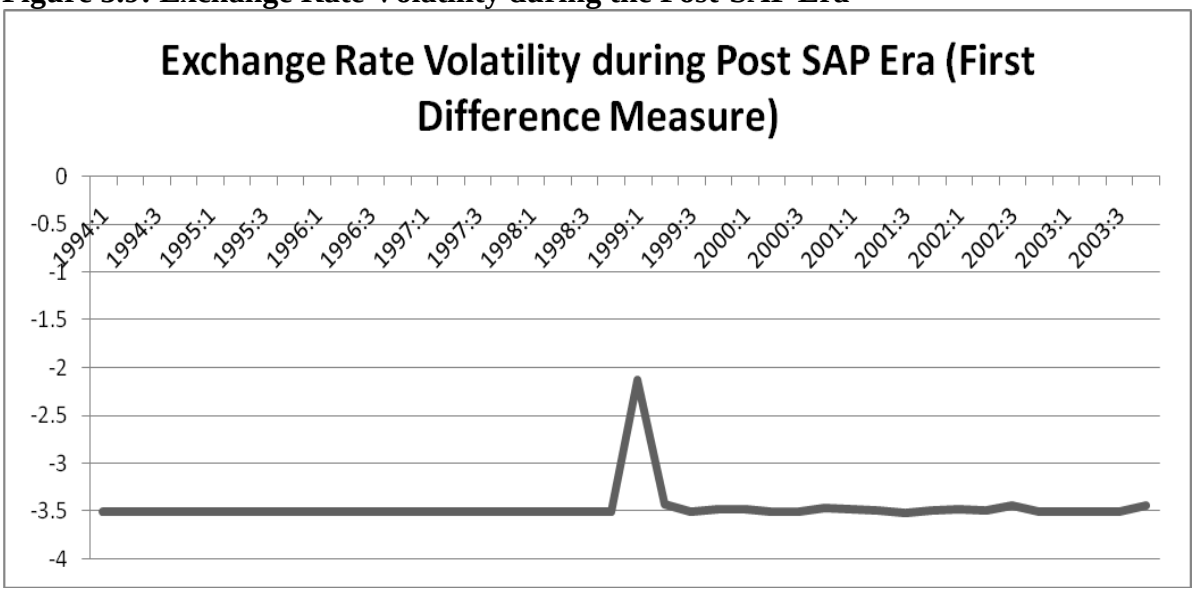
A closer look at Figure 5.9 shows that the graph was flat mostly during the period of reform lethargy. Between 1998 and 1999, exchange rate rose considerably (captured by the high spike in the exchange rate volatility) and thereafter, fell significantly in the subsequent periods. This shows that there was no strong or significant volatility in the exchange rate of naira vis-a-vis US dollar during the lethargy regime era, prior to the NEEDS era. That is, the exchange rate of naira vis-a-vis US dollar was not significantly volatile.

**Table 5.8: Exchange Rate Volatility results during Post-SAP era**

| **Volatility** | **First Difference Measure** | |
|---|---|---|
| | **Mean Equation** | |
| | **Co-eff.** | **Prob.** |
| **C** | -3.38611 | 0.0001 |
| **SV(-1)** | 0.02553 | 0.9360 |
| | **Variance Equation** | |
| | **Co-eff.** | **Prob.** |
| **C** | 0.028897 | 0.5063 |
| $\alpha$ **:ARCH(-1)** | -0.038920 | 0.5688 |
| $\beta$ **:GARCH(-1)** | 0.589029 | 0.2986 |
| | **Degree** | |
| | 0.550112 | |
| | **Residual Test** | |
| **Jarque Bera** | 2023.131 | |
| **Prob.** | 0.000000 | |
| | **ARCH Test** | |
| **F-Stat** | 0.028219 | |
| **Prob.** | 0.867509 | |
| | **Wald Test** | |
| | **Test Value** | **Prob.** |
| **F-Stat** | 0.809502 | 0.3744 |
| **Chi-square** | 0.809502 | 0.3683 |

**Source:** *Author's computation*

**Figure 5.9: Exchange Rate Volatility during the Post-SAP Era**




*Source: Extracted from the computed results*

*5.3.2.3 NEEDS Era (2004-2009)*

The results of the estimated GARCH (1, 1) models and diagnostic tests are presented in Table 5.9. From Table 5.9, the estimated mean equation for the exchange rate volatility series revealed that the first lag of exchange rate volatility has no significant effect on current exchange rate volatility which suggests that there is no volatility clustering. However, in determining the degree of volatility during the period, the sum of the ARCH and GARCH terms is1.376546 (Table 5.9). This is a clear case of an overshooting volatility in the exchange rate of naira vis-a-vis US dollar since the sum of the ARCH and GARCH terms (1.376546) is greater one. The time series graph of the exchange rate volatility during the NEEDS era is presented in Figure 5.10. This indicates that there is significant volatility in exchange rate of naira vis-a-vis US dollar during the period of NEEDS. On the basis of the forgoing, we conclude that there is presence of volatility clustering and overshooting volatility in the exchange rate of naira vis-a-vis US dollar in Nigeria.

### 5.3.3 Degree of Severity and Persistency of Exchange Rate Volatility under Different Exchange Rate Regimes

The main results of the degree and persistence of exchange rate volatility under different regime is presented in Figure 5.11 and values shown in Table 5.10. A closer look at Table 5.10 and Figure 5.11 revealed that exchange rate volatility of naira vis-a-vis U.S dollar overshoots and persist in the SAP era (flexible exchange rate era) and NEEDS era. The volatility was severely intense in the NEEDS era compared to the SAP era and the era of guided deregulation (lethargy period). That is, comparatively, exchange rate volatility in NEEDS era is still high and severe.

**Table 5.9: Exchange Rate Volatility results during NEEDS era**

| **Volatility** | **First Difference Measure** | |
|---|---|---|
| | **Mean Equation** | |
| | **Co-eff.** | **Prob.** |
| **C** | -2.874392 | 0.0000 |
| **SV(-1)** | 0.184540 | 0.1944 |
| | **Variance Equation** | |
| | **Co-eff.** | **Prob.** |
| **C** | -8.06E-05 | 0.5519 |
| $\alpha$ **:ARCH(-1)** | 0.052972 | 0.9130 |
| $\beta$ **:GARCH(-1)** | 1.323574 | 0.0718 |
| | **Degree** | |
| | 1.376546 | |
| | **Residual Test** | |
| **Jarque Bera** | 4.932867 | |
| **Prob.** | 0.084887 | |
| | **ARCH Test** | |
| **F-Stat** | 0.382005 | |
| **Prob.** | 0.543178 | |
| | **Wald Test** | |
| | **Test Value** | **Prob.** |
| **F-Stat** | 17.61476 | 0.0005 |
| **Chi-square** | 17.61476 | 0.0000 |

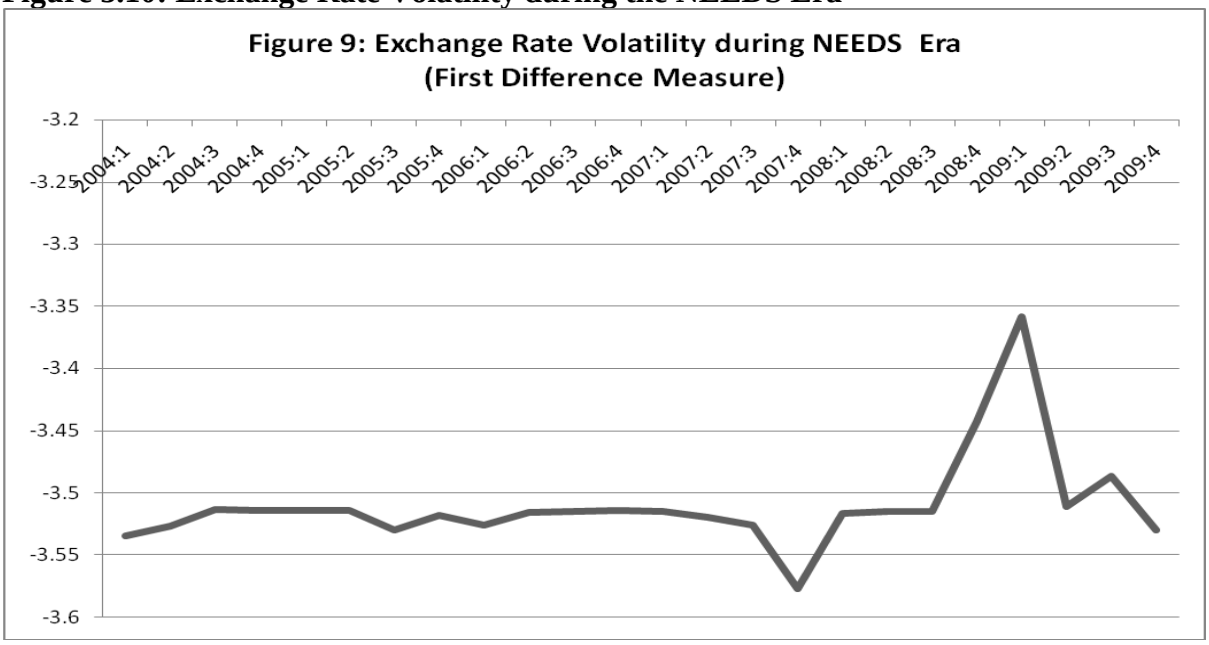
**Source:** *Author's computation.*

**Table 5.10: Exchange Rate Volatility Degree and Persistency under different Regimes**

| **Regime Era** | **Degree of Volatility** | **Persistence** |
|---|---|---|
| **SAP** | 1.0475 | -0.3065 |
| **Post-SAP** | 0.5501 | 0.0255 |
| **NEEDS** | 1.3765 | 0.1845 |

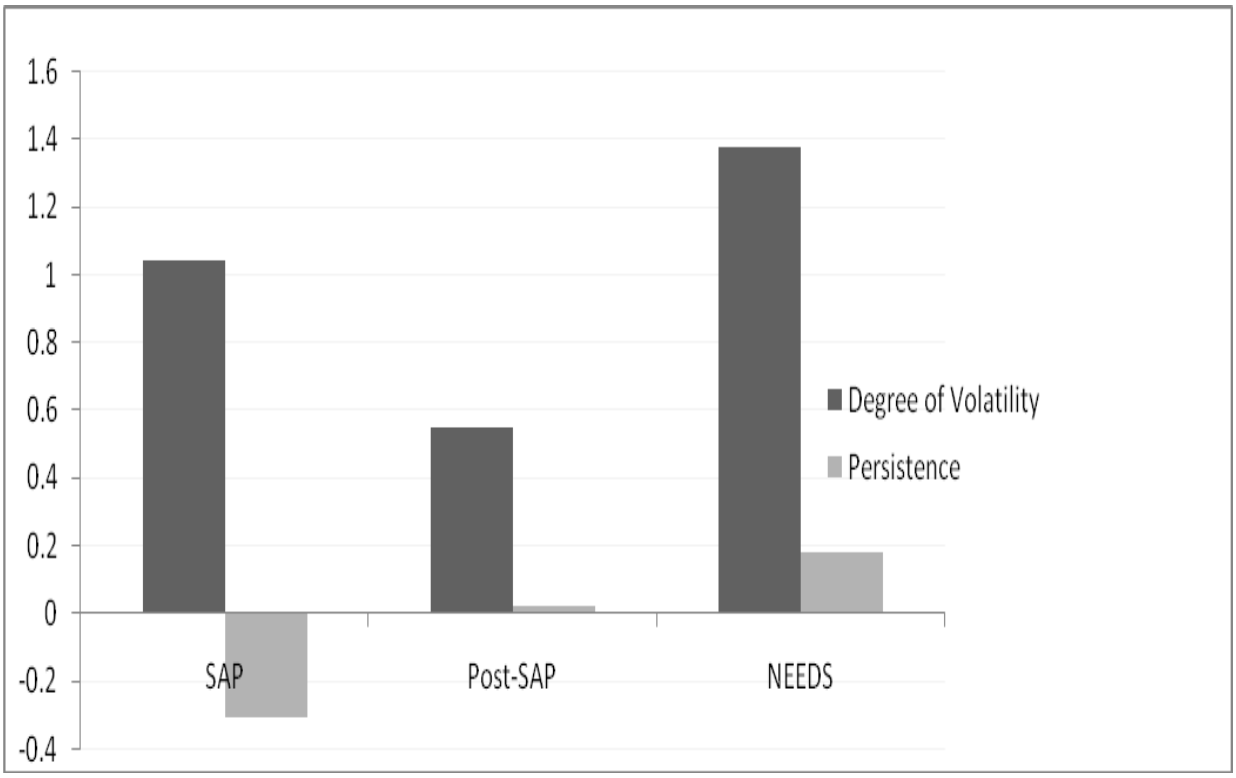
**Source:** *Author's Computation*

**Figure 5.10: Exchange Rate Volatility during the NEEDS Era**




*Source: Extracted from the computed results*

**Figure 5.11: Summary Plot of Exchange Rate Volatility under different Exchange Rate Regimes**




*Source: Extracted from the computed results*

## *5.4 Impact of Macroeconomic Policy Shocks on Exchange rate Volatility in Nigeria*

### 5.4.1 Impact of Macroeconomic Policy Shocks for the whole Sample Period

This section examines the main factors responsible for the volatility in exchange rate. Specifically the section tries to determine whether macroeconomic policy shocks could explain the volatility of exchange rate in Nigeria and whether there are differences in domestic and external policy shock effects on exchange rate volatility in Nigeria.

The starting point of the analysis is to examine the long run and short run dynamics of the model. There is a need to avoid mis-interpretation of cointegration results based on Johansen methodology. It is essential to deduce and clarify that the existence of seven cointegrating equations does not signify that there is long-run equilibrium among different combination or pairs of macroeconomic variables in the VAR system without any theoretical basis. Even, the reported cointegration results in Tables 5.3 and 5.4 do not mean that the total variation in exchange rate volatility is predominantly affected and accounted for by the incorporated macroeconomic policy variables. Therefore, the existence of long-run equilibrium among a set of variables (in the case of exchange rate volatility and macroeconomic policy) does not translate to the existence of equilibrium in all pairs of variables in the VAR model. Therefore, this can be further investigated by examining the short-run multivariate relationship among different set of variables in a Vector Error Correction (VEC) model. The in-sample effects and relative importance of the macroeconomic policy variables in explaining changes in exchange rate volatility is best determined with Impulse Response Function (IRF) and Variance Decomposition (VD) in a SVAR model as earlier discussed. This is as a result of the general contention in econometrics literature that a cointegrated non-stationary series in a VAR model is best examined under VEC model in order to determine the long-run cointegrating relationship, short-run adjustment mechanism to equilibrium and speed of adjustment.

However, the exchange rate general equilibrium model formulated sequentially from the Mundell-Fleming theoretical model which satisfies the balance of payment equilibrium condition under floating exchange rate that covers the money, goods and asset markets is employed to examine the contemporaneous effect of macroeconomic policy shocks on exchange rate volatility in Nigeria. Prior to the estimation of the exchange rate general equilibrium un-restricted VAR model, the lag order selections test was carried out using the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), Hannan-Quinn information criterion (HQI) and Final Prediction Error (FPE) to determine the appropriate lag length to estimate the un-restricted VAR model and later used to determine the cointegration rank in the model system. The results of the Lag length selection criteria indicated that lag 8 is the optimal lag to estimate the SVAR model, through which the Johansen Cointegration was performed as reported earlier. Although, the incorporated time series are non-stationary and found to be co-intergrated at rank of 7 and this therefore, informed a need to use VEC model to determine the short-run multivariate relationship among the set of variables considered since the Johansen Cointegration test has indicated that SVAR system represents the long-run equilibrium relationship between exchange rate volatility and macroeconomic policy shocks in Nigeria.

Therefore, the VEC model is also estimated at lag 3 for different possible causal effects of macroeconomic policy shocks (internal and external) on exchange rate volatility. However, seventeen (17) scenarios of how macroeconomic policy shocks affect exchange rate variation within the VEC model framework were examined and the descriptions are presented in Table 5.11. However, the existence of non-stationary and co-integrated prosperities of the time series in the VAR model [5.11e] for testing the null hypothesis that internal and external macroeconomic policy shocks have no significant effect on exchange

rate volatility in Nigeria is examined using the VEC model in equation 4.76 and its seventeen variants [5.11a – 5.11q] as presented in Table 5.11.

The reported results in Table 5.12 indicate the cointegrating relationship between pair set of considered macroeconomic policy variables and exchange rate volatility in Nigeria, thus, expressing the long-run relationship among them. According to Saibu and Oladeji (2008), the VEC model provided two sets of co-efficient estimates, which were crucial to the issue of exchange rate volatility under study. The first part of the VECM comprised the long-run estimates of model whose residual series entered the second part as terms accounting *for long-run adjustment of the short run interaction* among the variables in the model. The first part usually tagged "*long-run static model*" therefore served as a basis for analyzing the long run causal effects among the variables. The second part of the VEC model provided estimates of short-run (dynamic model) coefficients. Through the inclusion of the error correction term, generated from the long-run static model, in the dynamic short run model, the VECM made provision for testing the stability of the dynamic short-run model.

From Table 5.12, the long-run estimated model [5.11a] that examined the effect of foreign interest rate, foreign price, oil price and net foreign asset as external variables on exchange rate volatility in Nigeria revealed that the effect of these variables on exchange rate volatility is significant. The net foreign asset exerts positive significant influence on the exchange rate variability in the long-run. In comparison with the estimated model [5.11d] that incorporates only internal macroeconomic policy variables (domestic price, fiscal imbalance, monetary policy rate, money supply and foreign exchange demand - supply gap), there is a clear indication that foreign exchange demand – supply gap ( which captures the market conditions), domestic price and monetary policy variables (interest rate and money supply) have a significant negative effect on exchange rate volatility while fiscal policy variable (fiscal imbalance) has a positive influence on exchange rate variation in Nigeria.

This implies that the combination of foreign price, foreign interest rate, foreign exchange demand – supply gap and domestic monetary policy variables have significant influence on exchange rate volatility in Nigeria. The domestic monetary policy effectiveness in stabilizing exchange rate volatility in the long-run is a reflection of the efficient use of monetary policy tools by the monetary policy committee (MPC) under the purview of the Central Bank of Nigeria on monthly and quarterly basis, to ensure the stability of exchange rate over time. It is important to note that the foreign exchange demand-supply gap has been the most reliable means and channel through which the Central Bank of Nigeria tends to reduce the volatility in exchange rate by controlling the supply of foreign exchange funds at the official market amidst ever increasing demand for it by users. Likewise, fiscal revenue-spending gap tends to decelerate the level of exchange rate volatility in the long-run indicating proper management of fiscal spending that necessitate the demand for foreign exchange funds**.** Also, the reported results for model [5.11h] where only fiscal policy variable is considered, confirmed its slow effects on exchange rate volatility. This proves the less effectiveness of fiscal policy in stabilizing exchange rate volatility in Nigeria. However, it contributes more to the distortion in exchange rate instability in Nigeria and this can be adduced to lack of fiscal discipline and excess public spending that often necessitates excessive external debt reliance over the years.

