GENERAL EQUILIBRIUM ANALYSIS OF THE CAUSES AND EFFECTS OF EXCHANGE RATE VOLATILITY ON EXPORT DEMAND IN NIGERIA (1986–2013)

By

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ABSTRACT

This thesis provides empirical analyses of the relationship between exchange rate volatility (ERV) and export demand in Nigeria using the Nigeria-United States disaggregated bilateral quarterly export data from 1986Q3 to 2013Q4. Firstly, the study examines the contribution of macroeconomic (such as monetary and real) shocks to exchange rate volatility (ERV) in Nigeria using quarterly data from 1986Q3 to 2013Q4. The examination is to ascertain the determinants of ERV in Nigeria through internally generated volatility (endogenous volatility) in the exchange rate. Secondly, the endogenous volatility is employed to investigate the relationship between ERV and trade using the general equilibrium approach.

The study employs the oil and agriculture export model for the trade analysis because Nigeria's net export largely deteriorates from 26.2% in 2012 to -40.1% in 2013, which is a negative indication to economic growth. This study recognizes the role of oil price, interest rate and income in ERV determination. Also, it recognizes the role of price and income in the relationship between ERV and export demand in Nigeria. The BEKK Multivariate Generalized Autoregressive Conditional Heteroscedastic (BEKK-MGARCH) model together with the volatility impulse response functions (VIRFs) are employed for the analysis of exchange rate volatility modeling. While the autoregressive distributed lag (ARDL) model is employed for the sectoral export demand modeling.

The results provide strong evidence that previous shocks from interest rate, productivity growth, and oil price significantly influence exchange rate volatility in Nigeria between 1986 and 2013. Also, volatilities from interest rate and productivity growth significantly contribute to ERV while oil price provide mixed results for volatility spillover to ERV in Nigeria. The results from the exchange rate model indicate that exchange rate volatility in Nigeria increased due the shock effects from the interest rate and productivity growth employed in the model.

From the trade model, the study provides robust evidence that increase in ER volatility reduces the volume of export in the Nigerian oil and agricultural sector between 1986 and 2013. The evidence from this study supports the theoretical model that effect of exchange rate volatility on trade flow arises from the factors that drive ERV. The multiplier analysis of the ARDL techniques shows that the immediate effect of ERV on export demand in Nigeria between 1986 and 2013 has a high magnitude, which gradually dies off.

The policy implications of the finding of this thesis are in three-fold. Firstly, this study confirmed that shocks to exchange rate overtime are orchestrated by policy reversal from unstable political regime in Nigeria. The shocks to exchange rate overtime subsequently led to general high volatilities in the exchange rate, interest rate and output growth as well as overall unstable economy. The higher interest rate and output growth shocks and volatilities increase ERV, which in turn, deteriorates trade in oil and agricultural sectors. Thus, this study suggests that policy reversal under political regime shift should be controlled in Nigeria. Secondly, interest rate volatility is found in this study to escalate volatility of exchange rate overtime. Thus, this study suggests that a practical and stable monetary policy that will lower ERV is needed to boost trade in the two productive sectors in Nigeria. This will help to control the volatilities in the economy that is due to monetary volatility as well as real economy volatility.

Thirdly, this study finds that exchange rate variation alone cannot explain the full degree of trade imbalances in Nigeria. Thus, exchange rate arrangement is only a part of the needed resolution to trade improvement. The study, therefore, suggests that full resolution to trade development be pursued alongside other policy actions such as monetary policy. The study made the suggestion because this thesis confirms that there is an indirect effect from the monetary factor to trade. Finally, this study concludes that Nigeria political regime and monetary policy should be reviewed and become stable to allow a sustainable and enduring economic growth.

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Declaration

I declare that, except where explicit reference is made to the contribution of others, that this thesis is the result of my own work and has not been submitted for any other degree at the Kingston University London or any other institution.

Signature

Adebisi Temitope ADEBUSUYI

CHAPTER ONE: INTRODUCTION

1.1 Motivation and Scope of the Study

This study is motivated by the continuous deterioration of the Nigeria's gross domestic product (GDP) and the unstable exchange rate, which always affect every part of the economy through trade. The reduction in the growth of the Gross Domestic Product (GDP) of the Nigerian economy from 10.4% in 2003 to 5.4% in 2013 is a great concern and requires empirical investigation. At the beginning of this study, the growth of Nigeria's GDP deteriorates as much as the practically unstable exchange rate, CBN (2014). This study notices that the deterioration in Nigeria growth rate is possibly triggered by the unstable exchange rate through trade, which is the engine of growth. That is, it is possible that the instability in the exchange rate in Nigeria transmits into every part of the economy majorly through trade with the rest of the world.

The study observes that like many other African countries, Nigeria experienced economic distortions in virtually all the sectors of the economy from the 1970s through the entire decade of the 1990s, Ibrahim (2016).[1] As a result of the incessant economic challenges in Nigeria overtime, this study considers the effect of unstable exchange rate on trade activities in Nigeria since the period of major reform called Structural Adjustment Program (SAP) in 1986 till 2013. More importantly, this study examines the effect of the reform and its associated policies in the exchange rate and interest rate market on exchange rate volatility and its consequence on trade activities over the period, 1986 to 2013.

[1] See evidence in table 1.1

Table 1.1: Average annual growth rates of real output (%)

	1971-1980	1981-1990	1991-2000	2001-2010	2008-2012
Nigeria	4.92	-0.57	1.88	9.18	6.04
World	3.80	3.26	2.82	2.77	1.65
Developing Economies	5.80	3.53	4.89	6.07	5.17
Africa	4.22	1.81	2.62	5.28	3.79
America	5.97	1.76	3.12	3.64	3.02
Asia	6.18	5.34	6.24	7.13	6.09
Eastern Asia	7.80	9.66	8.13	8.30	7.20
Oceania	2.86	3.79	2.38	2.87	3.41

Data Source: (UNCTAD, 2014) and (CBN, Annual Reports, 2014)

Table 1.1 shows that:

- Nigeria recorded negative growth rate in the 1980s and a very low growth in the 1990s and 2000.
- The African continent recorded a very low growth rate between 1980 and 2000.