The error correction term explains the swiftness of long-run equilibrium which is required to be negative and less than one which captures the speed of adjustment from short-run distortion in exchange rate volatility to its long-run equilibrium between external [5.11a] and internal [5.11d] macroeconomic policy effectiveness. The ECM term results indicated that exchange rate long-run equilibrium is more swiftly restored for internal macroeconomic policy reliance when compared to external macroeconomic policy. This implies that internal macroeconomic policy is more effective in restoring long-run exchange rate equilibrium from

short-run distortion. In terms of time-horizon for equilibrium adjustment, exchange rate volatility converges to equilibrium within 4 months, whereas the external macroeconomic policy only compared to long-run equilibrium restoration within 3 months 12 days going by the internal macroeconomic policy (interest rate, money supply, price, and fiscal imbalance) only.

Furthermore, assessing the relative effectiveness between monetary policy rate (interest rate) and broad money supply in restoring exchange rate long-run equilibrium, the comparison between estimated models [5.11e] and [5.11f] revealed that 85.4% and 84.8% of the distortions to exchange rate volatility is swiftly corrected in the long-run relying on interest rate and broad money supply respectively. This indicates that monetary policy rate combined with foreign exchange demand-supply gap is more effective as a monetary policy tool compared to money in circulation as barometer for stabilizing exchange rate volatility within the first quarter. Though, the adjustment mechanism clearly indicate that the monetary policy rate restore long-run exchange rate equilibrium within 3 months 15 days compared to money supply which interest rate is its lead indicator, which restores exchange rate volatility to its long-run equilibrium within 3 months 16 days.

However, the effect of both external and internal macroeconomic policy shocks on exchange rate volatility in the long-run as reported in the estimated model [5.11f] in Table 5.11 revealed that all the incorporated macroeconomic policy (excluding oil prices) variables have simultaneous and significant high effect on exchange rate volatility in Nigeria. While the result of the ECM term revealed that exchange rate distortion in the short-run is restored to its long-run equilibrium within 3 months and 18 days compared to a period of 8 years 8 months and 23 days as evident in estimated model [5.11n] results that incorporates external, fiscal policy variables and foreign exchange demand-supply gap only. This reflects the influence of legislative delay in approving stabilizing funds to the government to finance

fiscal balance in the short-run which often results to external financing options in Nigeria. Therefore, this proves the efficacy of inclusion of monetary policy rate in stabilizing exchange rate volatility in the long-run in Nigeria with other macroeconomic policy.

In examining the structural stability of the seventeen (17) variants of the estimated VEC models, the lag exclusion Wald test which is based on the null hypothesis "individual or joint" variables are not significant. The Chi-Square test value and P-Values for each of the considered short run models estimated at lag 3 are presented at the lower part of Table 5.12. The results indicated that all the models reject the null hypothesis at 5% significance level. This implies that the first three lag of considered macroeconomic policy variables have significant influence on exchange rate volatility in Nigeria except for lag 2 of model [5.11f and 5.11i] that examine the effect of domestic price, broad money supply and foreign exchange demand-supply gap on exchange rate volatility in Nigeria. We therefore, conclude that all the considered scenarios for the dynamic interaction between exchange rate volatility and macroeconomic policy in the short-run is jointly significant in explaining the volatility of exchange rate in Nigeria as confirmed by the F-statistic results.

**Table 5.11: Different Macroeconomic Policy Variants of Estimated VEC Model**

| Scenario | Description | VEC Model |
|---|---|---|
| **A** | Only External Policy Variables | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \varepsilon_{1t}$ (5.11a) |
| **B** | Only Internal Policy Variables (interest rate) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11b) |
| **C** | Only Internal Policy Variable (Money Supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11c) |
| **D** | Only internal Policy variables (interest rate and money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11d) |
| **E** | Internal policy variables excluding fiscal policy variable - Only monetary policy (interest rate) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11e) |
| **F** | Internal policy variables excluding fiscal policy variable - Only monetary policy (money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11f) |
| **G** | Internal policy variables excluding fiscal policy variable - Only monetary policy (interest rate and money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11g) |
| **H** | Internal policy variables excluding monetary policy variable - Only fiscal policy variable | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta fd_{t-i} + \varepsilon_{1t}$ (5.11h) |
| **I** | Internal policy variables excluding monetary policy variable - Only Foreign Exchange demand-supply gap | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} dsg_{t-i} + \varepsilon_{1t}$ (5.11i) |

| | variable | |
|---|---|---|
| **J** | Internal policy variables excluding monetary policy variable - Only Fiscal Policy and Foreign Exchange demand-supply gap variable | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{13i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11j) |
| **K** | External policy variables with only an Internal monetary policy variable (interest rate) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11k) |
| **L** | External policy variables with only an Internal monetary policy variable (money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11l) |
| **M** | External policy variables with Internal monetary policy variables (interest rate and money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{17i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11m) |
| **N** | External policy variables with only Internal Fiscal Policy Variable | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11n) |
| **O** | External and Internal policy variables (interest rate) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{17i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{18i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11) |

| | | |
|---|---|---|
| **P** | External and Internal policy variables (Money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta p_{t-i} + \sum_{i=1}^{a} \theta_{16i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{17i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{18i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11o) |
| **Q** | External and Internal policy variables (interest rate and money supply) | $\Delta s_t = \Psi_1 + \rho_1 ECM_t + \sum_{i=1}^{a} \eta_{1i} \Delta s_{t-i} + \sum_{i=1}^{a} \theta_{11i} \Delta i^*_{t-i} + \sum_{i=1}^{a} \theta_{12i} \Delta p^*_{t-i} + \sum_{i=1}^{a} \theta_{13i} op_{t-i} + \sum_{i=1}^{a} \theta_{14i} \Delta nfa_{t-i} + \sum_{i=1}^{a} \theta_{15i} \Delta p_{t-i} \sum_{i=1}^{a} \theta_{16i} \Delta fd_{t-i} + \sum_{i=1}^{a} \theta_{17i} \Delta i_{t-i} + \sum_{i=1}^{a} \theta_{18i} \Delta ms_{t-i} + \sum_{i=1}^{a} \theta_{19i} \Delta dsg_{t-i} + \varepsilon_{1t}$ (5.11p) |

*Source:* Author's Specification.

**Table 5.12: Estimated VEC Models and Diagnostic Tests Results**

| Model/Variables | [5.11a] | [5.11b] | [5.11c] | [5.11d] | [5.11e] | [5.11f] | [5.11g] | [5.11h] | [5.11i] |
|---|---|---|---|---|---|---|---|---|---|
| **Foreign Int. Rate** | -0.050373 | | | | | | | | |
| | ***[-6.14259]*** | | | | | | | | |
| **Foreign Price** | -0.002714 | | | | | | | | |
| | ***[-0.88652]*** | | | | | | | | |
| **Oil Price** | -0.006884 | | | | | | | | |
| | ***[-4.12146]*** | | | | | | | | |
| **Net Foreign Asset** | 2.02E-07 | | | | | | | | |
| | ***[ 2.94436]*** | | | | | | | | |
| **Domestic Price** | | -0.000443 | -0.005107 | 0.000827 | -0.001375 | 0.001209 | -0.000488 | 3.20E-05 | -0.000915 |
| | | ***[-0.73326]*** | ***[-0.45596]*** | ***[ 0.39391]*** | ***[-2.36563]*** | ***[ 0.77081]*** | ***[-0.22625]*** | ***[ 0.05755]*** | ***[-1.60591]*** |
| **Fiscal Imbalance** | | 5.77E-07 | 3.64E-05 | -2.20E-06 | | | | 1.36E-06 | |
| | | **[ 0.72221]** | **[ 4.90980]** | **[-2.13233]** | | | | ***[ 1.75986]*** | |
| **Domestic Int. Rate** | | -0.004204 | | -0.002433 | -0.010467 | | -0.008881 | | |
| | | ***[-0.99794]*** | | ***[-0.39282]*** | ***[-2.31933]*** | | ***[-1.38614]*** | | |
| **Money Supply** | | | 0.569790 | -0.071888 | | -0.068337 | -0.029959 | | |
| | | | ***[ 1.86878]*** | ***[-1.39153]*** | | ***[-1.79584]*** | ***[-0.60250]*** | | |
| **Forex Demand – Supply Gap** | | -1.78E-07 | 5.22E-06 | -5.99E-07 | -1.45E-07 | -1.68E-07 | -1.20E-07 | | -1.82E-07 |
| | | ***[-1.52019]*** | ***[ 4.76162]*** | ***[-4.02575]*** | ***[-1.08465]*** | ***[-1.11305]*** | ***[-0.83921]*** | | ***[-1.30453]*** |
| **C** | 4.216631 | 3.596071 | -2.992523 | 4.384626 | 3.751011 | 4.312700 | 4.068475 | 3.510419 | 3.518379 |
| **ECM term** | -0.765002 | -1.132662 | 0.007121 | -0.749604 | -0.854252 | -0.847903 | -0.803835 | -1.138287 | -1.005601 |
| | ***[-4.06629]*** | ***[-4.75525]*** | ***[ 0.19911]*** | ***[-3.76341]*** | ***[-4.11459]*** | ***[-4.17085]*** | ***[-3.87631]*** | ***[-5.00514]*** | ***[-4.69365]*** |
| **R-squared** | 0.612234 | 0.530419 | 0.366673 | 0.490463 | 0.483976 | 0.478404 | 0.477651 | 0.516053 | 0.497522 |
| **Adj. R-squared** | 0.528393 | 0.423086 | 0.221912 | 0.345967 | 0.392082 | 0.385518 | 0.358257 | 0.455559 | 0.431406 |
| **F-statistic** | 7.302302 | 4.941816 | 2.532959 | 3.394309 | 5.266648 | 5.150397 | 4.000626 | 8.530725 | 7.525034 |
| **VEC Lag Exclusion Wald Test** | | | | | | | | | |
| **Lag 1** | 1016.470 | 675.9147 | 681.5918 | 846.9471 | 344.6670 | 39.01109 | 346.7285 | 385.3599 | 26.98317 |
| | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.001084]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.001408]*** |
| **Lag 2** | 250.1002 | 292.6730 | 217.0188 | 354.8132 | 110.9588 | 15.97624 | 113.1918 | 104.7412 | 10.80144 |
| | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 3.33e-16]*** | ***[ 0.454620]*** | ***[ 3.45e-13]*** | ***[ 0.000000]*** | ***[ 0.289566]*** |
| **Lag 3** | 206.9980 | 87.15504 | 121.5219 | 131.1868 | 47.98183 | 47.21855 | 78.42363 | 36.90073 | 15.90259 |
| | ***[ 0.000000]*** | ***[ 8.29e-09]*** | ***[ 1.19e-14]*** | ***[ 9.46e-13]*** | ***[ 4.78e-05]*** | ***[ 6.30e-05]*** | ***[ 2.01e-07]*** | ***[ 2.74e-05]*** | ***[ 0.068944]*** |

*Source: Author's Computation; Note: Figures in Parenthesis are the Standard Errors*

**Table 5.12: Estimated VEC Models and Diagnostic Tests Results (Continued)**

| | [5.11j] | [5.11k] | [5.11l] | [5.11m] | [5.11n] | [5.11o] | [5.11p] | [5.11q] |
|---|---|---|---|---|---|---|---|---|
| **Foreign Int. Rate** | | -0.003879 | 0.528664 | 0.036645 | -0.38435 | 0.016095 | 0.062864 | 0.017685 |
| | | ***[-0.66991]*** | ***[ 6.04212]*** | ***[ 4.56755]*** | ***[-4.90653]*** | ***[ 1.95128]*** | ***[ 4.55713]*** | ***[ 2.87825]*** |
| **Foreign Price** | | 0.003485 | -0.0484 | -0.00068 | -0.05619 | -0.06767 | -0.00142 | -0.04844 |
| | | ***[ 1.88318]*** | ***[-1.01803]*** | ***[-0.15912]*** | ***[-2.80245]*** | ***[-6.43325]*** | ***[-0.13378]*** | ***[-5.46747]*** |
| **Oil Price** | | -0.008299 | -0.08355 | -0.01275 | 0.058801 | -0.00017 | -0.02014 | -0.00217 |
| | | ***[-8.71213]*** | ***[-5.14870]*** | ***[-9.94078]*** | ***[ 3.74279]*** | ***[-0.07025]*** | ***[-6.38249]*** | ***[-1.25280]*** |
| **Net Foreign Asset** | | 1.46E-07 | -1.47E-07 | 1.60E-07 | 1.49E-06 | 0.016913 | 0.002782 | 0.015640 |
| | | ***[ 2.79920]*** | ***[-0.18641]*** | ***[ 2.16956]*** | ***[ 2.53421]*** | ***[ 6.34156]*** | ***[ 0.80557]*** | ***[ 7.82156]*** |
| **Domestic Price** | -8.15E-05 | | | | | 1.97E-07 | -2.27E-08 | 1.38E-07 |
| | ***[-0.14114]*** | | | | | ***[ 2.59839]*** | ***[-0.12337]*** | ***[ 1.53669]*** |
| **Fiscal Imbalance** | 1.47E-06 | | | | 1.79E-05 | 8.26E-06 | -6.38E-07 | 6.50E-06 |
| | ***[ 1.86268]*** | | | | ***[ 3.24244]*** | ***[ 5.56375]*** | ***[-0.44990]*** | ***[ 5.61947]*** |
| **Domestic Int. Rate** | | -0.002443 | | 0.001415 | | 0.042153 | | 0.034391 |
| | | ***[-1.14269]*** | | ***[ 0.53483]*** | | ***[ 6.40444]*** | | ***[ 7.53867]*** |
| **Money Supply** | | | 0.816797 | 0.056881 | | | 0.055957 | -0.02389 |
| | | | ***[ 3.54988]*** | ***[ 2.99385]*** | | | ***[ 0.65236]*** | ***[-0.63447]*** |
| **Forex Demand – Supply Gap** | -9.54E-08 | 1.23E-07 | -5.91E-06 | -2.78E-07 | 7.20E-06 | -5.18E-07 | -1.21E-06 | -4.46E-07 |
| | ***[-0.72544]*** | ***[ 1.12462]*** | ***[-3.91416]*** | ***[-2.19217]*** | ***[ 5.42229]*** | ***[-3.43008]*** | ***[-4.37831]*** | ***[-3.54793]*** |
| **C** | 3.513258 | 3.468130 | -4.21478 | 2.839596 | 8.849060 | 7.527235 | 2.934332 | 6.477165 |
| **ECM term** | -1.199043 | -1.737617 | 0.010209 | -1.066674 | -0.028372 | -0.826667 | -0.287934 | -1.374102 |
| | ***[-4.98532]*** | ***[-5.62603]*** | ***[ 0.37161]*** | ***[-3.39226]*** | ***[-0.92242]*** | ***[-3.27468]*** | ***[-1.55746]*** | ***[-4.09992]*** |
| **R-squared** | 0.525776 | 0.694224 | 0.539103 | 0.621186 | 0.552936 | 0.654157 | 0.579030 | 0.688540 |
| **Adj. R-squared** | 0.441325 | 0.589113 | 0.380669 | 0.465935 | 0.399257 | 0.487198 | 0.375803 | 0.512989 |
| **F-statistic** | 6.225822 | 6.604699 | 3.402708 | 4.001164 | 3.598006 | 3.918079 | 2.849178 | 3.922175 |
| **VEC Lag Exclusion Wald Test** | | | | | | | | |
| **Lag 1** | 363.5421 | 1394.701 | 1316.899 | 1549.058 | 1567.466 | 1943.420 | 1906.811 | 2264.206 |
| | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** |
| **Lag 2** | 198.8463 | 396.3341 | 419.1180 | 473.1848 | 504.6886 | 523.5541 | 609.9906 | 671.5758 |
| | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** |
| **Lag 3** | 58.49844 | 245.5092 | 310.5856 | 286.9928 | 343.9268 | 324.2789 | 433.8876 | 426.8409 |
| | ***[ 9.35e-07]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** |

*Source: Author's Computation*

*Note: Figures in Parenthesis are the Standard Errors*

### 5.4.2 Impact of Macroeconomic Policy Shocks under Different Exchange Rate Regimes

The effect of macroeconomic policy shocks on exchange rate volatility in Nigeria under different structural regimes (SAP era, Post-SAP era and NEEDS era) were examined based on the specified vector error correction (VEC) model since the series were earlier found non-stationary and cointegrated in the original VAR system. Like the aggregate analysis carried out earlier, only three scenarios of the link between macroeconomic policy shocks variables and exchange rate volatility were considered, namely; the empirical model [5.11a] that incorporates only external macroeconomic policy variables (foreign interest rate, foreign price, crude oil price and net foreign asset); model [5.11b] that integrate only internal macroeconomic policy variables (domestic price, fiscal imbalance, foreign exchange demand – supply gap and monetary policy rate); and model [5.11f] that incorporates both external and internal macroeconomic policy variables simultaneously.

The first [5.11a] and the last [5.11f] VEC models were estimated at optimal lag 1 for the short-run relationship between exchange rate volatility and macroeconomic policy in Nigeria, while the second VEC model [5.11b] was estimated at lag 2. A closer look at Table 5.13 revealed that the entire considered lag are jointly statistically significant at 5% critical level for each of the model across the regimes. This implies that external macroeconomic policy shocks have simultaneous significant effect on exchange rate volatility in Nigeria throughout the different exchange rate regime periods.

The reported R-square also indicated that external macroeconomic policy variables accounted for 64%, 23% and 74% of the total changes in exchange rate volatility in Nigeria during the SAP, Post-SAP and NEEDS regime eras respectively. However, the low explanatory of the external macroeconomic policy variables in the Post-SAP era is an indication that during the era, external forces had little or minimal impact on exchange rate volatility. It could therefore be deduced that exchange rate volatility during the SAP era is

mainly accounted for by external macroeconomic policy shocks; the Post-SAP era is majorly accounted for by internal macroeconomic policy shocks; and the NEEDS era is accounted for by both external and internal macroeconomic policy shocks.

However, comparing the speed of adjustment from short-run distortion in exchange rate volatility to its long-run equilibrium between the SAP era, Post-SAP and NEEDS era, the error correction term explains the swiftness of long-run equilibrium which is required to be negative and less than one. From Table 5.13 under model [5.11f] that incorporates both external and internal macroeconomic policy variables, the error correction (ECM) term results indicated that exchange rate long-run equilibrium is more swiftly restored in the NEEDS era compared to other regimes. Also, long-run equilibrium is more swiftly restored in the SAP era compared to the Post-SAP that marks predominantly the reform lethargy era. In terms of time-horizon for equilibrium adjustment, exchange rate volatility converges to equilibrium within 18months 16 days in the SAP era, 6211 months (517 years 5 months) in the Post-SAP era and 5months in the NEEDS era. This implies that macroeconomic policy is more effective in the NEEDS era compared to the SAP and Post-SAP regime era in adjusting exchange rate volatility to converge to long-run equilibrium. In the case of the Post-SAP era where restoration took 517 years indicate that long-run equilibrium is never achieved in the era and the problem of exchange rate disequilibrium caused in the SAP era prolonged till the Post-SAP era but under 5 month internal restoration benchmark till date.