The nature and pattern of Nigeria's growth in the above table might have contributed to the slow progress in poverty reduction and in realizing other development goals. Also, the negative economic growth rate in Nigeria in the 1980s might have affected many parts of the economy. This appeared in the form of low per capita income, increasing balance of payments deficit and huge debt followed by accumulation of servicing debts in the economy over the period.

The economy has featured low per capita income, increasing balance of payments deficit and huge debt, which were accompanied by high inflationary pressures. This kept on rising while monetary management began to experience imbalances and loss of external stability (see figure 1.1). The imbalances in the economy in the 1980s inspired the establishment of the World Bank/International Monetary Fund (IMF) Structural Adjustment Program (SAP) in 1986. SAP was established to restructure the economy. Consequently, major policy reforms such as trade reforms, exchange rate, and interest rate deregulations were introduced. The deregulation reform explains the pattern of Nigeria exchange rate, interest rate and trade orientation since 1986.

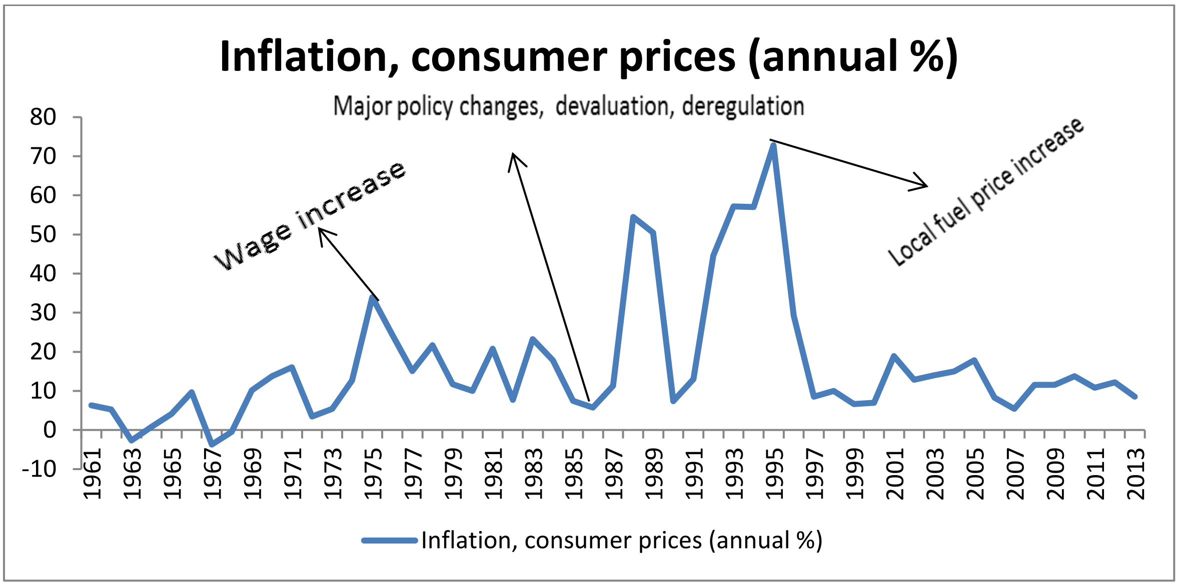

Figure 1. 1: Inflationary Trend (1961–2013)

Figure 1.1 shows that:

- Inflationary pressures intensified in the 1970s and 1990s.
- The spike in 1975 was inspired by the government decision to award salary increases with effects on its workers in 1975.
- Private sector enterprises also took similar action of salary increase.
- There was a major policy change/structural reform in 1986.
- The fuel price increase in Nigeria shows the direction of figure 1.1 between 1993 and 1998. The recent lower rate of inflation in the figure may be attributed to the lower global oil price in which Nigeria export a lot.

Consequently, loss of external stability was encouraged in Nigeria during the period when inflationary pressures worsened. In addition, international oil market collapsed in the 1980s and FX earnings of Nigeria fell markedly (see fig. 1.2).

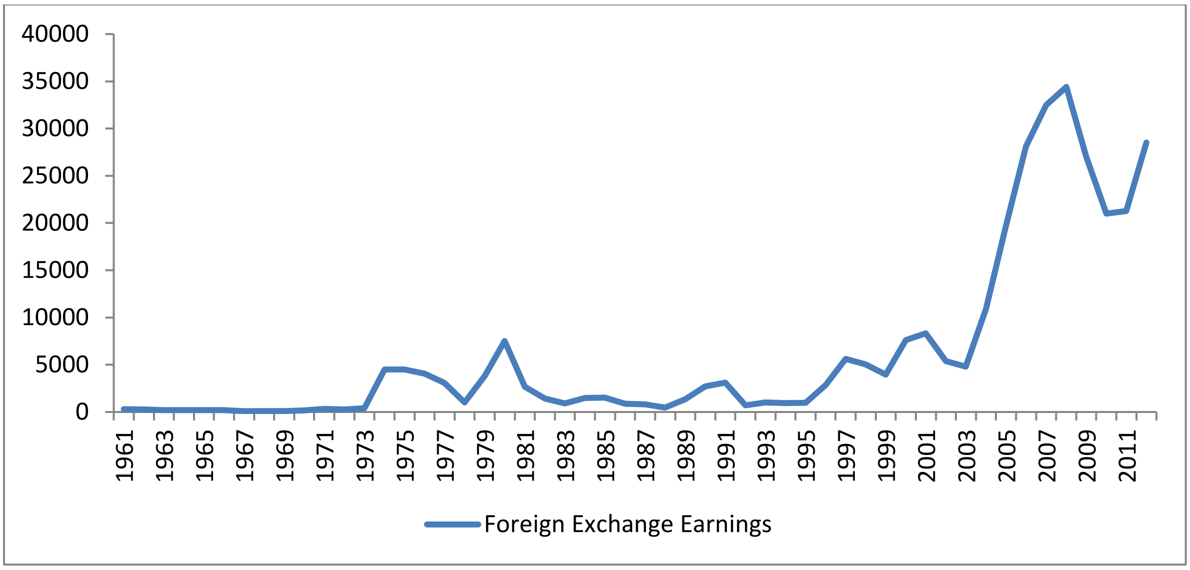

Figure 1. 2: Nigeria's Foreign Exchange Earnings ($) between 1961 and 2013

Figure 1.2 shows that:

- FX earnings fell in 1980 due to the global oil price reduction.
- The low foreign exchange earnings between 1981 and 1997 might be responsible for the balance of payment deficit during the period.
- The upsurge in figure 1.2 between 2005 and 2007 is attributed to the debt relief of 2005.

The Nigerian economic imbalances, such as inflationary pressure, negative economic growth rate, the weakening external sector and the poor state of Nigerians, have many causes and varied. To this study, the most important cause of poor economic performance is the application of poor macroeconomic policies of developing countries, including Nigeria; Adebusuyi, Ellyne & Obamuyi (2015). Nigeria introduced many developmental policies and projects (including trade, interest rate, and exchange rate reforms) to address the challenges of inflationary pressure, negative economic growth rate, deteriorating external sector as well as guarantee globally competitive and stable economy (see details in chapter two).[2]

[2] This study is interested in the exchange rate, interest rate and trade reforms in Nigeria for the period between 1986 and 2013.

It is obvious that inflationary pressure, negative economic growth rate and deteriorating external sector are usually visible in Nigeria at the spike of world oil price. However, the recent economic distortions as noted above are possibly activated by the continuous deteriorating exchange rate (ER). The unstable ER influences trade as agents of trade tends to reduce trading activities when exchange rate is not predictable. Meanwhile, one of the common trade arguments is that an economy that is internationally competitive will achieve rapid economic growth. Thus, an understanding of the factors that drive unstable ER or exchange rate volatility (ERV) and the extent to which it influences exports activities is important for best trade, interest rate, and exchange rate policies in Nigeria.

Several studies have been carried out on the role of interest rate, productivity growth and oil price persistence on exchange rate volatility (ERV) and its consequent effects on the trade flow of an economy, but very few are related to Nigeria (details in chapter three and four). Most of the earlier studies are restricted to the conventional (flexible price and sticky price) exchange rate volatility model. This study finds that most past studies showed that monetary (interest rate and money supply) shocks mainly influence exchange rate volatility ignoring the effect of real (productivity growth and oil price) shocks in the exchange rate volatility.

Likewise, most of the previous studies on the relationship between ERV and trade held that exchange rate volatility exogenously affects trade flows ignoring the fact that ERV should be endogenously measured (see details in chapter four). Firstly, this study overcomes these restrictions by considering the monetary factor (interest rate) and real factors (productivity growth and oil price) in determining the factors that drive ERV. Secondly, unlike most of the previous studies, this research work considers an endogenous measurement of ERV in investigating the relationship between ERV and export in Nigeria between 1986 and 2013. To this end, the study has two-fold scope that:

a. The monetary factors alone may not have comprehensive intuition about the determination of ERV. To this end, few studies have recently tried to provide both theoretical and empirical explanation to an all-inclusive ERV model which incorporates the non-monetary (real) factors to the determination of ERV. According to the new open economy macroeconomics, the real shocks, such as productivity shocks among others should be included in the models of exchange rate determination in addition to monetary shocks, (Calderon, 2004). It is important in this study to include the real shocks in the models of exchange rate determination because shocks to business cycles arising from unstable political system and production affect variations in exchange rate in Nigeria overtime.

   In addition, very few studies recently suggested that oil price might have a significant influence on exchange rate (Trung & Vinh, 2011). According to Al-Ezzee (2011), including oil in the model of exchange rate is recent, however, this study finds it to be an essential factor in determining ERV in Nigeria. Oil price appears to be an essential factor in this study because oil proceeds is the major source of revenue to the economy as oil is the main product of its exchange. Thus, this study employs the new model that incorporates oil price, which is relevant to the Nigerian economy. This study therefore follows the theoretical and empirical supports from previous similar studies (the empirical investigation is detailed in chapter six of this thesis).

b. The hypothesis that ERV exogenously affects trade flow, that is, other factors influencing exchange rate are presumed to be constant, was adopted earlier by several authors (see details in chapter four). However, in the presence of globalisation and development from new open economy macroeconomics, the relationship between ERV and trade is investigated endogenously (general equilibrium theory – GET) in this study. The study is developed such that the trade model that investigates the relationship between ERV and trade is subject to ERV sources and other macroeconomic shocks as detailed in chapter six of this thesis.

To the knowledge of the author, very few studies on Nigeria have adopted such trade models with disaggregated bilateral trade data (see Akinlo & Adejumo, 2014); and (Odili, 2015). Although, their results provided support to the GET, however, their models did not significantly improve the results relative to those that used aggregate trade flow such as, Arize, Osang, & Slottje, (2008). For example, the analysis in Akinlo & Adejumo (2014) and Odili (2015) still follow the aggregating analysis. Meanwhile, using aggregate trade model is likely to ignore the effect of exchange rate volatility, which may vary across sectors. Ignoring the differences of sectoral effect of exchange rate volatility might results to diluting the true picture of the relationship between exchange rate volatility and trade. Thus, it becomes important to take the disaggregating process a step further by examining sector-specific trade flow (see details in chapter four). Moreover, unlike other studies on Nigeria, this research work discerns the subsequent effect of persistent currency instability on the sectoral trade flows (using the deregulation policies, which is peculiar to Nigeria)[3]. This study therefore employs a trade model that is suitable with sector-specific trade (that is using sectoral trade model) as against the previous models based on economic aggregation. Also, by using the deregulation policies peculiar to the Nigerian exchange rate system, this thesis determines the subsequent effect of exchange rate volatility on sectoral trade using the ARDL multiplier analysis.