**Table 5.13: VEC Models Results under Different Exchange rate Regimes**

| | MODEL [5.11a] | | | MODEL [5.11b] | | | MODEL [5.11f] | | |
|---|---|---|---|---|---|---|---|---|---|
| | **SAP ERA** | **POST-SAP ERA** | **NEEDS ERA** | **SAP ERA** | **POST-SAP ERA** | **NEEDS ERA** | **SAP ERA** | **POST-SAP ERA** | **NEEDS ERA** |
| **Foreign Int. Rate** | 0.209844 | 0.049627 | 0.005883 | | | | -0.13562 | 7.174926 | 0.009164 |
| | ***[ 2.54337]*** | ***[ 3.63262]*** | ***[ 4.80687]*** | | | | ***[-21.9720]*** | ***[ 3.35307]*** | ***[ 5.66064]*** |
| **Foreign Price** | 0.102439 | -0.005012 | -9.84E-05 | | | | -0.70826 | 188.5574 | 0.003442 |
| | ***[ 3.92357]*** | ***[-0.45520]*** | ***[-0.15497]*** | | | | ***[-93.2812]*** | ***[ 75.5957]*** | ***[ 4.47405]*** |
| **Oil Price** | -0.678366 | -0.014476 | 0.005861 | | | | -0.05447 | -0.06267 | 0.002594 |
| | ***[-18.9389]*** | ***[-12.0938]*** | ***[ 10.6829]*** | | | | ***[-13.1585]*** | ***[-0.57796]*** | ***[ 4.27993]*** |
| **Net Foreign Asset** | 0.000177 | 1.04E-06 | -2.05E-07 | | | | 0.000183 | -0.00351 | -4.18E-08 |
| | ***[ 5.70381]*** | ***[ 3.43759]*** | ***[-12.1095]*** | | | | ***[ 45.4989]*** | ***[-65.8902]*** | ***[-5.05103]*** |
| **Domestic Price** | | | | -0.016321 | 0.049416 | -0.000210 | 0.474429 | -20.5159 | -0.00457 |
| | | | | ***[-0.28451]*** | ***[ 6.87044]*** | ***[-0.25557]*** | ***[ 38.2937]*** | ***[-48.9641]*** | ***[-9.49652]*** |
| **Fiscal Imbalance** | | | | 4.32E-05 | -6.84E-06 | -1.95E-06 | 0.000153 | -0.01209 | -4.33E-06 |
| | | | | ***[ 2.63353]*** | ***[-2.06560]*** | ***[-2.72794]*** | ***[ 30.2254]*** | ***[-61.2920]*** | ***[-21.6203]*** |
| **Domestic Int. Rate** | | | | 0.007666 | -0.233694 | -0.010840 | 0.437492 | 1.193735 | -0.04503 |
| | | | | ***[ 0.74530]*** | ***[-5.50316]*** | ***[-1.36430]*** | ***[ 107.057]*** | ***[ 1.49455]*** | ***[-34.2080]*** |
| **Forex Demand – Supply Gap** | | | | -0.000559 | -9.39E-06 | 6.33E-08 | 0.001880 | 0.000168 | 4.15E-08 |
| | | | | ***[-4.13726]*** | ***[-6.29950]*** | ***[ 7.58431]*** | ***[ 69.3196]*** | ***[ 3.81313]*** | ***[ 11.7264]*** |
| **C** | 6.101369 | 3.729910 | 3.400583 | 3.747776 | 6.386151 | 3.664157 | 44.88412 | -14402.2 | 4.145983 |
| **ECM term** | -0.065841 | -0.160387 | -1.051911 | -0.487580 | -0.185822 | -0.461627 | -0.161686 | -0.000483 | -0.523240 |
| | ***[-1.75348]*** | ***[-0.58631]*** | ***[-4.48017]*** | ***[-1.64836]*** | ***[-1.25574]*** | ***[-1.72214]*** | ***[-1.27046]*** | ***[-0.79938]*** | ***[-2.22390]*** |
| **R-squared** | 0.639981 | 0.233045 | 0.742890 | 0.663599 | 0.362911 | 0.652581 | 0.741445 | 0.244428 | 0.435703 |
| **Adj. R-squ** | 0.541794 | 0.093599 | 0.652145 | 0.432324 | 0.112626 | 0.334114 | 0.623921 | -0.016114 | 0.166990 |
| **F-statistic** | 6.517971 | 1.671219 | 8.186596 | 2.869303 | 1.449989 | 2.049134 | 6.308842 | 0.938153 | 1.621446 |
| **VEC LAG EXCLUSION WALD TEST** | | | | | | | | | |
| **Lag 1** | 718.9252 | 461.0729 | 334.2943 | 2449.150 | 658.3528 | 6386.827 | 41369.89 | 16276.84 | 7813.553 |
| | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** |
| **Lag 2** | | | | 1160.935 | 252.5253 | 1325.499 | | | |
| | | | | ***0.000000]*** | ***[ 0.000000]*** | ***[ 0.000000]*** | | | |

*Source: Author's computation; Note: Figures in Parenthesis are the Standard Errors*

### 5.4.3 Impulse Response of Exchange Rate Volatility to Macroeconomic Policy Shocks in Nigeria

In this section of the study, the response of exchange rate volatility to macroeconomic policy shocks is captured. The contemporaneous response of exchange rate volatility to one squared variance shocks exerted by foreign interest rate, foreign whole sale price index, oil price, and net foreign asset shocks (as ***externals shocks***), domestic interest rate (as ***monetary policy shocks***), fiscal deficit (as ***fiscal policy shock***), domestic price and foreign exchange demand-supply gap (as ***other macroeconomic shocks***) are presented in this subsection. Monetary, fiscal, and other macroeconomic policy shocks are grouped as ***internal shocks.*** The impulse response of exchange rate volatility to macroeconomic policy shocks are computed based on the contemporaneous imposed structural shocks as analysed using the SVAR model in the previous sub-section.

The purpose of this section is to determine the mechanism through which exchange rate volatility responds to both internal and external macroeconomic policy shocks as a result of innovation distortion. Therefore, an Impulse Response Function (IRF) is generated from the SVAR model to trace the response of one endogenous variable to one-standard shock in another variable and this can be thought of as a type of dynamic multiplier (Pericoli and Taboga, 2009). This study is particularly interested in three questions concerning the response of exchange to macroeconomic policy shocks:

- What is the timing or horizon of the peak exchange rate effect?
- What share of the squared variance of exchange rate is due to macroeconomic shocks?
- What is the implication of exchange rate volatility for each of the macroeconomic shocks, all through the horizon?

These questions are motivated by Dornbusch's classic work on overshooting in 1976; and the work of An and Sun and Mallick in analysing several foreign exchange intervention hypotheses. Table 5.14 depicts the impulse response function of each of the selected macroeconomic indicators, using a horizon of 12 quarters. Figure 5.12 presents the IRF plots of exchange rate volatility to macroeconomic policy shocks in Nigeria and Figure 5.13 presents plot of innovations shocks residuals of each of the considered macroeconomic policy variables in Nigeria.

#### 5.4.3.1 Response of Exchange Rate to External Macroeconomic Policy Shocks

In this sub-section, the study analyses the responses of exchange rate volatility to external macroeconomic policy shocks. The external macroeconomic policy shocks include the foreign interest rate, foreign Price, world oil price and net foreign assets. The detail discussions of the responses of exchange rate to external macroeconomic policy shocks are presented in what follows.

***Response of Exchange Rate to foreign interest rate shock***

Firstly, the study considers the response of exchange rate to foreign interest rate shock in Nigeria within 24 quarters. The first column of Table 5.14 reports the impulse response estimates of exchange rate to unexpected changes in foreign interest rate used to capture external shock.

The results further show that exchange rate volatility was highly influenced both negatively and positively, as a result of Cholesky one-standard deviation innovation of foreign interest rate shock but the negative effect outweighs the positive. This implies that foreign interest rate net shocks depreciate and brought about exchange rate volatility during the period under review. This is may be as a result of consistent increase in the foreign

interest rate resulting from high fund demand in the international markets where most economies resort to source for developmental funds including Nigeria especially during the implementation of reform programmes.

***Response of Exchange Rate Volatility to Foreign Price Shock***

The third column of Table 5.14 reports the impulse response analysis estimates of exchange rate volatility to one squared deviation innovation shock from foreign price level as an external macroeconomic policy variable. The result clearly shows that the negative response of exchange rate volatility to foreign price level shocks outweighs the positive response. Therefore, the impulse response analysis of exchange rate to foreign price level shocks indicates that the net shocks decreased the level of exchange rate volatility and steadily stabilises the movement of exchange rate in Nigeria within the 12 quarter horizon.

***Response of Exchange Rate Volatility to World Oil Price Shock***

The positive response of exchange rate volatility to unexpected shocks exerted on world oil price peaked at $6^{th}$ quarter, while the negative response peaked at $5^{th}$ quarter within the 12 horizon as shown in Figure 5.12. It should be noted that the negative response outweighs the positive throughout the period under review. This implies that for one-standard deviation net shock exerted on the crude oil price, exchange rate volatility is negatively influenced within the 12 quarters horizon. It can be deduced that an unexpected changes in the price of crude oil price due to either OPEC temporal actions, land disputes in exploration areas, political instability in any oil producing states and short-fall in supply seems to contribute to real exchange rate volatility in Nigeria.

**Table 5.14: Impulse Response Analysis of Exchange Rate to Macroeconomic Policy Shocks**

| Qtr. | i* | p* | op | P | nfa | fd | I | Dsg | s |
|---|---|---|---|---|---|---|---|---|---|
| | Shock 1 | Shock 2 | Shock 3 | Shock 4 | Shock 5 | Shock 6 | Shock 7 | Shock 8 | Shock 9 |
| **1** | -0.035154 | 0.060678 | 0.037621 | -0.044872 | 0.045803 | 0.033483 | 0.009870 | 0.012762 | 0.020859 |
| | ***(0.01372)*** | ***(0.01174)*** | ***(0.00931)*** | ***(0.00774)*** | ***(0.00680)*** | ***(0.00375)*** | ***(0.00257)*** | ***(0.00241)*** | ***(0.00161)*** |
| **2** | 0.077826 | -0.042581 | -0.050983 | 0.028744 | -0.075638 | -0.02915 | 0.013820 | -0.04869 | -0.040202 |
| | ***(0.03561)*** | ***(0.02782)*** | ***(0.03723)*** | ***(0.03079)*** | ***(0.03558)*** | ***(0.02336)*** | ***(0.02989)*** | ***(0.03143)*** | ***(0.00899)*** |
| **3** | -0.073943 | 0.006107 | 0.010704 | 0.002376 | 0.040105 | -0.060702 | -0.018758 | 0.029135 | 0.023797 |
| | ***(0.05646)*** | ***(0.04763)*** | ***(0.05917)*** | ***(0.05281)*** | ***(0.07924)*** | ***(0.04099)*** | ***(0.05122)*** | ***(0.06831)*** | ***(0.01963)*** |
| **4** | -0.032319 | 0.056928 | 0.070683 | -0.048333 | 0.023893 | 0.069329 | -0.006625 | 0.024641 | 0.004706 |
| | ***(0.07977)*** | ***(0.06909)*** | ***(0.08025)*** | ***(0.08889)*** | ***(0.12306)*** | ***(0.06438)*** | ***(0.08495)*** | ***(0.10191)*** | ***(0.02637)*** |
| **5** | 0.046897 | -0.129834 | -0.091837 | 0.042327 | -0.010487 | -0.013177 | 0.046672 | -0.073526 | 0.001123 |
| | ***(0.11995)*** | ***(0.12047)*** | ***(0.12750)*** | ***(0.12391)*** | ***(0.13091)*** | ***(0.09228)*** | ***(0.11311)*** | ***(0.12779)*** | ***(0.03349)*** |
| **6** | 0.094333 | 0.016860 | -0.02767 | 0.056371 | -0.002447 | -0.086452 | -0.031128 | 0.041650 | -0.018238 |
| | ***(0.17267)*** | ***(0.15027)*** | ***(0.19989)*** | ***(0.15414)*** | ***(0.19257)*** | ***(0.12789)*** | ***(0.17211)*** | ***(0.21691)*** | ***(0.05072)*** |
| **7** | -0.013906 | 0.077638 | 0.080563 | -0.093884 | 0.060185 | 0.071930 | -0.102778 | 0.059416 | 0.010384 |
| | ***(0.24236)*** | ***(0.19106)*** | ***(0.31912)*** | ***(0.24059)*** | ***(0.37296)*** | ***(0.22893)*** | ***(0.29012)*** | ***(0.34544)*** | ***(0.07076)*** |
| **8** | -0.126849 | -0.164779 | -0.131168 | 0.099080 | -0.121575 | 0.011382 | 0.249467 | -0.139564 | 0.007603 |
| | ***(0.37564)*** | ***(0.37054)*** | ***(0.47180)*** | ***(0.42540)*** | ***(0.50628)*** | ***(0.34158)*** | ***(0.49291)*** | ***(0.50759)*** | ***(0.11076)*** |
| **9** | 0.090197 | -0.074543 | -0.115303 | 0.043590 | -0.091349 | -0.178825 | 0.037526 | 0.002767 | -0.009965 |
| | ***(0.52166)*** | ***(0.48807)*** | ***(0.78787)*** | ***(0.61305)*** | ***(0.72223)*** | ***(0.54213)*** | ***(0.81796)*** | ***(0.84035)*** | ***(0.15297)*** |
| **10** | 0.148650 | 0.231194 | 0.193679 | -0.145062 | 0.166094 | 0.044517 | -0.261091 | 0.175755 | -0.001174 |
| | ***(0.69620)*** | ***(0.86491)*** | ***(1.56606)*** | ***(0.98996)*** | ***(1.34311)*** | ***(1.11000)*** | ***(1.50522)*** | ***(1.44954)*** | ***(0.21884)*** |
| **11** | -0.208962 | -0.050256 | -0.017289 | -0.08257 | 0.006377 | 0.165924 | 0.114978 | -0.107532 | 0.021372 |
| | ***(1.43468)*** | ***(1.46550)*** | ***(2.69844)*** | ***(1.80100)*** | ***(2.40955)*** | ***(1.83588)*** | ***(2.83895)*** | ***(2.61628)*** | ***(0.47245)*** |
| **12** | 0.100075 | -0.329638 | -0.236281 | 0.201661 | -0.118467 | -0.188063 | 0.210702 | -0.14287 | -0.011167 |
| | ***(2.53326)*** | ***(1.93526)*** | ***(5.24704)*** | ***(3.00216)*** | ***(4.35560)*** | ***(3.49561)*** | ***(5.49555)*** | ***(5.02902)*** | ***(0.72817)*** |
| **13** | 0.297104 | 0.328907 | 0.101629 | -0.194456 | 0.154326 | -0.079079 | -0.287437 | 0.193755 | -0.0032 |
| | ***(3.91133)*** | ***(3.58720)*** | ***(10.4762)*** | ***(5.59156)*** | ***(7.99511)*** | ***(7.34183)*** | ***(11.0047)*** | ***(9.11938)*** | ***(0.86214)*** |
| **14** | -0.226805 | 0.100393 | -0.036689 | -0.103918 | -0.020013 | 0.191252 | 0.196984 | -0.082485 | 0.008663 |
| | ***(7.96033)*** | ***(6.56550)*** | ***(21.4648)*** | ***(10.4558)*** | ***(15.6679)*** | ***(14.1887)*** | ***(22.5849)*** | ***(17.8032)*** | ***(1.85591)*** |
| **15** | -0.292273 | -0.550686 | -0.525664 | 0.307810 | -0.26419 | -0.268999 | 0.654877 | -0.370303 | 0.028546 |
| | ***(16.6991)*** | ***(10.8758)*** | ***(44.8248)*** | ***(19.5661)*** | ***(33.3970)*** | ***(29.4467)*** | ***(47.8390)*** | ***(37.1374)*** | ***(3.58089)*** |
| **16** | 0.371342 | 0.303574 | -0.052523 | -0.155377 | 0.096397 | -0.416867 | -0.080848 | 0.200740 | 0.015138 |
| | ***(32.5735)*** | ***(19.8445)*** | ***(94.2474)*** | ***(39.3381)*** | ***(68.6250)*** | ***(63.2342)*** | ***(100.095)*** | ***(73.9246)*** | ***(5.51349)*** |
| **17** | -0.116999 | 0.305153 | -0.034184 | -0.574198 | 0.135410 | 0.167121 | 0.194834 | -0.016977 | 0.035502 |
| | ***(69.1314)*** | ***(42.1456)*** | ***(202.859)*** | ***(79.7886)*** | ***(143.428)*** | ***(133.431)*** | ***(212.658)*** | ***(151.550)*** | ***(9.82047)*** |
| **18** | -0.377173 | -1.100797 | -1.197817 | 0.319514 | -0.534619 | -0.666579 | 1.454334 | -0.948909 | 0.044203 |
| | ***(148.880)*** | ***(78.6388)*** | ***(438.402)*** | ***(159.709)*** | ***(315.971)*** | ***(285.118)*** | ***(458.462)*** | ***(320.969)*** | ***(19.0061)*** |
| **19** | 0.639265 | -0.097195 | -0.942185 | -0.062828 | 0.066087 | -1.303364 | 0.563330 | -0.064996 | 0.038586 |
| | ***(322.525)*** | ***(158.301)*** | ***(948.146)*** | ***(331.346)*** | ***(689.379)*** | ***(618.677)*** | ***(991.021)*** | ***(676.938)*** | ***(36.1089)*** |
| **20** | -0.403034 | 0.502680 | -0.816836 | -1.20195 | -0.141706 | -0.633556 | 1.411334 | -0.374149 | 0.158483 |
| | ***(701.298)*** | ***(332.624)*** | ***(2077.62)*** | ***(701.729)*** | ***(1537.96)*** | ***(1344.65)*** | ***(2158.46)*** | ***(1444.83)*** | ***(67.5908)*** |
| **21** | -1.053137 | -2.258726 | -3.397574 | 0.236160 | -1.172689 | -2.015025 | 4.198700 | -2.198303 | 0.216835 |
| | ***(1553.77)*** | ***(697.760)*** | ***(4562.51)*** | ***(1481.98)*** | ***(3405.77)*** | ***(2937.12)*** | ***(4717.09)*** | ***(3108.10)*** | ***(133.831)*** |
| **22** | 0.993189 | -1.349369 | -3.864407 | -0.331192 | -0.507404 | -4.047479 | 3.539753 | -1.202608 | 0.242185 |
| | ***(3429.83)*** | ***(1456.52)*** | ***(10069.0)*** | ***(3158.85)*** | ***(7686.56)*** | ***(6444.21)*** | ***(10370.5)*** | ***(6759.64)*** | ***(270.549)*** |
| **23** | 0.018001 | 0.189087 | -4.178339 | -3.145149 | -0.29017 | -3.618244 | 5.068661 | -1.644259 | 0.499258 |
| | ***(7627.81)*** | ***(3119.35)*** | ***(22284.7)*** | ***(6795.87)*** | ***(17229.4)*** | ***(14201.0)*** | ***(22864.9)*** | ***(14727.0)*** | ***(553.744)*** |
| **24** | -1.952645 | -5.560103 | -10.47968 | -1.219078 | -3.124648 | -7.026155 | 12.69188 | -6.232247 | 0.691991 |
| | ***(16972.3)*** | ***(6688.14)*** | ***(49548.6)*** | ***(14734.2)*** | ***(39043.8)*** | ***(31386.6)*** | ***(50651.1)*** | ***(32394.2)*** | ***(1147.02)*** |

*Source: Author's Computation;*

*Note: Figures in Parenthesis are the Standard Errors*

***Response of Exchange Rate Volatility to Net Foreign Asset Shock***

The fifth column of Table 5.14 reports the impulse response analysis estimates of exchange rate volatility to a one-time standard deviation innovation shock from net foreign asset as the last considered external factor. Exchange rate positively reacts to one-squared variance shock from the net foreign asset as external shock more often in the entire quarters. Overall, the negative response of exchange rate volatility to shocks from the net foreign assets outweighs the positive response.

It is important to note that the impulse response analysis of exchange rate to net foreign asset shock shows that the net shocks initially influenced the depreciation of exchange rate and steadily stabilise its volatility. This is similar with the findings of Adebiyi (2007) which indicates that the effect of net foreign asset on the exchange rate sterilises almost through the period of 1986 to date.