[3] The persistent unstable exchange rate volatility might have had negative impact on trade flow, such that it was later reflected in the growth of the economy overtime. The subsequent effect shall be analysed in this thesis using the multiplier effect analysis of the ARDL model employed in chapter seven.

1.2 Statement of the Problem

Exchange rate policy is one of the major macroeconomic policies in Nigeria because the prevailing objective of monetary policy is price stability. This study believes that volatility in the exchange rate is counter-productive to the goals of price stability in Nigeria. Counter-productivity occurs when economic agents (external and internal) tend to reduce trading activities when exchange rate is not predictable. Such situation is examined in Nigeria from political sensitivity of exchange rate regimes as each political administration institute different exchange rate policies at inception of office (details in chapter two).

There is a widespread presumption that volatility of the exchange rates in developing countries is one of the main sources of economic instability around the world, (Adebusuyi, et al., 2015). To the authors, an unstable exchange rate makes a developing country internationally non-competitive because agents of trade in the developing countries are majorly risk-averse. Consequently, it is difficult to achieve stable economic growth. 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 and later generate major economic challenges as observed in Nigeria's situation.

In the recent years, there has been lingering economic depression (negative economic growth in agriculture and industry sectors) in Nigeria which is triggered by the unstable exchange rate and negative growth of external reserves. At the beginning of this study, Nigeria recorded a growth of 2.9% in 2013 against 6.7% recorded in 2012 in the agriculture sector. In the same vein, industry sector recorded 1.8% growth in 2013 from 2.2% in 2012. The aggregate GDP growth rate in 2013 is 5.3% against 7.9% recorded in 2010. Aggregate demand in the recent year declined and results in recession during the course of this research because there is a decline in aggregate demand from 15.6% in 2013 to 4.2% in 2014 CBN, (2014).

The above statistics are affected by both external and domestic sectors. The maximum lending rate increased in 2012 from 23.79 to 24.38 in 2013 while money stock growth rate reduced from 9.6% in 2012 to -5.2% in 2013. The external reserve reduced from $43,830.40 in 2012 to $34,241.5 in 2014. The overall external sector balance declined from 2.4% in 2012 to -1.7 in 2014. This results in massive depreciation of the exchange rate, which rose from 159.5 in 2012 to 191.5 in 2014 for the market/parallel rate[4] and 157.33 in 2012 to 169.68 in 2014 for the average official rate. The average premium between the official and market rate widened from 3.3% in 2013 to 8.1% in 2014. The premium exceeded the globally acceptable benchmark of 5.0% in 2014. Consequently, the net export declined from 26.2% in 2012 to -40.1% in 2013 while the current account balance reduced from 3.8% in 2012 to -0.3% in 2014.

Similar economic problems, both in external and domestic sectors, usually persist in Nigeria overtime mostly at the spike in world oil price. However, the recent problems listed above were observed to be activated by oil price changes coupled with the unending deteriorating exchange rate (ER) that is caused by political instability (see figure 1.3 for more details).

[4] It is the illegal currency exchange activities in foreign exchange market. The Nigerian black market is the aspect of the underground operation outside the legal Central Bank of Nigeria channels, called official rate. The Naira parallel market rate was established during the exchange rate deregulation policy of SAP.

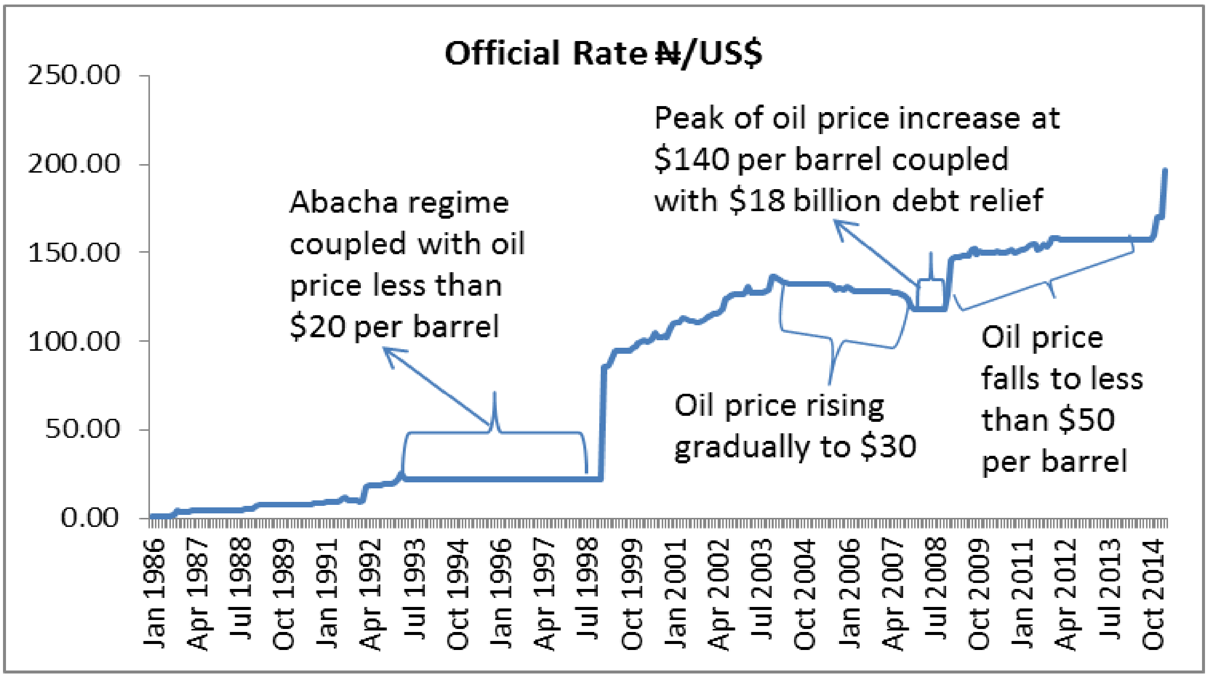

Figure 1. 3: Exchange Rate Series

From figure 1.3 above, this study noticed that:

- The global oil price was less than $20 per barrel up till 1998. This happened during the autocratic system of government headed by General Sani Abacha from 1991 to 1998.
- The second quarter of the year 1999 witnessed the birth of a democratic administration in Nigeria as headed by Olusegun Obasanjo which ended in 2007. At the time, oil price rose gradually to about $30
- Oil price rose and reached its peak of about $140 in 2009 during the Umar Yar'Adua's administration.
- Oil price later fell to about $50 per barrel between 2009 and 2013 during Goodluck Jonathan's administration.

The situation above was followed by exchange rate deterioration from ₦159.5/$1 in 2012 to ₦191.5/$1 in 2014 for the market/parallel rate and ₦157.33/$1 in 2012 to ₦169.68/$1 in 2014 for the average official rate. This means that each of the oil price fluctuations and political regime instability affects the pattern of Nigeria exchange rate overtime. This study opines that the unstable ER as determined by oil price fluctuations given several regime-shifts in Nigeria influences exports in both agriculture and oil sectors (Nigeria's primary external sectors). Thus, the study emphasized the fundamental factors that drive ERV and the extent to which ERV influences exports activities for the best trade, monetary, and exchange rate policies in Nigeria.

To find the best trade, monetary, and exchange rate policies in Nigeria, this study considers the effect of ERV (as influenced by the unstable regime shift and the incessant oil price changes) on exports activity. It is worth noting that interest rate (key monetary policy), trade and exchange rate policies have proved elusive in Nigeria. The policies seem not effective because inflation has been high and unstable (as explained in figure 1.1) and exchange rate has been highly unstable (the prevailing levels of exchange rate since 1991 have contributed to the weakening of the country's international competitiveness).

Moreover, 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. Market interest rates have remained very high in nominal terms while real interest rates have been volatile. The huge budget deficits had further brought about persistent pressures on the demand for foreign exchange at the foreign exchange market with its concomitant depreciation and variability of the naira exchange rate. Thus, the economy is characterized 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.

1.3 Research Questions and Objectives

The volatility of exchange rate in Nigeria suggests that its presence is counter-productive to the goal of price stability. Also, it is one of the main sources of economic instability as it is around the world, especially in developing countries because economic agents tend to reduce trading activities when the exchange rate is not predictable. Given that one of the dominant factors of economic stability is trade, this study investigates the impact of exchange rate volatility on Nigerian export demand and recommends ways to achieve economic stability in the country. Meanwhile, due to the failure of both the monetary and real economic policies put in place to stabilize prices in Nigeria, this study first determines the factors that drive exchange rate volatility (ERV) in Nigeria. Thus, this research work is set to answer two major questions that are important in the exchange rate and trade theories with a key reference to the Nigerian economy as;

1. What are the fundamental factors that drive exchange rate volatility in Nigeria considering the several political regime shift and oil price fluctuation?

This research question is answered by using the models of exchange rate volatility as proposed in this study and supported by the literature. This study proposes a model of ERV that incorporates oil price in Nigeria as inspired by the literature under different structural shifts as generated by the data generating process (details in chapter six). The study investigates the extent to which interest rate (IRD), productivity growth (PGD) and oil price (OIL) influence exchange rate volatility in Nigeria. This method of analysis for this research question is the Multivariate Generalized Autoregressive Conditional Heteroscedasticity (MGARCH) with volatility impulse response functions (VIRFs) methodology. The method helps to model the internally generated volatility of the series and provides shock effect analysis. Research question 1 is attached to hypothesis 1 of this thesis.

2. Is there any relationship between ERV and sectoral exports in Nigeria?

This study provides an answer to this research question by validating research hypothesis 2a and 2b. The aim of this research work is to improve on the previous related studies in Nigeria and seek answers to the above question using the Autoregressive Distributed Lag (ARDL) technique. This econometric tool will help to determine the multiplier effect of exchange rate volatility (as derived by interest rate, productivity growth and oil price) on trade in Nigeria between 1986 and 2013. Consequently, the study analyzes the policy implications of interest rate and exchange rate policies using the delayed and impact effect analysis.

The Broad Objective of the Study

The broad objective of this study is to investigate the relationship between exchange rate volatility (as derived from interest rate, productivity growth, and oil price considering the structural shift of the series) and oil as well as agriculture export demand in Nigeria between 1986 and 2013.

Deriving from the broad objective, the study has the under-listed specific objectives:

1. Since exchange rate works through the dynamics of its changes and volatility in the economy, the study focuses on the changes and volatility of exchange rate, interest rate, productivity growth and oil in the Nigerian economy. Thus, the study aims to determine the extent to which interest rate, productivity growth, and crude oil price influence ERV in Nigeria between 1986 and 2013.

2. The study investigates the relationship between exchange rate volatility and oil as well as agriculture export demand in Nigeria. The relationship directly establishes the contribution of exchange rate volatility in economic instability in Nigeria between 1986 and 2013 as well as the multiplier effects of the policies.

1.4 Research Hypotheses

The following are testable null hypotheses for the research:

Hypothesis 1: This study investigates whether volatilities in interest rate, productivity growth and crude oil price drive exchange rate volatility in Nigeria between 1986 and 2013. The study also examines to what extend do interest rate volatility, productivity growth volatility and oil price volatility influence ERV in Nigeria between 1986 and 2013 considering the various structural and historical shifts in the sample series.

Null Hypothesis 1: One-time shock and persistence in interest rate, productivity growth and crude oil price do not drive exchange rate volatility in Nigeria between 1986 and 2013.