Generally, it can be deduced from the analyses so far that the impulse response analysis of exchange rate to external macroeconomic policy shocks indicates that the external macroeconomic policy shocks have significantly contributed to the depreciation as well as the high volatility levels of exchange rate in Nigeria. Although, evidence from the results indicate that shocks from foreign interest rate depreciate exchange rate in the short- run which later appreciate the exchange rate in the long-run as a result of ineffective implementation of macroeconomic stabilisation tools to stabilise the naira and reduce the effect of external real shocks on exchange rate volatility in Nigeria.

### 5.4.3.2 Response of Exchange rate to Internal Macroeconomic Policy Shocks

In this section however, the study further analyses the responses of exchange rate to internal macroeconomic policy shocks. The internal macroeconomic policy shocks include the domestic price shock, domestic interest rate shock, fiscal shock and foreign exchange

demand-supply gap shock. The detail discussions of the responses of exchange rate to internal macroeconomic policy shocks are presented in what follows.

***Response of Exchange Rate Volatility to Domestic Price Shock***

The contemporaneous response result of exchange rate to one-squared variance shocks from domestic price shock proxied by CPI as an internal macroeconomic policy shock is presented in the fifth column of Table 5.14 and graphically captured in Figure 5.12. The impulse response analysis of exchange rate to the domestic price shock shows that the positive net shock highly depreciates the value of naira in the entire period. Also, the analysis result indicates that shocks from domestic price appreciate exchange rate in the short run which later depreciates exchange rate in the long run as a result of ineffectiveness of the CBN monetary policy in stabilising the general price level via liquidity management in the economy.

***Response of Exchange Rate Volatility to Domestic Interest Rate Shock***

The impulse response of exchange rate volatility to one-standard deviation shock from domestic interest rate is presented in the eight column of Table 5.14. The impulse response analysis of exchange rate to one-time shock on domestic interest rate reveals the following:

i. The net shock effect exerts on interest rate negatively influence the volatility of exchange rate in Nigeria during the review period. This implies that a squared variance shock on interest rate tends to stabilize exchange rate volatility of naira vis-à-vis dollar over time.
ii. The trend of exchange rate volatility appreciates in value as a result of increase in domestic interest rate during the first years of the analysis. This implies that the

implementation of various reforms did not help in stabilising the domestic interest rate within horizon which consequently exerts shock and depreciates the value of exchange rate afterwards till date.

iii. The monetary policy instituted during this review period which was based on high interest rate leads to persistent rise in exchange rate. This implies that the interest rate oriented monetary policy was ineffective in stabilising exchange rate volatility and monetary policy rate is not tight enough to stabilize the variation in exchange rate within the review horizon.

***Response of Exchange Rate Volatility to Fiscal Shock***

The sixth column of Table 5.14 reports the contemporaneous reaction of exchange rate volatility to one-standard deviation shock from fiscal deficit. The impulse response analysis of exchange rate reaction to one-standard deviation shock from fiscal deficit shows that fiscal policy has a very strong depreciating effect on real exchange rate in the first three months of budgetary allocation. This therefore tends to facilitate external budgetary short-fall financing options and interest payments of past debts, thus leading to excess demand for foreign currency with limited supply. After, a period of six months the exchange rate response to unexpected changes to fiscal policy via excess spending compared to accrued revenue tends to be sluggish and have minimal and persistent stability effect on exchange rate volatility in Nigeria.

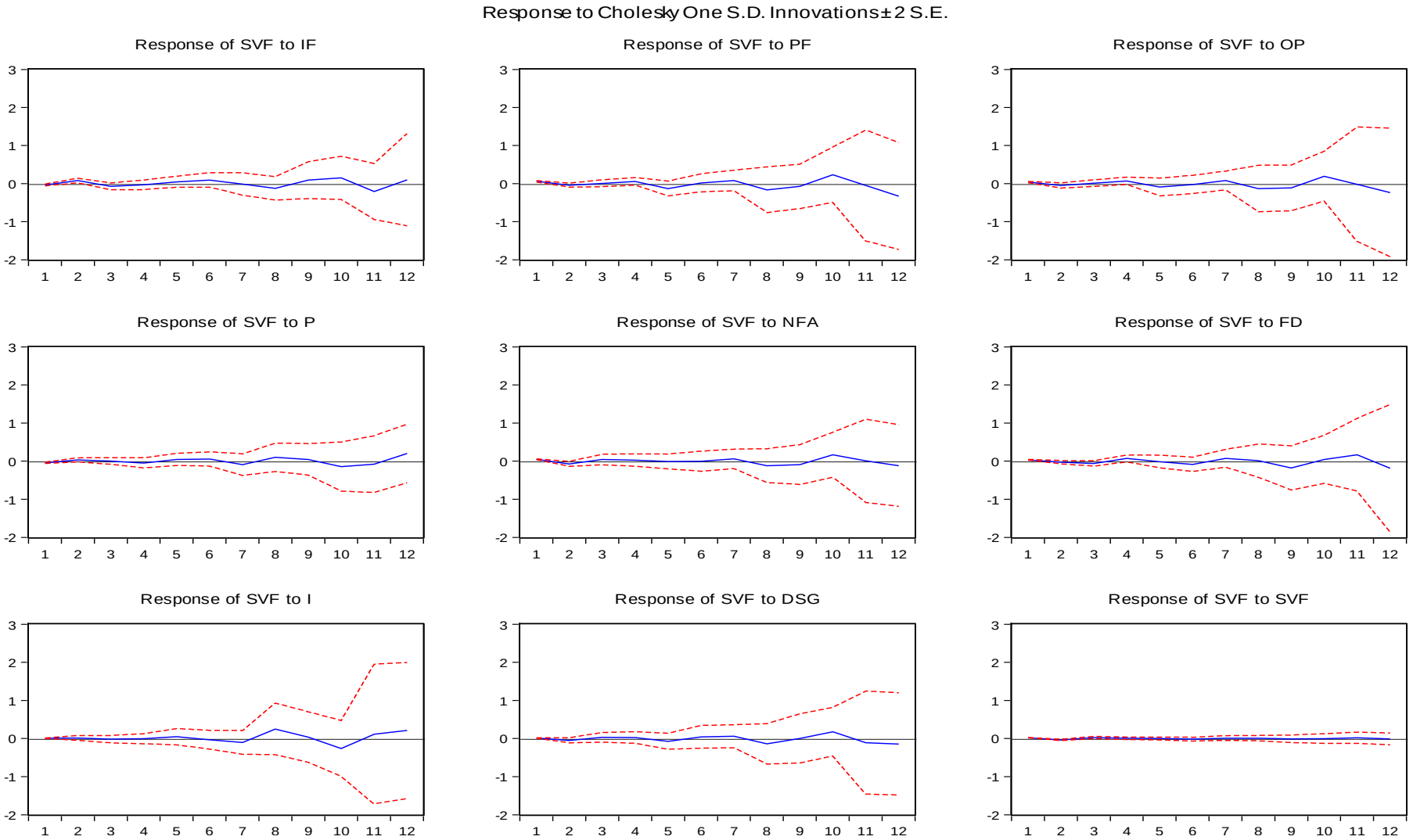
***Response of Exchange Rate Volatility to Foreign Exchange Demand-Supply Shock***

The unexpected shock response result of exchange rate to one-squared variance shocks from foreign exchange demand – supply shock captured by the difference between demand and supply of foreign exchange funds as an internal macroeconomic policy shock is

presented in the tenth column of Table 5.14. The graphical illustration is captured in Figure 5.12. The impulse response analysis of exchange rate to the domestic price shock shows that the negative net shock highly depreciates the value of naira in the entire period. Thus, the analysis result indicates that shocks from the foreign exchange demand-supply gap accelerate the exchange rate volatility in the short-run and later tends to decelerate the volatility as the horizon tends further in the long-run. Though, the supply of foreign exchange funds is under the control of the CBN as a barometer to devalue naira in the short-run but despite this, the demand for foreign exchange tends to increase and therefore causing a wide gap between the demand and supply which consequently exerts high pressure on exchange rate. Therefore, there is a clear indication that the wide foreign exchange demand-supply gap has highly and significantly influenced exchange rate devaluation in the short-run and later tends to decelerate the volatility in the long-run.

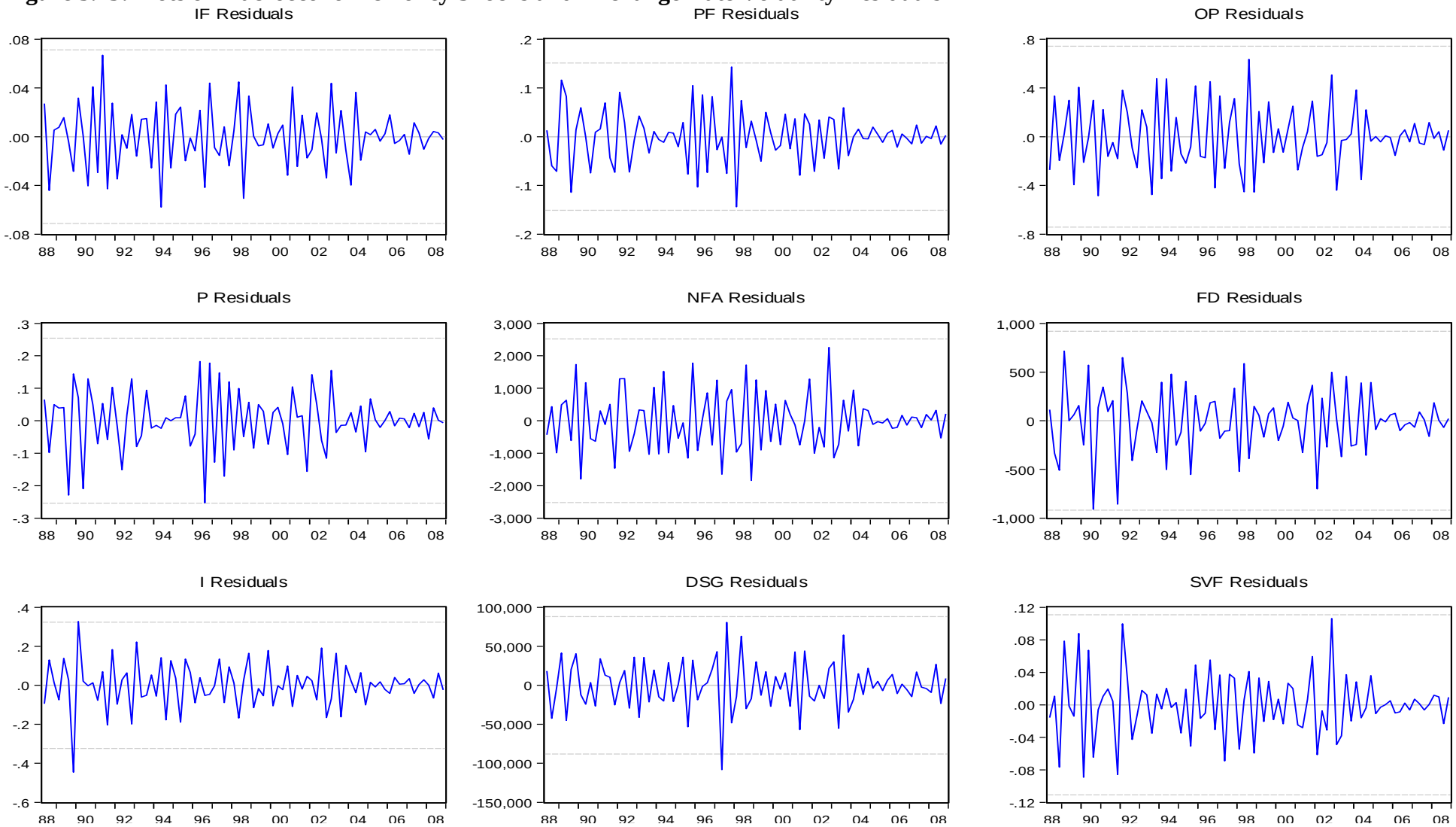
It is important to note that exchange rate liberalisation in Nigeria created increased uncertainties in the system that aggravated the erratic behaviour of exchange rate in Nigeria. The erratic behaviour of the exchange rate made planning difficult and therefore encouraged speculative activities which more often than not encourages exchange rate instability in Nigeria. The analyses so far revealed that most of the macroeconomic policy shocks that have contributed immensely to the level of exchange rate volatility in Nigeria are the external macroeconomic policy shocks which domestic macroeconomic policies could find difficult to control.

**Figure 5.12: Impulse Response Function of Macroeconomic Policy Shocks on Exchange Rate Volatility in Nigeria**




*Source: Extracted from computer output*

**Figure 5.13: Plots of Macroeconomic Policy Shocks and Exchange Rate Volatility Residuals**




*Source: Extracted from Computer output*

### 5.4.4 Forecast Error Variance Decomposition Analysis

This sub-section is complementary to the previous section 5.4.3 which analyses the impulse response function of exchange rate to Cholesky's one-standard deviation innovation macroeconomic shocks. The impulse reaction functions trace the effects of a shock from one endogenous variable on to other variables in the SVAR. That is, variance decomposition separates the variation in an endogenous variable into the component shocks of the SVAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the SVAR. Also, it determines the proportion of the forecast error variance of exchange rate volatility accounted for by innovations to each of the macroeconomic policy shocks in the SVAR.

The result of variance decomposition of exchange rate to individual innovation shocks in the SVAR is presented in Table 5.15 and the graph is shown in Figure 5.14. From the Table 5.15, the second and the sixth quarters decomposition based on the Monte Carlo error simulations and structural decomposition factorisation for exchange volatility in the SVAR system revealed that the total variance in exchange rate is completely accounted for by changes in previous exchange rate volatility shock, monetary policy rate shock (as internal macroeconomic policy shocks), foreign price shock and oil Price shock (as external macroeconomic policy shocks). This is similar to the case of the impulse response function where exchange rate volatility is driven by monetary policy and external macroeconomic policy shocks in the SVAR system. As the horizon extends to the $4^{th}$ quarter, previous exchange rate shock, domestic price shock, monetary policy shock, and fiscal policy shock took the lead in explaining the major variation in exchange rate volatility in Nigeria (see Figure 5.14). It is clear from the results that domestic price shock and foreign exchange demand-supply gap shock have consistent 7.5% - 10% bound explanation for the changes in exchange rate in Nigeria. This implies that the internal macroeconomic policy (fiscal policy

and monetary policy rate) shocks and external macroeconomic policy shocks (foreign price and oil price shocks) are key determinants of exchange rate volatility in the long-run. But, the exchange rate volatility is dominated accounted by external macroeconomic policy shocks in the short-run (see Figure 5.14).

However, a closer look at the Table 5.15 indicated that the relevance of monetary and fiscal policy shocks was intense contributing almost 65 per cent of the total shocks and volatility in the exchange rate in Nigeria. But, as the horizon moves towards the 24$^{th}$ quarter, monetary policy shocks strength fades-out in explaining the total variation in exchange rate volatility in the long-run with an approximate value of 2% (see Figure 5.14). This indicates that external shocks (foreign interest rate, foreign price shock and oil price shock) are the main source of current exchange rate instability in the entire 24 quarters horizon covered by the study (see Figure 5.14). However, the least significant factors are domestic price level and foreign price level.

From the foregoing discussion, we can deduce that foreign price shock, foreign interest rate, domestic price shock and oil price shock are the most significant sources of exchange rate volatility in Nigeria. This implies that the proportion of total variation in exchange rate volatility accounted for by external and internal macroeconomic policy shocks is higher than other factors. Generally, the empirical result has shown that the depreciation of naira or its volatility over time is as a result of external shocks. Also, key fiscal and monetary policy shocks like monetary policy rate and fiscal deficit are found to cause exchange rate volatility especially in the short-run. Arguably, in the short run and long run the external and internal macroeconomic policy shocks are most consistent in explaining variations in exchange rate volatility in Nigeria as shown by the spikes depicted in Figures 5.14, 5.15a 5.15b and 5.15c.

The results from the variance decomposition show that the total variance in exchange rate volatility is significantly accounted for by external macroeconomic policy shocks. Foreign price shocks, oil price shocks and foreign interest rate shocks contributed 16.1 per cent, 15.9 per cent and 11.9 per cent respectively to the total shocks in exchange rate volatility (Table 5.16b and Figure 5.15a). Monetary policy shocks and fiscal policy shocks are the key internal macroeconomic policy that exerts major impacts on exchange rate volatility (19.3% and 11.9 % respectively) (Table 5.16c). Foreign exchange demand - supply gap appears not to have contributed much to the volatility in exchange rate in Nigeria. It contributed about 8.5 per cent to the total shocks (Table 5.16c). This may be as a result of foreign exchange supply fixing by the CBN which is not subjected to the forces of demand and supply in the Forex market. Besides, it might be an indication that there are other fundamental macroeconomic factors that determine the behaviour of exchange rate. Therefore, monetary policy shocks and fiscal policy shocks significantly contribute to the volatility of exchange rate in Nigeria. Generally, external macroeconomic policy shocks are the dominant sources of exchange rate volatility in the long-run (about 52 per cent) as reflected in Table 5.16c and Figure 5.16b. This indicates that external shocks are the main sources of exchange rate instability in the economy.

Besides, the results of the study revealed that foreign price is the major channel through which external macroeconomic policy shocks affect exchange rate volatility in Nigeria. These results are striking, interesting and revealing in that these shocks affects domestic exchange rate through importation of goods and services. This further revealed that Nigeria's economy is still vulnerable to external shocks from her trading partners being a primary product exporter and an import dependent economy. Thus, there is a need for an urgent diversification of the economy away from primary production to production of manufactured goods.