Alternative Hypothesis 1: One-time shock and persistence in interest rate, productivity growth and crude oil price drive exchange rate volatility in Nigeria between 1986 and 2013.

This hypothesis is tested using multivariate GARCH methods of (Baba, et al., 1990)– BEKK MGARCH alongside the volatility impulse response (VIR) analysis. The method has been observed to permit examination of relationships of volatility in a model. The study employs the method because it generates a reliable model than separate univariate models; (Tanattrin, 2015). That is, it is effective in capturing the joint effect of shocks to interest rate volatility, productivity growth volatility and oil price volatility on exchange rate volatility. The model is also seen as the most natural way of dealing with multivariate matrix operations by estimating the relationships of all the variables in the system. In addition to establishing the key determinants of ERV in Nigeria, the analysis from the applied method allows this study to examine the spillover effects of the various level shocks and volatilities shocks.

Hypothesis 2: The study investigates whether export demand in Nigeria responds to changes in exchange rate volatility that is due to policy changes between 1986 and 2013. Two hypotheses are attached to the export demand (XD) model in this study as follows;[5]

[5] Details in chapter seven

Null Hypothesis 2a: Exchange rate volatility (ERV) changes, as derived by its fundamental factors[6], do not depress oil export demand (XDO) due to policy changes in Nigeria between 1986 and 2013.

Alternative Hypothesis 2a: Exchange rate volatility (ERV) changes, as derived from its fundamental factors (interest rate volatility, productivity growth volatility and oil price volatility), depress oil export demand (XDO) due to policy changes in Nigeria between 1986 and 2013.

Null Hypothesis 2b: Exchange rate volatility (ERV) changes, as derived from its fundamental factors (interest rate volatility, productivity growth volatility and oil price volatility), do not affect agriculture export demand (XDA) due to policy changes in Nigeria between 1986 and 2013.

Alternative Hypothesis 2b: Exchange rate volatility (ERV) changes, as derived by its fundamental factors, reduce agriculture export demand (XDA) due to policy changes in Nigeria between 1986 and 2013.

Hypotheses 2a and 2b above are tested using the Autoregressive Distributed Lag (ARDL) method of (Pesaran, et al., 2001) as employed by (Baum & Caglayan, 2010). The relationship between ERV and export in Nigeria requires the introduction of lags, so as to permit impact and delay multiplier effect in the relationship. This study considers this important because earlier researchers showed that a considerable lag may be related to the effects of ERV on trade flow (see Bahmani-Oskooee, Hegerty, & Xu, 2013; and Bahmani-Osloee, Hegerty, & Xi, 2015). Also, sufficient lags structure is essential to eliminate potential serial correlation in the model; Hill, Griffiths & Lim (2017). In addition to the multiplier applicability of this technique, it also permits delayed effect in each relationship considered, (see Bahmani-Oskooee *et al*, 2013). Two models (oil export demand and agriculture export demand) are

[6] Hypothesis 1 investigates whether the identified factors in the model drives exchange rate volatility in Nigeria. The exchange rate volatility changes derived from the model to investigate hypothesis 1 is used to investigate whether exchange rate changes depresses oil and agriculture sector in Nigeria in hypothesis 2.

employed for trade modeling for disaggregation benefits as discussed earlier. The sectors are the main productive sectors of the economy that deals with trade and exchange.

1.5 Contributions and Significance of the Study

The aim of this thesis is to empirically explore the role of interest rate, productivity growth and crude oil price in the determination of exchange rate volatility (ERV) in Nigeria and consequently establish ERV effect on the export demand, which is an important component of growth in the economy. This thesis is sub-divided into two different modeling structures featuring; the exchange rate volatility (ERV) model and export demand (XD) models.

The role of interest rate shock, productivity growth shock, and crude oil price shock in the determination of exchange rate volatility in Nigeria is first examined considering the various structural and historical shocks within the sample period. Given this objective, this research work focuses on the developments that have evolved in the ERV model overtime, which has all-encompassing monetary and real factors that influence ERV. Thus, the ERV model in this study predicts that interest rate, productivity growth, and oil price contribute to exchange rate fluctuation in Nigeria between 1986 and 2013. The internally generated ERV that is driven by the variances of interest rate, productivity growth and crude oil price is estimated for the general equilibrium analysis in the trade model.

Furthermore, this research work investigates the relationship between exchange rate volatility and export demand in Nigeria between 1986 and 2013 using the general equilibrium analysis. The export demand model followed the general equilibrium theory (GET) awareness from the Barkoulas, Baum, & Caglayan, (2002) as applied in Baum & Caglayan (2010). The model predicts that ERV (as derived from its fundamental factors in the ERV model), income from the trading partner and exchange rate changes influence exports in the agriculture and oil sectors in Nigeria between 1986 and 2013. The trade model suggests that when major policy indicators (such as exchange rate, interest rate, and trade) are linked, then a comprehensive picture of the relationship between ERV and trade is captured. Thus, the study ascertains the response of oil and agriculture export demand to variability in ER, income and exchange rate in Nigeria between 1986 and 2013.

To the knowledge of the author, this study is the first study on Nigeria to model ERV with the oil price changes and volatility. Secondly, it is the first study to employ a model that has the ability to capture the dynamic or joint effect of shocks to interest rate, productivity growth rate and oil price on exchange rate volatility by using the MGARCH and VIR analysis[7]. Thirdly, this study is the first on Nigeria to consider the effect of historical events on ERV determination. This study employs three different regime shifts to analysis the factors that drive exchange rate volatility in Nigeria. To this research work, regimes are applicable to the exchange rate structure of the economy and the shifts are likely to produce different results. Fourthly, this study is the first on Nigeria that employs a sectoral trade model to investigate the relationship between ERV and export demand using the general equilibrium approach. This study is pertinent to the Nigerian economy, which has a longstanding currency devaluation trend with policy changes that result in variability of the exchange rate.

The first notable significance of this study is the inclusion of oil price shock and volatility as ERV influencing factor, which most of the previous studies on Nigeria ignored. Al-Ezzee (2011) explained that the proposition that oil price might be adequate to explain all the long run movements in exchange rate appear to be new. This thesis supports the proposition and takes it further because the proposition is viewed relevant and important to the oil-dependent economies (oil exporting or heavy oil importing countries) such as Nigeria. This study held that oil price volatility is particularly important in determining exchange rate variability in Nigeria because the main component and fundamental drive of trade in Nigeria is the oil

[7] The dynamic or joint effect examines shocks in interest rate, productivity growth rate and oil price; and investigate the effect of the shocks on exchange rate volatility simultaneously.

contribution and it has stood, for over three decades, to be the major product of exchange for the economy (see figure 2.1 for example). Figure 2.1 shows that the percentage of crude oil exports as share of total export earnings is always above 90 percent since 1974 till 2013. Thus, this thesis for the first time unifies the theoretical and empirical literature on the determinants of ERV in Nigeria.

The second significance of this study is the development of a simple monetary and non-monetary exchange rate volatility model to analyze the role of interest rate shock, productivity growth shock, and crude oil price shock in determining ERV in Nigeria between 1986 and 2013. The model is applied to Nigeria through the GARCH-BEKK model (Baba, Engle, Kraft and Kroner, 1990) as discussed in chapter three and five. As explained by Peijie (2009), the BEKK is the most natural way of dealing with multivariate matrix operations. The method is employed in this study because its specification allows the conditional variance-covariance of the series to impact each other without estimating large number of parameters. In addition, its specification is fitted to the examination of volatility spillovers among two economic variables. Within this framework, it is possible to combine monetary and non-monetary factors (see chapters two, three and four for more details) in the explanation of ERV. Also, the GARCH-BEKK approach permits the study to examine relationships in the model in terms of volatility shock. In addition to time-varying variances and covariances estimated by BEKK, the BEKK model employed in this study allows the examination of the spillover effects of the various shocks as well as responses.

The third significance of this study is the investigation of the causes of exchange rate volatility in Nigeria under various historical events as generated by the data generated process. Three different regime shifts were employed because regimes are applicable to the exchange rate structure of the economy and the shifts are likely to produce different results. To the author’s knowledge, this is the first study on Nigeria that analyses ERV under different historical events, compares the results under different regime shifts and investigates volatility spillovers between exchange rate volatilities and monetary and non-monetary factors.

The fourth significance of this study is the examination of the relationship between exchange rate volatility and export demand in Nigeria using sectoral trade analysis. This study observes that there has not been any significant empirical study on oil export and agriculture export demand analysis in determining the relationship between exchange rate volatility and export demand in Nigeria. Generally, the study finds that most of the previous literature on the impact of ERV on trade employed aggregate trade data (see chapter four for details and examples). Meanwhile, using aggregate trade data is likely to ignore the effect of exchange rate volatility, which may vary across sectors because sectors differ in their degree of openness in international trade. Also, level of concentration of industries differs as well as the way industries use long term contracts. Furthermore, the study notices that aggregation constrains price, income, and elasticity of ER risk to be the same across sectors. With the differences in markets structure for trade in Nigeria, it is possible that ERV will affect each sector differently. However, aggregating across the sectors depicts loss of key information.

In addition, using aggregate data is likely to have contributed to the many inconsistent results derived in the previous studies. For instance, the use of national trade data assumed that the effect of ERV is identical among countries as well as commodities in terms of both magnitude and direction. If the assumption is right; then this research work believes that the true picture of the relationship might have been diluted when aggregate data is employed. Consequently, the probability of getting a significant result is lessened. Given this possibility, many studies have adopted the model of trade that focuses on disaggregated data using the bilateral trade flows (see chapter four for examples). However, this does not significantly improve the results relative to those that used aggregate trade flow. Tunç & Solakoğlu (2016) concluded that exchange rate volatility and trade relationship should be examined at the firm level. Thus, to overcome aggregating bias in the previous studies this thesis takes the disaggregating process a step further by examining sector-specific trade flow.

Lastly, this thesis employs a method that is capable of statistical adjustments and economic as well as policy analysis. The study examines the immediate and delayed effects of the exchange rate and interest rate policies on export demand in Nigeria between 1986 and 2013. The study follows the theoretical and empirical model of Barkoulas, *et al* (2002) and Baum & Caglayan (2010) respectively. The study investigates the effects of exchange rates volatility on export demand (XD) using the ARDL method of Pesaran, *et al* (2001) as employed by Baum & Caglayan (2010). The study employs this method because it effectively dealt with multiplier analysis and statistical adjustments, which are important for policy analysis and statistical inference.

1.6 Outline of Chapters

This research work is structured as follows:

1.6.1 Chapter Two: Macroeconomic Policy in Nigeria (1986 – 2013)

This chapter evaluates and analyzes the exchange rate policies, interest rate policies and trade policies between 1986 and 2013 indicating that much emphasis is on the SAP and Post SAP era of the economy. The main aim of the chapter is to evaluate exchange rate and interest rate policies and their effect on trade as reflected in the (overall) economy. Specifically, the chapter examines the different reforms put in place in Nigeria since 1960, although the interest of this study is on the SAP and post SAP reforms starting from 1986 till 2013. The chapter also provides extensive discussion of the relationship between exchange rate policy, interest rate policy and trade policy in Nigeria between 1986 and 2013.

1.6.2 Chapter Three: Literature Review of Factors that drive Exchange rate Volatility

The focus of this chapter is to review relevant theoretical and empirical literature on the determination of exchange rate volatility especially in the developing countries. Firstly, the chapter provides detailed theoretical foundations and the practical formulations of determination of ERV (second moment of exchange rate) with the conventional (monetary) ERV models – flexible price and sticky price models. The development in the application of these models suggests that non-monetary factors are indeed significant in the determination of ERV especially in the developing countries. Furthermore, recent development suggests that oil price is also significant in the determination of ERV, which is the major product of exchange in the Nigerian economy. Thus, this study held the proposition, thereby developed a simple ERV model in its empirical section (see chapter five and six) due to the effect of oil in the study.