**Table 5.15: Variance Decomposition of Exchange Rate Volatility from Macroeconomic Policy Shocks**

| Horizon | Foreign Interest Rate Shock | Foreign Price Shock | Oil Price Shock | Domestic Price Shock | Net Foreign Asset Shock | Fiscal Policy Shock | Monetary Policy Shock | Forex Demand-Supply Gap Shocks | Exchange Rate Shock |
|---|---|---|---|---|---|---|---|---|---|
| 2 | 21.3 | 16.0 | 11.7 | 8.3 | 22.8 | 5.7 | 0.84 | 7.4 | 6.0 |
| 4 | 21.4 | 13.6 | 14.1 | 8.0 | 15.5 | 16.2 | 1.1 | 6.2 | 4.1 |
| 6 | 19.9 | 20.7 | 14.6 | 8.1 | 8.1 | 14.4 | 3.1 | 8.9 | 2.4 |
| 8 | 12.2 | 17.5 | 12.5 | 8.5 | 8.5 | 6.9 | 22.7 | 10.1 | 0.93 |
| 10 | 10.7 | 17.6 | 13.8 | 7.7 | 9.6 | 8.6 | 21.8 | 9.7 | 0.48 |
| 12 | 11.3 | 20.7 | 13.5 | 9.0 | 7.1 | 10.9 | 18.4 | 8.8 | 0.35 |
| 14 | 16.0 | 21.0 | 9.7 | 8.9 | 6.2 | 9.8 | 19.6 | 8.5 | 0.24 |
| 16 | 13.5 | 20.6 | 12.2 | 7.4 | 5.0 | 11.3 | 21.1 | 8.8 | 0.14 |
| 18 | 6.0 | 19.0 | 17.4 | 6.5 | 4.5 | 8.2 | 27.0 | 11.3 | 0.08 |
| 20 | 6.3 | 12.0 | 17.9 | 11.2 | 2.7 | 15.5 | 27.2 | 7.1 | 0.18 |
| 22 | 2.9 | 8.1 | 26.4 | 2.0 | 1.9 | 20.6 | 31.2 | 6.7 | 0.12 |
| 24 | 1.21 | 6.8 | 26.7 | 2.3 | 2.0 | 14.6 | 37.8 | 8.4 | 0.15 |

*Source: Author's Computation*

**Table 5.16a: Average Contribution of Macroeconomic Policy Shocks to Exchange Rate Volatility (%)**

| External Macroeconomic Shocks | | | Internal Macroeconomic Shocks | |
|---|---|---|---|---|
| ***Sources of Shocks*** | | ***% Contribution*** | ***Shocks*** | ***% Contribution*** |
| 1. | Foreign Interest Rate Shock | 23.0 | Domestic Price Shock | 15.2 |
| 2. | Foreign Price Shock | 31.2 | Fiscal Policy Shock | 24.6 |
| 3. | Oil Price Shock | 30.7 | Monetary Policy Shock | 40.0 |
| 4. | Net Foreign Asset Shock | 15.1 | FX DD-SS Gap Shock | 17.6 |
| 5. | | | Exchange Rate Shock | 2.6 |
| | **Total** | **100** | | **100** |

*Source: Author's Computation*

**Table 5.16b: Rank of Macroeconomic Policy Shocks as a Percentage of total Shocks**

| ***S/n*** | ***Source of Shocks*** | ***% Share*** |
|---|---|---|
| 1. | Monetary Policy Shock | 19.3 |
| 2. | Foreign Price Shock | 16.1 |
| 3. | Oil Price Shock | 15.9 |
| 4. | Foreign Interest Rate Shock | 11.9 |
| 5. | Fiscal Policy Shock | 11.9 |
| 6. | FX DD-SS Gap Shock | 8.5 |
| 7. | Net Foreign Asset Shock | 7.8 |
| 8. | Domestic Price Shock | 7.3 |
| 9. | Exchange Rate Shock | 1.3 |
| | **Total** | **100.0** |

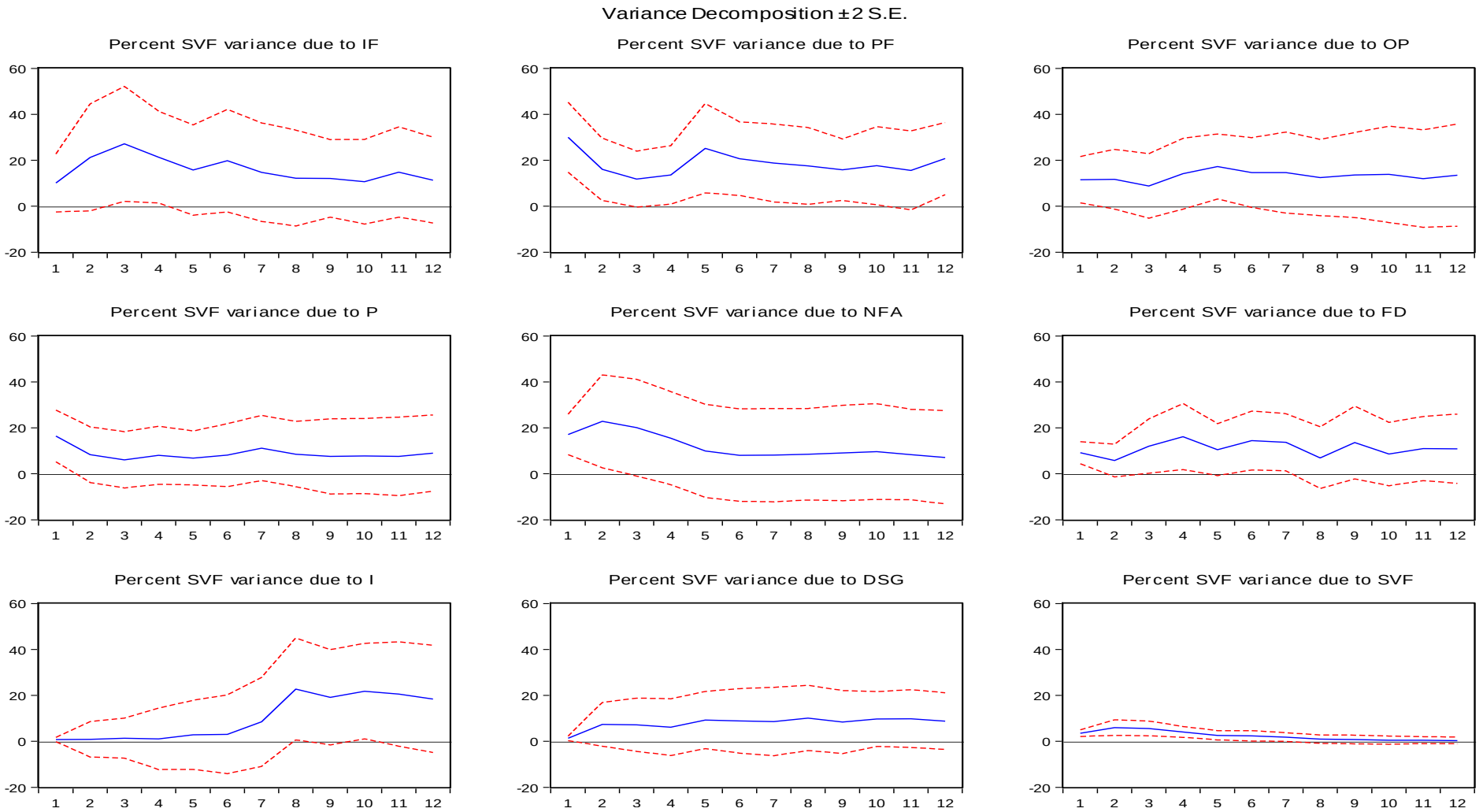
*Source: Author's Computation*

**Table 5.16c: Share of Internal and External Policy Shocks in total Macroeconomic Policy Shocks**

| | ***Macroeconomic Shocks*** | ***% Share*** |
|---|---|---|
| 1. | External Shocks | 51.7 |
| 2. | Internal Shocks | 48.3 |
| | **Total** | **100.0** |

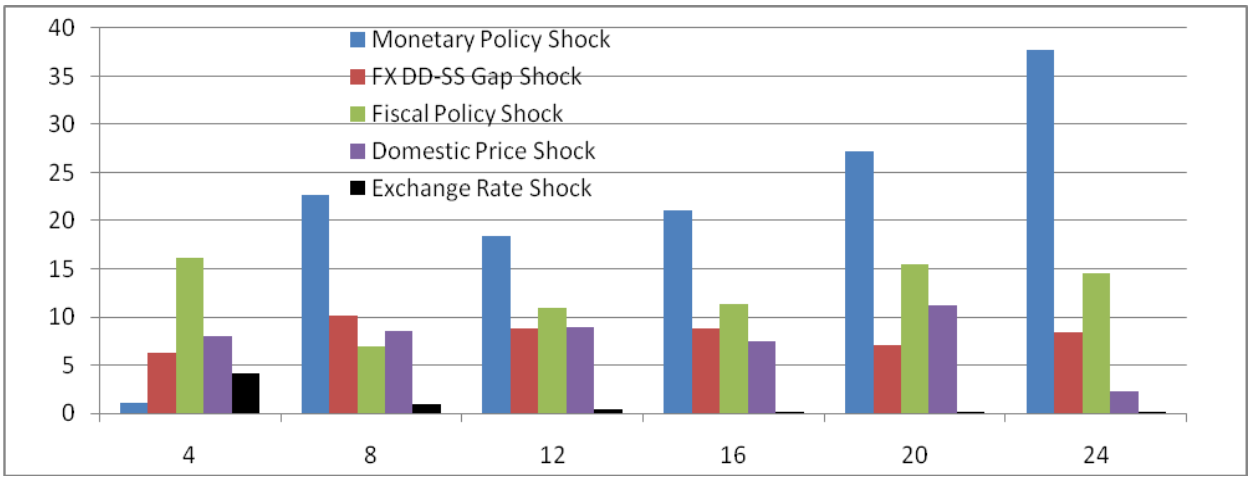
*Source: Author's Computation*

**Figure 5.14: Variance Decomposition Graph of Macroeconomic Policy Shocks to Exchange Rate Volatility**



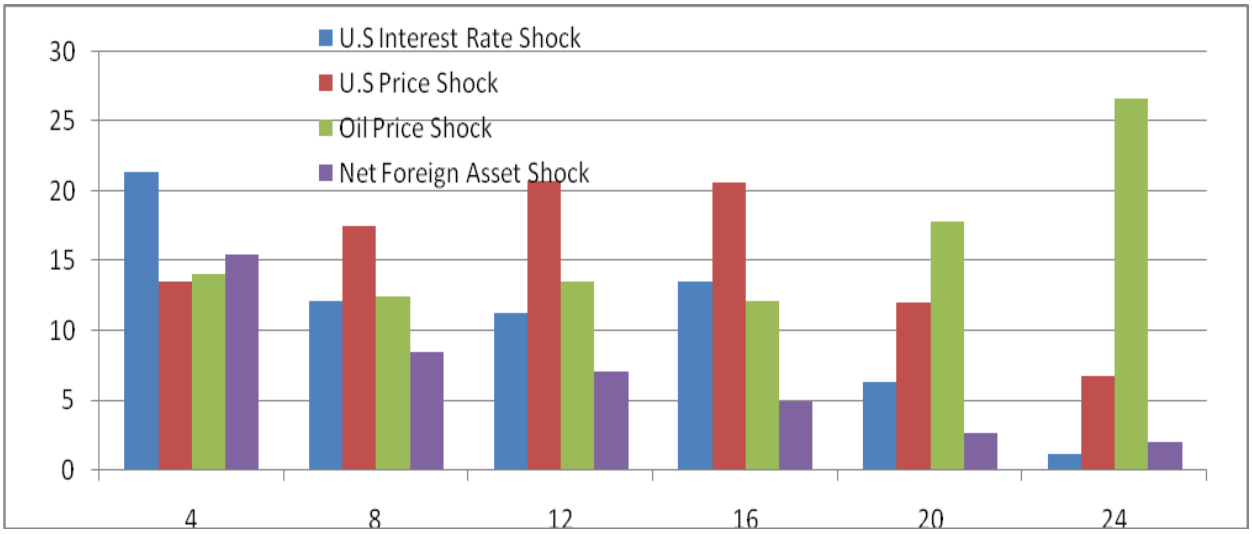

*Source: Extracted from Computer output*

**Figure 5.15a: Variance Decomposition Graph of Internal Macroeconomic Policy Shocks**



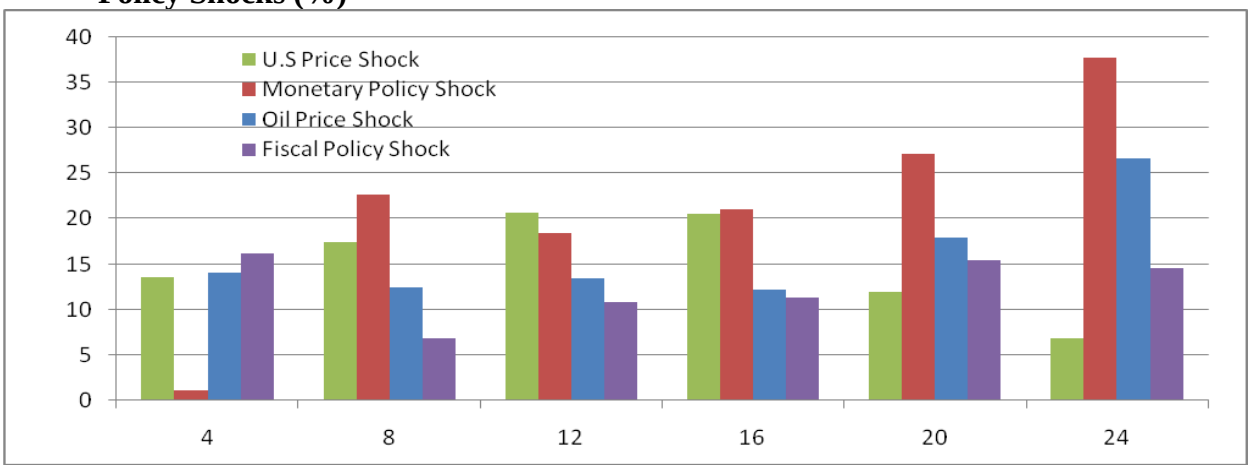

*Source: Extracted from Computer output*

**Figure 5.15b: Variance Decomposition Graph of External Macroeconomic Policy Shocks**



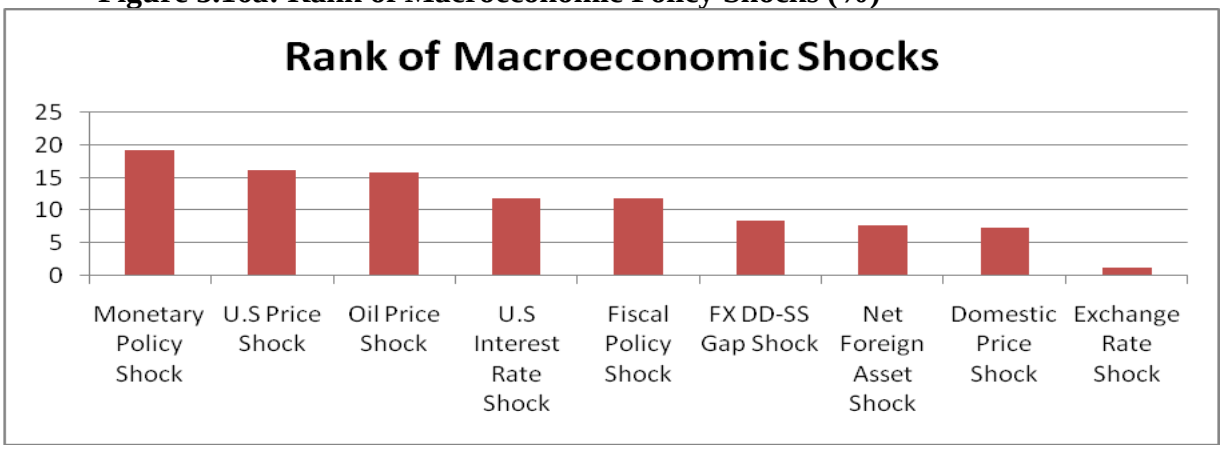

*Source: Extracted from Computer output*

**Figure 5.15c: Variance Decomposition Graph of Internal and External Macroeconomic Policy Shocks (%)**



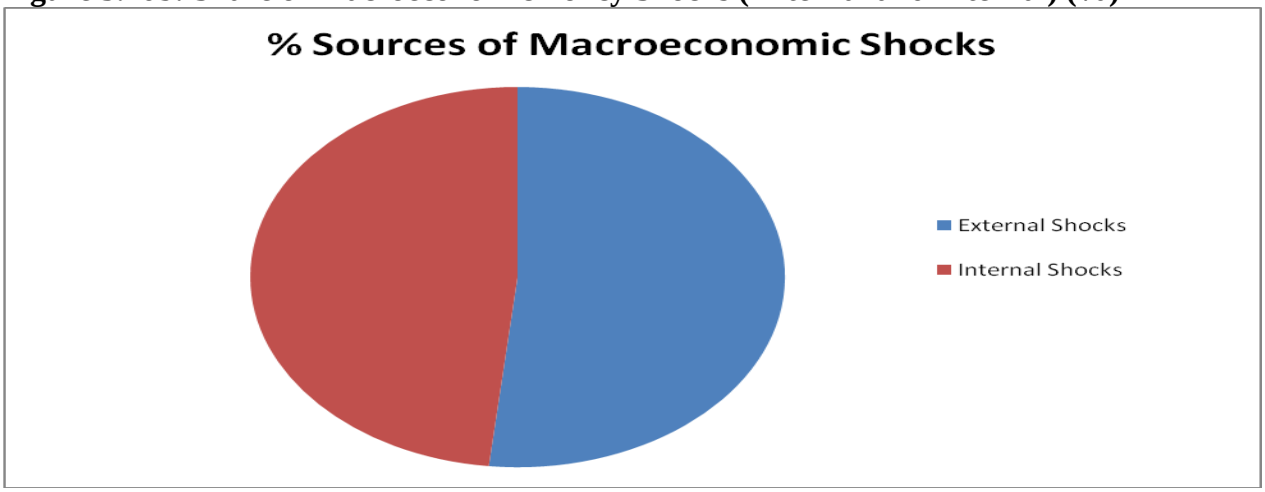

*Source: Extracted from Computer output*

**Figure 5.16a: Rank of Macroeconomic Policy Shocks (%)**




*Source: Extracted from Computer output*

**Figure 5.16b: Share of Macroeconomic Policy Shocks (External and Internal) (%)**




*Source: Extracted from Computer output*

## *5.5 Analysis of Causal Relationship between Macroeconomic Policy and Exchange Rate Volatility*

In this subsection, causality between exchange rate volatility and other macroeconomic policy variables in Nigeria was investigated using a VAR pair-wise causality test. The VAR pair-wise Granger-Causality test is conducted to examine the lead-lag relationship between exchange rate and macroeconomic variables incorporated in the VAR model. It should be noted that correlation does not necessarily imply causation in any meaningful sense of that word. The econometric graveyard is full of magnificent correlations which are simply spurious or meaningless. The approach to the question of whether x causes

y is to see how much of the current y can be explained by the past values of y and then to see whether adding lagged values of x can improve the explanation. y is said to be Granger-caused by x if x helps in the prediction of y, or equivalently if the coefficients on the lagged x's are statistically significant. Note that two-way causation is frequently the case: x Granger-causes y and y Granger-causes x term as bi-causality.

It is important to note that the statement "x Granger-causes y" does not imply that y is the effect or the result of x. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. In general, it is better to use more rather than fewer lags, in carrying out Granger-causality test, since the theory is couched in terms of the relevance of all past information. For our purpose, we picked lag length of three since we used quarterly data. This corresponds to reasonable beliefs about the longest time over which one of the variables could help predict the other.

The results for the estimated seventeen variants of the models as in Table 5.12 are reported in Table 5.17a, 5.17b, and 5.17c. The causality result revealed that there is bi-causality between exchange rate volatility and U.S interest rate in the case of model [5.11a], with only external macroeconomic policy variables. Also, there exist bi-causal relationship between exchange rate volatility and crude oil price in model [5.11k], with external and monetary policy rate variables; model [5.11l], with external and Forex demand and supply gap variables only; model [5.11m], with external and monetary policy rate and money supply variables only; model [5.11], with external and internal policy variables without money supply, and model [5.11p], with both all external and internal policy variables. Also, bi-causality is found between exchange rate volatility and net foreign asset; Forex demand and supply gap in Nigeria.

For the case of uni-directional causality from macroeconomic policy variables to exchange rate volatility, a closer look at Table 5.17a revealed that in the model [5.11a]

foreign interest rate and world oil price Granger cause exchange rate volatility in Nigeria. In model [5.11d], forex demand and supply gap was found to Granger cause exchange rate volatility in Nigeria; while in model [5.11k] and [5.11l] both crude oil price and net foreign asset were found to Granger cause changes in exchange rate volatility in Nigeria as presented in Table 5.17b. Likewise, the reported Table 5.17c showed that foreign interest rate, foreign price level, world crude oil price, domestic price, and monetary policy rate Granger cause exchange rate volatility in Nigeria.

Therefore, our empirical findings suggest that foreign interest rate, foreign price, Net foreign asset, Crude oil price , domestic interest rate, monetary policy rate and Forex demand and supply gap are leading indicators for changes in current exchange rate volatility in Nigeria. Besides, there exist a bi-directional causation between exchange rate volatility and macroeconomic policy variables.

The summary of how all the objectives of the study were achieved and the outcomes from the analysis is presented in Table 5.18. Table 5.18 shows that the techniques of analysis are adequate in achieving the stated objectives of the study.

**Table 5.17a: Pair-wise Granger-Causality Test Result**

| | Model [5.11a] | | Model [5.11b] | | Model [5.11c] | | Model [5.11d] | | Model [5.11e] | | Model [5.11f] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** |
| **Foreign Int. Rate** | 7.230168* | 0.0649 | | | | | | | | | | |
| **Foreign Price** | 1.624002 | 0.6540 | | | | | | | | | | |
| **Oil Price** | 39.95437 | 0.0000 | | | | | | | | | | |
| **Net Foreign Asset** | 2.021844 | 0.5679 | | | | | | | | | | |
| **Domestic Price** | | | 4.862500 | 0.1821 | 0.043686 | 0.9976 | 5.226064 | 0.1560 | 4.834166 | 0.1844 | 6.099145 | 0.1069 |
| **Fiscal Policy** | | | 2.648113 | 0.4491 | 1.239107 | 0.7436 | 4.249038 | 0.2358 | | | | |
| **Domestic Int. Rate** | | | 2.179132 | 0.5361 | | | 1.464818 | 0.6904 | 2.606044 | 0.4564 | | |
| **Money Supply** | | | | | 0.205689 | 0.9767 | 0.582462 | 0.9004 | | | 0.552388 | 0.9072 |
| **Forex Demand –Supply Gap** | | | 3.529493 | 0.3170 | 0.306812 | 0.9587 | 7.613472 | 0.0547 | 1.347052 | 0.7180 | 1.829431 | 0.6086 |
| **All** | 44.35670 | 0.0000 | 10.98218 | 0.5304 | 1.656086 | 0.9998 | 12.21846 | 0.6624 | 7.349170 | 0.6008 | 7.273869 | 0.6086 |

**indicate bi-causality*

*Source: Author's Computation*

**Table 5.17b: Pair-wise Granger-Causality Test Result**

| | Model [5.11g] | | Model [5.11h] | | Model [5.11i] | | Model [5.11j] | | Model [5.11k] | | Model [5.11l] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** |
| **Foreign Int. Rate** | | | | | | | | | 6.248073 | 0.1001 | 1.304200 | 0.7281 |
| **Foreign Price** | | | | | | | | | 0.372284 | 0.9459 | 0.059836 | 0.9962 |
| **Oil Price** | | | | | | | | | 56.10275* | 0.0000 | 17.49167* | 0.0006 |
| **Net Foreign Asset** | | | | | | | | | 8.808909 | 0.0319 | 0.862354 | 0.8345 |
| **Domestic Price** | 4.943656 | 0.1760 | 5.387307 | 0.1455 | 5.883688 | 0.1174 | 4.547615 | 0.2081 | | | | |
| **Fiscal Policy** | | | 4.365797 | 0.2246 | | | 2.683641 | 0.4430 | | | | |
| **Domestic Int. Rate** | 1.765978 | 0.6224 | | | | | | | 2.712823 | 0.4381 | | |
| **Money Supply** | 0.281549 | 0.9635 | | | | | | | | | 0.992332 | 0.8031 |
| **Forex Demand –Supply Gap** | 0.944765 | 0.8146 | | | 2.692224 | 0.4416 | 1.844797 | 0.6052 | 1.880544 | 0.5976 | 0.099447 | 0.9919 |
| **All** | 7.124012 | 0.8493 | 10.04944 | 0.1226 | 7.301403 | 0.2939 | 8.127756 | 0.5213 | 66.82580 | 0.0000 | 25.44966 | 0.1130 |

**indicate bi-causality*

*Source: Author's Computation*

**Table 5.17c: Pair-wise Granger-Causality Test Result**

| | Model [5.11m] | | Model [5.11n] | | Model [5.11] | | Model [5.11o] | | Model [5.11p] | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** | **Chi-Squ.** | **Prob.** |
| **Foreign Int. Rate** | 2.060021 | 0.5600 | 1.635873 | 0.6513 | 6.922276 | 0.0744 | 2.565843 | 0.4635 | 8.171602 | 0.0426 |
| **Foreign Price** | 5.287930 | 0.1519 | 0.182528 | 0.9804 | 4.731982 | 0.1925 | 2.014240 | 0.5695 | 6.737826 | 0.0807 |
| **Oil Price** | 38.03367* | 0.0000 | 15.02229 | 0.0018 | 19.63189* | 0.0002 | 16.57525 | 0.0009 | 18.68077* | 0.0003 |
| **Net Foreign Asset** | 4.440161 | 0.2177 | 1.583702 | 0.6631 | 7.429444* | 0.0594 | 0.864493 | 0.8340 | 9.050548* | 0.0286 |
| **Domestic Price** | | | | | 8.344930 | 0.0394 | 1.726891 | 0.6310 | 9.218314 | 0.0265 |
| **Fiscal Policy** | | | 2.165977 | 0.5387 | 2.224935 | 0.5271 | 1.987741 | 0.5750 | 2.829751 | 0.4186 |
| **Domestic Int. Rate** | 1.268946 | 0.7365 | | | 5.266049 | 0.1533 | | | 8.925990 | 0.0303 |
| **Money Supply** | 0.793930 | 0.8509 | | | | | 0.063072 | 0.9959 | 0.547990 | 0.9082 |
| **Forex Demand – Supply Gap** | 4.298164 | 0.2310 | 0.396791 | 0.9409 | 7.886585* | 0.0484 | 1.890198 | 0.5955 | 11.93099* | 0.0076 |
| **All** | 43.61629 | 0.0026 | 28.34598 | 0.0570 | 48.38950 | 0.0023 | 31.36415 | 0.1436 | 56.13783 | 0.0008 |

**indicate bi-causality*

*Source: Author's Computation*

**Table 5.18: Summary of Objectives, Methodology and Findings of the Study**

| S/N | Objective | Methodology | Findings |
|---|---|---|---|
| **1** | Establish the degree and severity of exchange rate volatility in Nigeria. | ARCH and GARCH Models | There is presence of severe, high and strong volatility in the exchange rate of naira. The volatility was found to persist over time. |
| **2** | examine the effects of macroeconomic policy shocks on real exchange rate volatility in Nigeria during the sample period | VEC Model | Domestic price and monetary policy variables (interest rate and money supply) have strong and significant negative effects on exchange rate volatility while fiscal policy variable (fiscal imbalance) has a positive influence on exchange rate variation in Nigeria. Foreign interest rate, Foreign price and oil price shocks were found to exert negative effect on exchange rate volatility in Nigeria with external macroeconomic policy shocks contributing dominant effects to exchange rate volatility |
| **3** | determine the differential effects of both internal and external macroeconomic policy shocks on the exchange rate volatility in Nigeria; | SVAR Model – IRF and VD | Exchange rate is found to be more responsive to external macroeconomic shocks resulting to depreciation based on the IRF analysis.<br>The VD analysis indicated that external macroeconomic policy shocks are the predominant sources of exchange rate volatility in the long-run, followed by domestic price shocks among the entire internal macroeconomic policy shocks. |
| **4** | analyse the implications of exchange rate policy regime shift on exchange rate volatility in Nigeria | ARCH, GARCH and VEC Models | The differential results revealed presence of strong volatility in the SAP era (deregulated period); weak volatility in the Post-SAP era (reform lethargy era); and over-shooting volatility in the NEEDS regime era (period of guided deregulation period). |
| **5** | ascertain the causal relationship between the macroeconomic policy shocks and exchange rate volatility in Nigeria | Granger Causality Test | There exists a bi-directional causality between some (and not all) selected macroeconomic policy variables most especially the external macroeconomic policy variables. |

*Source: Author's Compilation***.**

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# CHAPTER 6

## SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

### *6.1 Introduction*

In this chapter, the summary of findings and policy implications of the study are presented. This is followed by major conclusions and limitations. Other areas for further research are also highlighted.

### *6.2 Summary of Findings*

Since the focus of this study is to investigate the relationship between exchange rate volatility and macroeconomic policy and to determine the dynamic path of exchange rate volatility in Nigeria, we started by detailing the fundamental macroeconomic background 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, following many years of maladministration, massive corruption and other macroeconomic mismanagement. All these are contained in chapter one.

Chapter two contains a review of macroeconomic policies which in Nigeria are mostly monetary and exchange rate. The review indicated that there was a very high degree of exchange rate instability reflected in appreciation and depreciation of the naira in both the official and parallel markets which could be attributable to poor macroeconomic policy management. Also, the monetary authority's experience with monetary and fiscal targeting has been characterised by the problem of monetary and fiscal aggregates overshooting set targets.

Chapter three presents a vivid review of related literature. A remarkable feature of all the literature reviewed is that there is very little agreement among different authors regarding

the effects of macroeconomic policies on exchange rate volatility in Nigeria. Thus, our literature review followed a specific pattern. It ranges from the issues, theoretical bases, models, methodologies and findings to conclusions covered by these different authors. The striking conclusion from the review is that the debate on the relationship between macroeconomic policies and exchange rate volatility or movement remains inconclusive, given the conflicting results of current research.

Chapter four contains the theoretical framework and methodology that forms the basis for an elaborate model specification. In this chapter, the research methods employed in the process of carrying out this study are discussed. We first present the theoretical framework. The main issues involve discussing the main theories that have been applied in the literature. Various models are reviewed with a view to gaining insight into different theoretical constructs that have influenced the current state of knowledge in this area. This was followed by the analytical framework and model specification. Based on the analytical framework of the study, a VAR model was constructed to determine the dynamic responses of all the variables in the VAR to a one – time standard innovation to any of the variable in the system. This allowed us to resolve the issue of potency of macroeconomic policies in controlling exchange rate volatility in Nigeria. Tests for volatility of exchange rate were also presented. Sources of data and measurement of variables were presented in the latter part of this chapter. The chapter concluded with a discussion of the analytical techniques employed, under which tests for stationarity and cointegration were considered.

Chapter five contains the results from the models estimated. This chapter specifically focuses on the key objective of the study in analysing the response of exchange rate contemporaneously to macroeconomic policy shocks. The macroeconomic policy indicators which have the potential of influencing the movement of exchange rate in Nigeria are classified into ***external and internal.*** The internal factors include ***monetary, fiscal and other***

***macroeconomic factors***. These macroeconomic variables are plausible factors that could exert shocks on exchange rate volatility.

The monetary policy variables are proxy by domestic interest rate and monetary aggregate measured by money supply. Fiscal deficit as a ratio of GDP is used to capture fiscal policy variables, that is, fiscal imbalances. The external factors in the VAR system are proxied by the foreign asset, foreign interest rate and price level and the world oil price. The results from our estimated models reveal many interesting and striking outcomes, summarised as follows.

### 6.2.1 Existence and Severity/Persistency of Exchange Rate Volatility in Nigeria

The study established clearly that exchange rate in Nigeria has been unstable and volatile during the period under review. It was shown that exchange rate volatility exists and it was high, severe and persisted over a long period of time. The study examined the impact of regime shifts on exchange rate volatility and found that the different exchange rate regimes experienced by country over years have different impacts on the behaviour of exchange rate. For instance, it was established in the study that during the flexible exchange rate regime, there is presence of an overshooting volatility in the exchange rate with little volatility and less severe during the reform lethargy regime. In addition, it was found exchange rate was significantly volatile from NEEDS era to date.

The study noted that these different exchange rate regimes witnessed several foreign exchange rate markets as part of government efforts to stabilise the exchange rate. Despite these efforts however, CBN finds it difficult to stabilise and manage volatility in the exchange rate. Comparatively, the study's findings showed that exchange rate from NEEDS era to date is still high and severe.

### 6.2.2 Impact of Macroeconomic Policy Shocks on Exchange Rate Volatility

The findings from the study clearly revealed that foreign price, foreign interest rate, oil price and net foreign assets are the significant external macroeconomic policy variables contributing significantly to exchange rate volatility in Nigeria. These external shocks account for about 52.0 per cent of the total shocks that bring about exchange rate volatility in Nigeria. Besides, the study was able to establish that a major channel through which exchange rate impacts on exchange rate in Nigeria is through the foreign price as its impact on exchange rate volatility was severe. This finding is not surprising since Nigeria has remained an import dependent economy. Therefore, shocks are transmitted into the domestic economy through importation of goods.

Considering the internal macroeconomic policy shocks and their impacts on exchange rate volatility, the study established that monetary policy shocks and fiscal policy shocks are the key macroeconomic shocks impacting on exchange rate in Nigeria. Therefore, monetary policy of the CBN is only effective on short term basis. The study established that the use of monetary policy rate proxied by domestic interest rate is more effective as a tool than regulating the amount of money in the circulation. The study also confirmed the less effectiveness of fiscal policy as an instrument to stabilise exchange rate in Nigeria. Fiscal policy is confirmed slow in stabilising exchange rate due mainly to lags in fiscal policy formulation and implementation. This proves the less effectiveness of fiscal policy in stabilizing exchange rate volatility in Nigeria. Moreover, it contributes more to the distortion in exchange rate instability in Nigeria and this can be adduced to lack of fiscal discipline and excess public spending that often necessitates excessive external debt reliance over the years.

The findings from the study pointed out clearly that exchange rate volatility during the SAP era is mainly accounted for by external macroeconomic policy shocks while exchange rate volatility during Post –SAP period was accounted for by internal

macroeconomic policy shocks, most especially the monetary policy shocks. The volatility of exchange rate during the NEEDS period was accounted for by both internal and external macroeconomic policy shocks.

The study's analyses revealed that most of the macroeconomic policy shocks that have contributed immensely to the level of exchange rate volatility in Nigeria are external and exogenous which the domestic macroeconomic policies put in place by the government could find difficult to address.

## *6.3 Conclusions of the Study*

The study noted that while exogenous factors contribution to exchange rate volatility in Nigeria may be difficult to control or address, the endogenous factors could be addressed through a sound and consistent macroeconomic policies. More importantly, the attempt to eliminate exchange rate instability or to maintain exchange rate stability through any *direct policy measure* will further throw the economy into crisis.

Generally, the overall results show that instability in exchange rate over the years are caused by various factors, *endogenous (internal) and exogenous (external)*. It should be noted that the volatility experienced in the profile of exchange rate since 1986 to date could be ascribed to instability in macroeconomic policies (both fiscal and monetary). The major sources of this instability were the untamed fiscal deficits leading to high domestic inflation, real parallel market exchange rate, speculative business activities of market agents in the foreign exchange market and poor /inconsistent or uncertainty in public policies. It should be noted that while exogenous factors contribution to exchange rate volatility in Nigeria may be difficult to control or address, the endogenous factors could be addressed through a sound and consistent macroeconomic policies. More importantly, the attempt to eliminate exchange

rate instability or maintain exchange rate stability through any *direct policy measure* will further throw the economy into crisis.

The principal conclusion that can be drawn from this result is that exchange rates in Nigeria had been volatile during the period under review. The policy implication of this result was that any shock to exchange rates in Nigeria will have lasting effects in the economy. If the shock is negative, the uncertainty it will inject into the economy will take a long time before it can be eliminated. Indeed, this could be very damaging given that our economy (indeed, all the sectors of the Nigerian economy) is very vulnerable to this important price (exchange rate).

## *6.4 Significance of the Study*

This study has provided a very relevant policy guide tool for policy makers in Nigeria and other developing countries both within and outside Africa for better understanding of macroeconomic mechanism through which shocks affect exchange rate volatility which have serious impediment and implications for trade, welfare and growth. Also, the study through its findings has drawn policy lessons that are relevant in dealing with choice and design of exchange rate regimes, interest rate and monetary policy management for absorbing most shocks in order to enhance capital inflows and investment.

More importantly the findings from the study have provided insights for policy makers in developing countries for formulating policy actions that will help to mitigate the impacts of macroeconomic shocks by dampening exchange rate volatility. Countries with close ties with Nigeria and similar economic features and structure is better informed of the policy implications of designing appropriate exchange rate stabilization instruments for managing excess volatility and facilitate adjustment to neutralize macroeconomic shocks. Besides, findings from this study could be used to generalize the possible effects of oil price

shocks on the macroeconomy in other oil producing countries after considering the structural characteristics of these countries.

In addition, this study has shed more light on the role of monetary policy in achieving macroeconomic stability especially exchange rate stability in Nigeria given the untamed fiscal deficits, inflation and the current move towards monetary integration in West Africa. A clear understanding of the linkages between exchange rate volatility and macroeconomic policy shocks especially monetary policy affords policy makers in Nigeria, the opportunity of developing a new financial architecture for the economy that will be capable of accommodating shocks from global financial system.

Finally, the study has contributed to the ongoing debate concerning the choice of appropriate monetary-exchange rate arrangements for developing countries especially Nigeria.

## *6.5 Policy Recommendations*

Based on the above findings of the study, the following policy recommendations stand out clearly.

- There should be discipline and harmony between fiscal and monetary policies. Expansionary monetary and fiscal policies in the past tended to worsen exchange rate depreciation. It is therefore, important monetary and fiscal policies are coordinated and harmonised in order to achieve macroeconomic stability. The situation should be avoided whereby monetary policy adjusts passively to the expansionary fiscal operations of the government. As government spending has a direct relationship with the exchange rate, it is necessary to rationalise and restructure government expenditure towards productive activities and reduce the fiscal deficits significantly.

- Monetary authority (CBN) should include in its policy objectives the pursuance of "weak" exchange rate targeting. Fixing exchange rate at all costs should be discouraged. This is because a policy of fixing exchange rate without any regard for inflation is misguided. Also, a policy of raising interest rates to control inflation without any regard to what is happening to the exchange rate should not be conceived. Some flexibility in the exchange rate should be welcomed since it enables a country to cope with macroeconomic shocks arising from policy changes.
- Monetary authority should avoid unhealthy speculation in the foreign exchange, as well as rent-seeking behaviour and adopt positive attitudes geared towards ensuring stable naira exchange rate.

## *6.6 Contributions to Knowledge*

The study has made some meaningful contributions to our knowledge in the research area. It has contributed to knowledge in filling wide gap observed in literature, theory and empirical analyses. We shall outline some of the preliminary ones.

(i) This study had contributed to reaffirming the presence of exchange rate volatility in Nigeria and also determined the degree of such volatility. More specifically, it has provided a deeper insight into the study of exchange rate volatility in Nigeria than any other previous studies on Nigeria by extending the analysis to include persistence and severity of the volatility; these are missing in previous studies on Nigeria.

(ii) The study has also contributed to the examination of the underlining macroeconomic forces behind the exchange rate volatility. Such analysis is scarce in existing studies that have investigated exchange rate volatility in Nigeria. Apart from that the study was able to decompose the factors underlining the volatility into domestically and externally induced macroeconomic policy factors. Such analysis helps to provide insight into the relative

strength of domestic policy and the implication of economic integration of domestic economy. It also brings to the fore the role played by demand side and supply side forces in the exchange rate movement in Nigeria. Such forces were usually assumed homogenous in existing studies. The outcome of this study has shown that such assumption is too restrictive.

(iii) The outcome of the study had further enhanced our understanding of the channels through which macroeconomic factors from domestic economic misalignment and externally induced shock had affected the exchange rate volatility. Such understanding will assist in identifying appropriate policy instrument and intermediate variables that have to be addressed in ensuring stable exchange rate.

(iv) The examination of the implication of policy shift and different exchange rate regime of the exchange rate volatility had helped to determine the robustness of the established relationship between exchange rate and other macroeconomic policy variables as well as assessing the relative effectiveness of different exchange rate regime in Nigeria. Such analysis also provides insight into the desirability and relevance of different exchange rate management approach to Nigeria economic environment.

## *6.7 Limitations of the Study and Agenda for Further Research*

The study had examined the impact of macroeconomic policy shocks on exchange rate volatility in Nigeria. It covered a period of 24 years using quarterly data. Recent econometric technique was adopted. The outcome of the study is revealing as it shed more light on the implications of macroeconomic policy shocks on the behavior of exchange rate in Nigeria as well as the potency of macroeconomic policy in Nigeria.

However, the study would have been further enriched if our initial attempt to use monthly data were not constrained by non-availability of data on some of the variables used in the study especially GDP and fiscal deficit. The difficulty of making policy inferences

from the interpolated series makes it a no option to generate monthly data. It is therefore hoped that with current efforts at ensuring prompt release of macroeconomic data on monthly basis, future empirical studies in this area will provide insight to whether the level of frequencies affects the robustness of the results from the current efforts. Secondly, some non-economic macroeconomic variables could also be used to carry out the empirical investigation. For instance, the link between corruption and exchange rate volatility could be explored.

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# APPENDICES

**Appendix A: VEC RESULTS**

Vector Error Correction Estimates
Date: 11/21/11 Time: 12:04
Sample (adjusted): 1987Q2 2008Q4
Included observations: 87 after adjustments
Standard errors in ( ) & t-statistics in [ ]

| Cointegrating Eq: | CointEq1 |
|---|---|
| SVF(-1) | 1.000000 |
| IF(-1) | 0.017685<br>(0.00614)<br>[ 2.87825] |
| PF(-1) | -0.048435<br>(0.00886)<br>[-5.46747] |
| OP(-1) | -0.002173<br>(0.00173)<br>[-1.25280] |
| P(-1) | 0.015640<br>(0.00200)<br>[ 7.82156] |
| NFA(-1) | 1.38E-07<br>(9.0E-08)<br>[ 1.53669] |
| FD(-1) | 6.50E-06<br>(1.2E-06)<br>[ 5.61947] |
| I(-1) | 0.034391 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (0.00456) | | | | | | | | | |
| | [ 7.53867] | | | | | | | | | |
| LMS(-1) | -0.023885 | | | | | | | | | |
| | (0.03765) | | | | | | | | | |
| | [-0.63447] | | | | | | | | | |
| DSG(-1) | -4.46E-07 | | | | | | | | | |
| | (1.3E-07) | | | | | | | | | |
| | [-3.54793] | | | | | | | | | |
| C | 6.477165 | | | | | | | | | |

| Error Correction: | D(SVF) | D(IF) | D(PF) | D(OP) | D(P) | D(NFA) | D(FD) | D(I) | D(LMS) | D(DSG) |
|---|---|---|---|---|---|---|---|---|---|---|
| CointEq1 | -1.374102 | -0.284383 | -1.278769 | -4.270344 | -3.906561 | -59380.43 | 6641.806 | 0.140478 | -0.356848 | -1561082. |
| | (0.33515) | (0.33781) | (1.25457) | (4.06448) | (2.51885) | (18806.5) | (6608.88) | (1.17173) | (0.11424) | (501523.) |
| | [-4.09992] | [-0.84184] | [-1.01929] | [-1.05065] | [-1.55093] | [-3.15745] | [ 1.00498] | [ 0.11989] | [-3.12372] | [-3.11268] |
| D(SVF(-1)) | -0.040364 | 0.139930 | 1.544285 | 2.682412 | 3.436655 | 53634.67 | -2187.699 | -0.082587 | 0.306645 | 1040061. |
| | (0.28120) | (0.28342) | (1.05259) | (3.41013) | (2.11333) | (15778.8) | (5544.90) | (0.98309) | (0.09585) | (420781.) |
| | [-0.14354] | [ 0.49371] | [ 1.46713] | [ 0.78660] | [ 1.62618] | [ 3.39917] | [-0.39454] | [-0.08401] | [ 3.19933] | [ 2.47174] |
| D(SVF(-2)) | -0.316933 | 0.030219 | 1.235156 | -1.563107 | 2.290618 | 32273.15 | 3535.391 | -0.088848 | 0.157493 | 456093.2 |
| | (0.18620) | (0.18767) | (0.69698) | (2.25804) | (1.39935) | (10448.0) | (3671.59) | (0.65096) | (0.06347) | (278623.) |
| | [-1.70215] | [ 0.16102] | [ 1.77216] | [-0.69224] | [ 1.63691] | [ 3.08893] | [ 0.96290] | [-0.13649] | [ 2.48155] | [ 1.63695] |
| D(SVF(-3)) | -0.253116 | -0.060355 | 0.290375 | -2.125403 | 0.740535 | 9069.947 | 2128.691 | -0.251660 | 0.042261 | 140255.5 |
| | (0.09913) | (0.09991) | (0.37107) | (1.20216) | (0.74501) | (5562.44) | (1954.72) | (0.34656) | (0.03379) | (148337.) |
| | [-2.55340] | [-0.60406] | [ 0.78254] | [-1.76799] | [ 0.99400] | [ 1.63057] | [ 1.08900] | [-0.72616] | [ 1.25076] | [ 0.94552] |
| D(IF(-1)) | 0.271087 | 1.569499 | 0.128986 | 1.375003 | 1.232254 | -8888.823 | -5038.292 | 0.199040 | -0.010662 | 407351.9 |
| | (0.12268) | (0.12365) | (0.45923) | (1.48779) | (0.92202) | (6884.06) | (2419.16) | (0.42891) | (0.04182) | (183581.) |
| | [ 2.20967] | [ 12.6926] | [ 0.28088] | [ 0.92419] | [ 1.33648] | [-1.29122] | [-2.08266] | [ 0.46406] | [-0.25497] | [ 2.21892] |
| D(IF(-2)) | -0.205304 | -1.212240 | -0.136773 | -1.801358 | -1.591347 | 18375.67 | 6401.077 | -0.226007 | 0.012984 | -583912.6 |
| | (0.18619) | (0.18767) | (0.69697) | (2.25801) | (1.39934) | (10447.9) | (3671.55) | (0.65095) | (0.06346) | (278620.) |
| | [-1.10264] | [-6.45943] | [-0.19624] | [-0.79776] | [-1.13721] | [ 1.75879] | [ 1.74343] | [-0.34720] | [ 0.20458] | [-2.09573] |
| D(IF(-3)) | 0.129641 | 0.582611 | 0.081021 | 1.401066 | 0.406915 | -707.8775 | -302.2167 | -0.076772 | 0.003697 | 204969.1 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (0.13040) | (0.13143) | (0.48811) | (1.58136) | (0.98000) | (7317.01) | (2571.31) | (0.45588) | (0.04445) | (195127.) |
| | [ 0.99420] | [ 4.43282] | [ 0.16599] | [ 0.88599] | [ 0.41522] | [-0.09674] | [-0.11753] | [-0.16840] | [ 0.08319] | [ 1.05044] |
| D(PF(-1)) | 0.137476 | -0.073958 | 0.663476 | 1.685757 | -1.534650 | -9617.281 | -370.5336 | 0.131668 | 0.002779 | -121055.5 |
| | (0.09523) | (0.09599) | (0.35648) | (1.15492) | (0.71573) | (5343.85) | (1877.91) | (0.33295) | (0.03246) | (142508.) |
| | [ 1.44356] | [-0.77049] | [ 1.86117] | [ 1.45963] | [-2.14418] | [-1.79969] | [-0.19731] | [ 0.39546] | [ 0.08562] | [-0.84947] |
| D(PF(-2)) | -0.246016 | 0.094748 | -0.386605 | -1.002036 | 1.223555 | 9742.815 | 742.2284 | -0.235341 | 0.004581 | 507367.1 |
| | (0.14196) | (0.14308) | (0.53138) | (1.72154) | (1.06688) | (7965.63) | (2799.24) | (0.49629) | (0.04839) | (212424.) |
| | [-1.73304] | [ 0.66220] | [-0.72755] | [-0.58206] | [ 1.14686] | [ 1.22311] | [ 0.26515] | [-0.47420] | [ 0.09467] | [ 2.38846] |
| D(PF(-3)) | 0.024700 | -0.079871 | -0.273423 | -0.661631 | -1.014010 | -5611.053 | -2189.700 | 0.169384 | -0.056243 | -358914.3 |
| | (0.09886) | (0.09964) | (0.37005) | (1.19885) | (0.74296) | (5547.13) | (1949.35) | (0.34561) | (0.03370) | (147929.) |
| | [ 0.24985] | [-0.80160] | [-0.73889] | [-0.55189] | [-1.36483] | [-1.01152] | [-1.12330] | [ 0.49010] | [-1.66915] | [-2.42627] |
| D(OP(-1)) | 0.021833 | 0.005416 | 0.063828 | 1.518865 | 0.017842 | 779.0930 | 158.3595 | -0.002955 | 0.001075 | 7798.340 |
| | (0.01332) | (0.01343) | (0.04988) | (0.16159) | (0.10014) | (747.671) | (262.743) | (0.04658) | (0.00454) | (19938.6) |
| | [ 1.63855] | [ 0.40325] | [ 1.27972] | [ 9.39964] | [ 0.17817] | [ 1.04203] | [ 0.60272] | [-0.06344] | [ 0.23676] | [ 0.39112] |
| D(OP(-2)) | -0.004549 | -0.005769 | -0.050505 | -1.140398 | 0.061503 | -1051.030 | -374.8524 | 0.016607 | -0.002284 | -22589.77 |
| | (0.01886) | (0.01901) | (0.07061) | (0.22877) | (0.14177) | (1058.53) | (371.984) | (0.06595) | (0.00643) | (28228.5) |
| | [-0.24116] | [-0.30342] | [-0.71522] | [-4.98488] | [ 0.43381] | [-0.99291] | [-1.00771] | [ 0.25180] | [-0.35527] | [-0.80025] |
| D(OP(-3)) | -0.012500 | 0.020343 | 0.029453 | 0.175110 | -0.085246 | 1493.817 | 541.5999 | -0.014486 | 0.002831 | 29842.56 |
| | (0.01370) | (0.01381) | (0.05128) | (0.16614) | (0.10296) | (768.729) | (270.143) | (0.04790) | (0.00467) | (20500.1) |
| | [-0.91240] | [ 1.47323] | [ 0.57435] | [ 1.05400] | [-0.82795] | [ 1.94323] | [ 2.00486] | [-0.30246] | [ 0.60633] | [ 1.45572] |
| D(P(-1)) | -0.115537 | 0.032407 | -0.220771 | -0.801216 | 0.847200 | 2900.332 | 652.9863 | -0.093365 | -0.004451 | 50945.63 |
| | (0.04739) | (0.04777) | (0.17741) | (0.57476) | (0.35619) | (2659.43) | (934.564) | (0.16569) | (0.01615) | (70920.5) |
| | [-2.43779] | [ 0.67839] | [-1.24442] | [-1.39400] | [ 2.37850] | [ 1.09058] | [ 0.69871] | [-0.56348] | [-0.27550] | [ 0.71835] |
| D(P(-2)) | 0.078004 | -0.050990 | 0.120039 | 0.502624 | -0.661546 | -4156.719 | -488.4993 | 0.109348 | -0.017828 | -256164.5 |
| | (0.06778) | (0.06832) | (0.25373) | (0.82202) | (0.50942) | (3803.50) | (1336.61) | (0.23697) | (0.02310) | (101430.) |
| | [ 1.15080] | [-0.74634] | [ 0.47310] | [ 0.61145] | [-1.29862] | [-1.09287] | [-0.36548] | [ 0.46143] | [-0.77165] | [-2.52553] |
| D(P(-3)) | -0.027470 | 0.024398 | -0.120448 | 0.381257 | 0.195770 | 1003.639 | 224.4156 | -0.069214 | -0.006836 | 143943.0 |
| | (0.04212) | (0.04245) | (0.15766) | (0.51079) | (0.31655) | (2363.44) | (830.547) | (0.14725) | (0.01436) | (63027.1) |
| | [-0.65220] | [ 0.57470] | [-0.76396] | [ 0.74641] | [ 0.61846] | [ 0.42465] | [ 0.27020] | [-0.47004] | [-0.47615] | [ 2.28383] |
| D(NFA(-1)) | -4.40E-06 | -1.08E-06 | 3.48E-06 | 3.72E-06 | 5.39E-07 | 1.659222 | 0.044047 | -5.07E-06 | 4.65E-09 | -6.043604 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (2.5E-06) | (2.5E-06) | (9.3E-06) | (3.0E-05) | (1.9E-05) | (0.13919) | (0.04891) | (8.7E-06) | (8.5E-07) | (3.71173) |
| | [-1.77430] | [-0.43129] | [ 0.37447] | [ 0.12372] | [ 0.02889] | [ 11.9210] | [ 0.90053] | [-0.58433] | [ 0.00550] | [-1.62824] |
| D(NFA(-2)) | 3.31E-06 | 5.39E-07 | -1.41E-05 | -7.21E-06 | -1.67E-07 | -1.360291 | -0.127560 | 8.75E-06 | -1.19E-06 | -1.853103 |
| | (3.8E-06) | (3.8E-06) | (1.4E-05) | (4.6E-05) | (2.8E-05) | (0.21081) | (0.07408) | (1.3E-05) | (1.3E-06) | (5.62170) |
| | [ 0.88113] | [ 0.14233] | [-1.00341] | [-0.15823] | [-0.00592] | [-6.45279] | [-1.72191] | [ 0.66626] | [-0.92759] | [-0.32963] |
| D(NFA(-3)) | -1.81E-06 | -1.12E-06 | 1.98E-05 | 2.67E-06 | 1.27E-05 | 0.491715 | 0.097567 | -3.52E-06 | 1.16E-06 | 3.799027 |
| | (2.1E-06) | (2.1E-06) | (7.7E-06) | (2.5E-05) | (1.5E-05) | (0.11567) | (0.04065) | (7.2E-06) | (7.0E-07) | (3.08466) |
| | [-0.88027] | [-0.53921] | [ 2.56056] | [ 0.10675] | [ 0.81751] | [ 4.25098] | [ 2.40026] | [-0.48898] | [ 1.65494] | [ 1.23159] |
| D(FD(-1)) | -1.19E-05 | -6.72E-06 | 0.000179 | -0.000299 | 0.000235 | 1.142915 | 1.922736 | 3.26E-07 | 2.29E-06 | -28.33793 |
| | (1.3E-05) | (1.3E-05) | (4.8E-05) | (0.00016) | (9.6E-05) | (0.72047) | (0.25318) | (4.5E-05) | (4.4E-06) | (19.2132) |
| | [-0.92461] | [-0.51940] | [ 3.72964] | [-1.92194] | [ 2.43719] | [ 1.58635] | [ 7.59423] | [ 0.00726] | [ 0.52405] | [-1.47492] |
| D(FD(-2)) | 2.12E-05 | 6.88E-06 | -0.000198 | 0.000270 | -0.000203 | -1.748557 | -1.793010 | 1.02E-05 | -3.65E-06 | 1.982872 |
| | (1.8E-05) | (1.8E-05) | (6.7E-05) | (0.00022) | (0.00013) | (0.99966) | (0.35129) | (6.2E-05) | (6.1E-06) | (26.6584) |
| | [ 1.19094] | [ 0.38329] | [-2.97506] | [ 1.24794] | [-1.51919] | [-1.74916] | [-5.10402] | [ 0.16445] | [-0.60086] | [ 0.07438] |
| D(FD(-3)) | -5.09E-06 | 2.82E-06 | 0.000139 | -0.000183 | 0.000157 | 1.603503 | 0.834402 | -1.72E-07 | 6.99E-06 | 27.58807 |
| | (1.3E-05) | (1.3E-05) | (4.8E-05) | (0.00016) | (9.7E-05) | (0.72447) | (0.25459) | (4.5E-05) | (4.4E-06) | (19.3198) |
| | [-0.39456] | [ 0.21655] | [ 2.88402] | [-1.16888] | [ 1.61887] | [ 2.21335] | [ 3.27745] | [-0.00381] | [ 1.58736] | [ 1.42797] |
| D(I(-1)) | -0.004491 | -0.007039 | 0.197600 | -0.356951 | 0.355941 | 2042.971 | -378.4018 | 1.717174 | -0.014700 | -14524.40 |
| | (0.04524) | (0.04560) | (0.16934) | (0.54863) | (0.34000) | (2538.54) | (892.082) | (0.15816) | (0.01542) | (67696.7) |
| | [-0.09928] | [-0.15438] | [ 1.16685] | [-0.65062] | [ 1.04689] | [ 0.80478] | [-0.42418] | [ 10.8570] | [-0.95333] | [-0.21455] |
| D(I(-2)) | 0.081155 | 0.019937 | -0.224229 | 0.548557 | -0.283476 | -1311.224 | 72.09639 | -1.417801 | 0.037225 | 48440.22 |
| | (0.06360) | (0.06410) | (0.23806) | (0.77125) | (0.47796) | (3568.58) | (1254.05) | (0.22234) | (0.02168) | (95165.4) |
| | [ 1.27609] | [ 0.31103] | [-0.94191] | [ 0.71126] | [-0.59310] | [-0.36744] | [ 0.05749] | [-6.37678] | [ 1.71728] | [ 0.50901] |
| D(I(-3)) | -0.004766 | 0.005348 | 0.250741 | -0.218937 | 0.325711 | 4926.369 | -28.07461 | 0.458587 | 0.007513 | 51551.38 |
| | (0.04870) | (0.04908) | (0.18228) | (0.59054) | (0.36597) | (2732.46) | (960.229) | (0.17024) | (0.01660) | (72868.2) |
| | [-0.09788] | [ 0.10895] | [ 1.37558] | [-0.37074] | [ 0.88999] | [ 1.80290] | [-0.02924] | [ 2.69370] | [ 0.45262] | [ 0.70746] |
| D(LMS(-1)) | 0.170173 | -0.008770 | -3.159724 | -3.634959 | -3.851945 | -62980.01 | -7253.978 | -0.158507 | -0.299055 | 320618.4 |
| | (0.36403) | (0.36691) | (1.36264) | (4.41462) | (2.73584) | (20426.6) | (7178.22) | (1.27267) | (0.12408) | (544728.) |
| | [ 0.46748] | [-0.02390] | [-2.31882] | [-0.82339] | [-1.40796] | [-3.08324] | [-1.01055] | [-0.12455] | [-2.41019] | [ 0.58858] |
| D(LMS(-2)) | 0.156039 | -0.087680 | -0.988270 | 3.201669 | -0.997462 | -5865.587 | -8389.811 | -0.971614 | -0.039501 | -397350.9 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | (0.36641) | (0.36932) | (1.37157) | (4.44356) | (2.75377) | (20560.5) | (7225.27) | (1.28101) | (0.12489) | (548298.) |
| | [ 0.42586] | [-0.23741] | [-0.72054] | [ 0.72052] | [-0.36222] | [-0.28528] | [-1.16118] | [-0.75848] | [-0.31628] | [-0.72470] |
| D(LMS(-3)) | -0.153435 | 0.263672 | 0.011334 | -3.007154 | 0.814431 | 28504.88 | 3607.495 | 0.372699 | -0.008309 | 30491.43 |
| | (0.34136) | (0.34407) | (1.27781) | (4.13978) | (2.56551) | (19154.9) | (6731.31) | (1.19343) | (0.11635) | (510814.) |
| | [-0.44948] | [ 0.76634] | [ 0.00887] | [-0.72640] | [ 0.31745] | [ 1.48813] | [ 0.53593] | [ 0.31229] | [-0.07141] | [ 0.05969] |
| D(DSG(-1)) | -6.79E-07 | -1.59E-07 | -1.17E-06 | -9.54E-07 | -4.53E-07 | -0.007449 | -0.006272 | 9.81E-08 | -2.26E-07 | -1.207379 |
| | (2.0E-07) | (2.0E-07) | (7.5E-07) | (2.4E-06) | (1.5E-06) | (0.01129) | (0.00397) | (7.0E-07) | (6.9E-08) | (0.30118) |
| | [-3.37399] | [-0.78236] | [-1.55304] | [-0.39073] | [-0.29920] | [-0.65956] | [-1.58040] | [ 0.13937] | [-3.30121] | [-4.00884] |
| D(DSG(-2)) | -4.69E-07 | -4.65E-07 | 3.15E-07 | -2.61E-06 | 6.13E-08 | -0.028984 | 0.001809 | 3.42E-07 | -5.76E-08 | -1.029002 |
| | (2.1E-07) | (2.1E-07) | (7.8E-07) | (2.5E-06) | (1.6E-06) | (0.01171) | (0.00412) | (7.3E-07) | (7.1E-08) | (0.31229) |
| | [-2.24779] | [-2.21067] | [ 0.40281] | [-1.03001] | [ 0.03905] | [-2.47506] | [ 0.43965] | [ 0.46891] | [-0.80981] | [-3.29500] |
| D(DSG(-3)) | -3.65E-07 | -3.58E-07 | 2.76E-06 | 2.10E-07 | 3.17E-06 | -0.014530 | 0.009579 | -1.95E-07 | -1.40E-07 | 0.309414 |
| | (1.9E-07) | (1.9E-07) | (7.2E-07) | (2.3E-06) | (1.4E-06) | (0.01075) | (0.00378) | (6.7E-07) | (6.5E-08) | (0.28659) |
| | [-1.90778] | [-1.85259] | [ 3.84495] | [ 0.09038] | [ 2.20482] | [-1.35205] | [ 2.53644] | [-0.29072] | [-2.14604] | [ 1.07963] |
| C | 0.212082 | 0.037516 | 1.006235 | 0.486031 | 1.796326 | 12099.85 | 575.4354 | 0.091964 | 0.164301 | 208849.2 |
| | (0.08060) | (0.08124) | (0.30172) | (0.97749) | (0.60577) | (4522.86) | (1589.40) | (0.28179) | (0.02747) | (120614.) |
| | [ 2.63121] | [ 0.46179] | [ 3.33504] | [ 0.49723] | [ 2.96536] | [ 2.67527] | [ 0.36205] | [ 0.32635] | [ 5.98033] | [ 1.73156] |
| R-squared | 0.688540 | 0.908503 | 0.829724 | 0.936792 | 0.584709 | 0.971526 | 0.938391 | 0.881201 | 0.540942 | 0.770028 |
| Adj. R-squared | 0.512989 | 0.856932 | 0.733750 | 0.901166 | 0.350636 | 0.955477 | 0.903666 | 0.814241 | 0.282200 | 0.640408 |
| Sum sq. resids | 1.479683 | 1.503235 | 20.73333 | 217.6166 | 83.57671 | 4.66E+09 | 5.75E+08 | 18.08561 | 0.171911 | 3.31E+12 |
| S.E. equation | 0.164022 | 0.165323 | 0.613979 | 1.989137 | 1.232711 | 9203.798 | 3234.354 | 0.573436 | 0.055908 | 245442.9 |
| F-statistic | 3.922175 | 17.61657 | 8.645321 | 26.29490 | 2.497975 | 60.53456 | 27.02333 | 13.16018 | 2.090663 | 5.940635 |
| Log likelihood | 53.77483 | 53.08790 | -61.06145 | -163.3296 | -121.7014 | -897.5810 | -806.5975 | -55.11823 | 147.4133 | -1183.241 |
| Akaike AIC | -0.500571 | -0.484779 | 2.139344 | 4.490336 | 3.533366 | 21.36968 | 19.27810 | 2.002718 | -2.653179 | 27.93657 |
| Schwarz SC | 0.406430 | 0.422221 | 3.046344 | 5.397337 | 4.440367 | 22.27668 | 20.18510 | 2.909719 | -1.746178 | 28.84357 |
| Mean dependent | -0.001574 | -0.044113 | 0.616760 | 0.828966 | 1.507949 | 25971.05 | -739.6214 | 0.041642 | 0.067175 | 43523.92 |
| S.D. dependent | 0.235036 | 0.437080 | 1.189895 | 6.327184 | 1.529738 | 43618.75 | 10420.70 | 1.330486 | 0.065989 | 409303.4 |

| | |
|---|---|
| Determinant resid covariance (dof adj.) | 7.56E+17 |
| Determinant resid covariance | 7.71E+15 |
| Log likelihood | -2825.772 |
| Akaike information criterion | 72.54649 |
| Schwarz criterion | 81.89993 |

VEC Lag Exclusion Wald Tests
Date: 11/21/11 Time: 12:05
Sample: 1986Q1 2009Q4
Included observations: 87

Chi-squared test statistics for lag exclusion:
Numbers in [ ] are p-values

| | D(SVF) | D(IF) | D(PF) | D(OP) | D(P) | D(NFA) | D(FD) | D(I) | D(LMS) | D(DSG) | Joint |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DLag 1 | 39.05389<br>[ 2.48e-05] | 223.3248<br>[ 0.000000] | 113.5130<br>[ 0.000000] | 196.8085<br>[ 0.000000] | 14.78369<br>[ 0.140149] | 368.9587<br>[ 0.000000] | 260.9573<br>[ 0.000000] | 201.1328<br>[ 0.000000] | 25.42009<br>[ 0.004604] | 56.87312<br>[ 1.41e-08] | 2264.20<br>[ 0.00000 |
| DLag 2 | 28.85885<br>[ 0.001313] | 62.63392<br>[ 1.15e-09] | 46.25380<br>[ 1.29e-06] | 56.57759<br>[ 1.60e-08] | 7.725539<br>[ 0.655626] | 83.82377<br>[ 8.90e-14] | 96.39781<br>[ 3.33e-16] | 56.98466<br>[ 1.34e-08] | 19.38290<br>[ 0.035660] | 33.72026<br>[ 0.000206] | 671.575<br>[ 0.00000 |
| DLag 3 | 20.12148<br>[ 0.028124] | 37.64735<br>[ 4.37e-05] | 50.53836<br>[ 2.12e-07] | 13.30397<br>[ 0.207169] | 15.61305<br>[ 0.111258] | 55.78879<br>[ 2.25e-08] | 39.40417<br>[ 2.16e-05] | 13.03803<br>[ 0.221553] | 32.36284<br>[ 0.000348] | 12.03306<br>[ 0.282850] | 426.840<br>[ 0.00000 |
| Df | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 100 |

**Appendix B: VARIANCE DECOMPOSITION RESULTS**

| Period | S.E. | IF | PF | OP | P | NFA | FD | I | DSG | SVF |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.071263 | 10.07907 | 30.02904 | 11.54374 | 16.42189 | 17.11071 | 9.144014 | 0.794566 | 1.328385 | 3.548571 |
| | | (6.02757) | (7.72864) | (4.84325) | (5.27830) | (4.37865) | (2.90927) | (0.48102) | (0.52520) | (0.81228) |
| 2 | 0.194674 | 21.25842 | 16.01786 | 11.70275 | 8.277800 | 22.79243 | 5.745138 | 0.840723 | 7.385327 | 5.979555 |
| | | (10.8692) | (8.07836) | (6.52041) | (5.68059) | (8.70945) | (3.18880) | (3.39987) | (5.12450) | (1.71716) |
| 3 | 0.308213 | 27.15525 | 11.77315 | 8.787390 | 6.055188 | 20.06232 | 12.03566 | 1.362529 | 7.198013 | 5.570509 |
| | | (14.0965) | (7.93495) | (6.52401) | (5.53785) | (10.7180) | (6.98527) | (4.26398) | (6.36244) | (2.00607) |
| 4 | 0.407427 | 21.35046 | 13.56823 | 14.11304 | 8.013591 | 15.46319 | 16.18062 | 1.058089 | 6.170184 | 4.082606 |
| | | (11.6434) | (8.79701) | (5.82182) | (6.48923) | (9.20569) | (7.10415) | (6.61158) | (7.09329) | (1.55089) |
| 5 | 0.576106 | 15.71977 | 25.17432 | 17.24719 | 6.849122 | 9.928569 | 10.44673 | 2.811562 | 9.228674 | 2.594070 |
| | | (11.0075) | (10.1368) | (6.76828) | (6.61748) | (9.18183) | (6.12756) | (7.36717) | (6.68345) | (1.20631) |
| 6 | 0.967588 | 19.85061 | 20.65656 | 14.60710 | 8.091290 | 8.062212 | 14.43561 | 3.054083 | 8.872195 | 2.370336 |
| | | (9.72800) | (8.92545) | (6.58092) | (6.08790) | (8.83000) | (6.29642) | (6.77489) | (7.13756) | (1.25475) |
| 7 | 1.530991 | 14.76473 | 18.79196 | 14.59935 | 11.15740 | 8.081459 | 13.69826 | 8.468775 | 8.625174 | 1.812888 |
| | | (9.66269) | (8.04056) | (7.95410) | (6.67124) | (9.54653) | (6.00095) | (9.01994) | (6.96870) | (1.00512) |
| 8 | 2.447080 | 12.22456 | 17.53944 | 12.47194 | 8.542569 | 8.464029 | 6.949195 | 22.74389 | 10.13262 | 0.931757 |
| | | (8.19349) | (8.39688) | (8.60225) | (7.66666) | (9.71656) | (5.49840) | (10.4625) | (6.48983) | (0.82788) |
| 9 | 4.204757 | 12.09935 | 15.85948 | 13.56948 | 7.526577 | 9.042582 | 13.58822 | 19.14333 | 8.376515 | 0.794460 |
| | | (8.40924) | (8.41206) | (8.22867) | (7.87496) | (9.48735) | (6.98388) | (10.1538) | (7.31206) | (0.64568) |
| 10 | 6.731226 | 10.65361 | 17.61713 | 13.84700 | 7.715790 | 9.613859 | 8.558406 | 21.80944 | 9.701460 | 0.483304 |
| | | (7.53093) | (7.50701) | (10.6754) | (7.38906) | (9.58386) | (6.82292) | (10.3343) | (7.06361) | (0.60426) |
| 11 | 10.22852 | 14.82099 | 15.53478 | 11.99311 | 7.539334 | 8.305230 | 10.93430 | 20.53140 | 9.864775 | 0.476076 |
| | | (8.28522) | (7.97074) | (10.4858) | (7.82866) | (9.56917) | (6.17058) | (11.0645) | (7.52221) | (0.63654) |
| 12 | 15.96868 | 11.31096 | 20.73125 | 13.46787 | 8.970126 | 7.099828 | 10.87448 | 18.42861 | 8.771353 | 0.345515 |
| | | (8.26653) | (8.73652) | (10.2162) | (7.92367) | (9.94660) | (6.77006) | (11.4341) | (7.09688) | (0.64028) |
| 13 | 24.93089 | 14.21675 | 22.48534 | 10.61298 | 9.129779 | 6.818924 | 8.430336 | 19.08542 | 8.965161 | 0.255300 |
| | | (8.83791) | (9.31145) | (10.4223) | (8.13046) | (9.26615) | (6.68733) | (11.4335) | (6.33766) | (0.49842) |
| 14 | 38.07239 | 15.97979 | 20.97244 | 9.693065 | 8.920204 | 6.199846 | 9.842305 | 19.62658 | 8.530024 | 0.235746 |
| | | (8.87138) | (8.36854) | (11.0541) | (8.30623) | (9.72641) | (7.10278) | (12.1106) | (7.36181) | (0.56959) |
| 15 | 58.61700 | 11.20438 | 20.81988 | 13.97858 | 7.760046 | 5.519680 | 7.532732 | 24.12475 | 8.908906 | 0.151049 |
| | | (8.40857) | (7.98436) | (11.2664) | (6.75701) | (10.2505) | (7.67435) | (11.3210) | (7.67844) | (0.58623) |
| 16 | 90.59488 | 13.51053 | 20.56376 | 12.17039 | 7.382073 | 5.032731 | 11.32706 | 21.05325 | 8.823169 | 0.137027 |
| | | (8.30674) | (8.49305) | (10.9573) | (7.53570) | (9.42827) | (7.05221) | (12.2081) | (6.86176) | (0.59366) |
| 17 | 138.3442 | 12.13174 | 20.21265 | 10.65851 | 14.41867 | 4.839128 | 10.56886 | 19.30672 | 7.713583 | 0.150157 |
| | | (8.27600) | (9.26098) | (11.2461) | (7.98601) | (10.0369) | (7.16673) | (12.4644) | (6.76724) | (0.45402) |
| 18 | 211.5945 | 5.977578 | 19.00559 | 17.40756 | 6.482698 | 4.510333 | 8.181043 | 27.04151 | 11.31791 | 0.075778 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | (7.57627) | (8.05740) | (11.2515) | (6.86367) | (10.3311) | (7.28713) | (12.1730) | (7.21511) | (0.50831) |
| 19 | 325.3972 | 7.460491 | 14.57942 | 19.58323 | 4.978096 | 3.474996 | 18.28563 | 22.89754 | 8.672180 | 0.068415 |
| | | (8.40054) | (6.49809) | (11.5112) | (6.91663) | (10.3013) | (7.54001) | (11.6981) | (7.04453) | (0.66832) |
| 20 | 499.0448 | 6.323663 | 12.02086 | 17.85243 | 11.17350 | 2.656241 | 15.51624 | 27.17951 | 7.096600 | 0.180944 |
| | | (8.32826) | (7.74948) | (11.3767) | (8.05341) | (10.4697) | (6.87647) | (12.3733) | (6.90855) | (0.55605) |
| 21 | 765.8986 | 3.577416 | 11.40792 | 23.04745 | 3.390615 | 2.902279 | 10.83869 | 35.17276 | 9.536976 | 0.125885 |
| | | (7.96813) | (7.86663) | (11.3416) | (8.18787) | (11.1534) | (7.07942) | (12.1084) | (7.69759) | (0.41080) |
| 22 | 1179.079 | 2.917027 | 8.134770 | 26.35146 | 2.037608 | 1.888258 | 20.63875 | 31.17465 | 6.733747 | 0.123742 |
| | | (8.10753) | (6.98342) | (11.4606) | (7.74432) | (11.0554) | (7.87157) | (12.3680) | (7.24997) | (0.51155) |
| 23 | 1813.240 | 1.812250 | 5.072931 | 25.92539 | 6.680028 | 1.219081 | 19.98649 | 33.42771 | 5.662819 | 0.213298 |
| | | (8.48512) | (7.10058) | (11.5164) | (7.44605) | (10.1899) | (7.94427) | (12.0296) | (6.62336) | (0.56587) |
| 24 | 2788.582 | 1.210974 | 6.830682 | 26.72056 | 2.327269 | 2.038288 | 14.59909 | 37.76425 | 8.361245 | 0.147644 |
| | | (7.06834) | (8.62385) | (11.4665) | (7.88439) | (9.93804) | (7.25026) | (12.8299) | (6.49741) | (0.50849) |

**Appendix C: TESTS OF EXCHANGE RATE VOLATILITY UNDER DIFERENT EXCHANGE RATE REGIME**

**1. SAP ERA (1986:Q1 – 1993:Q4**

Dependent Variable: SVF
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/10/11 Time: 16:44
Sample (adjusted): 1986Q4 1993Q4
Included observations: 29 after adjustments
Convergence achieved after 52 iterations
Variance backcast: ON
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

| | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C | -4.496566 | 0.767687 | -5.857292 | 0.0000 |
| SVF(-1) | -0.306522 | 0.124364 | -2.464724 | 0.0137 |
| SVF(-2) | 0.008642 | 0.137559 | 0.062822 | 0.9499 |
| Variance Equation | | | | |
| C | 0.000386 | 0.001157 | 0.333249 | 0.7389 |
| RESID(-1)^2 | -0.143207 | 0.072534 | -1.974356 | 0.0483 |
| GARCH(-1) | 1.190735 | 0.209970 | 5.670969 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.283624 | Mean dependent var | -3.460407 |
| Adjusted R-squared | 0.127890 | S.D. dependent var | 0.157769 |
| S.E. of regression | 0.147335 | Akaike info criterion | -1.396981 |
| Sum squared resid | 0.499277 | Schwarz criterion | -1.114092 |
| Log likelihood | 26.25622 | F-statistic | 1.821206 |
| Durbin-Watson stat | 1.703597 | Prob(F-statistic) | 0.148362 |

**2. POST - SAP ERA (1994:Q1 – 2003:Q4)**

Dependent Variable: SVF
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/10/11 Time: 17:21
Sample: 1994Q1 2003Q4
Included observations: 40
Convergence achieved after 11 iterations
Variance backcast: ON
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

| | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C | -3.386114 | 0.872001 | -3.883153 | 0.0001 |
| SVF(-1) | 0.025530 | 0.317817 | 0.080330 | 0.9360 |
| Variance Equation | | | | |
| C | 0.028897 | 0.043476 | 0.664679 | 0.5063 |
| RESID(-1)^2 | -0.038917 | 0.068293 | -0.569844 | 0.5688 |

| | | | | |
|---|---|---|---|---|
| GARCH(-1) | 0.589029 | 0.566694 | 1.039413 | 0.2986 |

| | | | |
|---|---|---|---|
| R-squared | -0.000374 | Mean dependent var | -3.467996 |
| Adjusted R-squared | -0.114703 | S.D. dependent var | 0.217330 |
| S.E. of regression | 0.229456 | Akaike info criterion | -0.123136 |
| Sum squared resid | 1.842748 | Schwarz criterion | 0.087974 |
| Log likelihood | 7.462717 | Durbin-Watson stat | 1.998865 |

**3. NEEDS ERA (2004:Q1 – 2009:Q4)**

Dependent Variable: SVF
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 05/15/11 Time: 11:11
Sample: 2004Q1 2009Q4
Included observations: 24
Convergence achieved after 38 iterations
Variance backcast: ON
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

| | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C | -2.874392 | 0.493685 | -5.822316 | 0.0000 |
| SVF(-1) | 0.184540 | 0.142203 | 1.297722 | 0.1944 |
| Variance Equation | | | | |
| C | -8.06E-05 | 0.000135 | -0.594890 | 0.5519 |
| RESID(-1)^2 | 0.052972 | 0.485094 | 0.109199 | 0.9130 |
| GARCH(-1) | 1.323574 | 0.735227 | 1.800225 | 0.0718 |

| | | | |
|---|---|---|---|
| R-squared | -0.013037 | Mean dependent var | -3.510194 |
| Adjusted R-squared | -0.226307 | S.D. dependent var | 0.039044 |
| S.E. of regression | 0.043237 | Akaike info criterion | -4.188709 |
| Sum squared resid | 0.035520 | Schwarz criterion | -3.943281 |
| Log likelihood | 55.26451 | Durbin-Watson stat | 1.466312 |