Secondly, the chapter surveys the empirical literature on the role of macroeconomic shocks in ERV determination through which the earlier developments in the model were made possible. Thirdly, the chapter assesses the choice of ERV proxy detailing the different measures of ERV employed by various empirical studies. Lastly, it evaluates the different econometric methods employed for the exchange rate volatility model. The chapter discusses the different methods of modeling uncertainties, especially in multivariate time series and thereby reviews multivariate GARCH - BEKK, which is employed later in chapter five and six of this thesis.

1.6.3 Chapter Four: Trade Effect of Exchange rate Volatility: A Literature Survey

The chapter evaluates relevant theoretical and empirical literature on how exchange rate volatility affects trade flows. Firstly, the chapter reviews and evaluates the different theoretical models on the relationship between ERV and trade in the literature viz; the partial equilibrium model and the general equilibrium model. It specifically discusses theories relating to partial equilibrium models such as attitude to risk and uncertainty, the presence of hedging, flexible production and sales, the nature of the firm and its environment, adjustment costs and cost of entry and exit and hysteresis in trade. Secondly, the chapter surveys the empirical literature on the relationship between ERV and trade flow. Lastly, the chapter discusses the different methods of modeling trade, especially by using lag structure in the series and thereby reviews autoregressive distributed lag (ARDL) method, as employed later in chapter five and seven.

1.6.4 Chapter Five: Research Methodology using Multivariate GARCH (MGARCH) and Autoregressive Distributed Lag (ARDL) Techniques

The main aim of this chapter is to discuss the methods of analysis employed in this thesis. This study employs two methods overall; one for each model. Firstly, the chapter discusses the theoretical and empirical methods of modeling uncertainties in multivariate time series. The chapter discusses theoretical methods of estimating the multivariate GARCH – BEKK models, which is employed in chapter six. It specifically examines how to generate independent volatility shock through data generating process (DGP). Also, the theoretical framework and development of the simple ERV model, which incorporate oil price for Nigeria is discussed. In this chapter, I specify that exchange rate volatility in Nigeria is determined by the volatility of interest rate, volatility of productivity growth and volatility of oil price considering various historical events in the series. Thus, the study takes the variance of the theoretical models by the power of MGARCH-BEKK (see chapter three and six).

Secondly, the chapter considers modeling long run export demand using a single equation technique. It surveys the model associated with the ARDL estimation techniques with specific interest in multiplier analysis. The chapter provides a brief theoretical framework of the Barkoulas, *et al* (2002) model, which is employed in the study. The chapter further describes the models with specific attention to modeling the mean of oil and agriculture export demand in Nigeria.

1.6.5 Chapter Six: Factors that Drive Exchange Rate Volatility in Nigeria (1986 – 2013): A Multivariate Generalized Autoregressive Conditional Heteroscedasticity (MGARCH) Analysis

This chapter is the empirical chapter for the factors that drive exchange rate volatility in Nigeria between 1986 and 2013. The chapter presents, and analyses results from exchange rate volatility model. The full BEKK techniques with volatility impulse response analysis is employed to determine the key causes of exchange rate volatility (ERV) in Nigeria from 1986 to 2013 using quarterly data. The chapter specifies the empirical model to be estimated using a four-variable BEKK model. The model specification is immediately followed by the estimation procedures and presentation of result. As explained earlier, the exchange rate in a floating/managed float exchange rate system, interest rate, productivity growth and oil price between 1986 and 2013 were used. The diagnostic tests were carried out and reported in the chapter and the results were estimated and validated.

1.6.6 Chapter Seven: General Equilibrium Analysis of the Effect of Exchange Rate Volatility on Oil and Agriculture Export Demand in Nigeria (1986 – 2013)

The aim of this chapter is to model trade flow using export demand in the context of Nigeria. The chapter presents and analyses the results for the export demand model, which estimate the effect of exchange rate fluctuations as driven by its fundamental factors on sectoral export demand in Nigeria - US bilateral trade data for the period 1986 to 2013. The chapter specifies and describes the empirical model to be estimated using the GET awareness employed by Baum & Caglayan (2010). The diagnostic tests were carried out and reported in the chapter and the results were estimated and validated. Furthermore, the chapter analyses the multiplier effect as applied in the ARDL techniques.

1.6.7 Chapter Eight: Conclusion, Recommendations and Suggestions for Further Studies

The chapter first presents the conclusion of the thesis with specific attention to validating the two hypotheses of the study. Secondly, the chapter identifies the policy recommendations as requirement for a stable and sustainable economy. This helps to recommend viable and applicable policy to the Nigerian economy given the model and the analysis. Thirdly, the chapter details the limitations inherent in this research work even though it is an all-inclusive analysis. Lastly, the chapter presents suggestions for future studies on exchange rate and trade relationship. Suggestions for future research is necessary due to some limitations suffered by this study.

CHAPTER TWO: MACROECONOMIC POLICY IN NIGERIA (1986 – 2013)

2.1 Introduction

This chapter critically evaluates the exchange rate, trade and interest rate policies in Nigeria, especially between 1986 and 2013. The period covered by the study indicates that much emphasis will be on the Structural Adjustment Programme (SAP) and Post SAP era of the economy. In addition, the chapter examines the effect of these policies on the overall economy as reflected in various key macroeconomic indicators such as productivity growth, exchange rate, interest rate and trade flow. The examination is important because of the effect of the volatile Nigerian currency on trade and price stability goal of the economy after the structural Adjustment Programme in 1986. The chapter provides the background knowledge of the Nigerian situation over the period using the exchange rate policy, interest rate policy and trade policy since the deregulation reforms in 1986.

Following this introduction is section two, which examines general overview of the Nigerian economy with special interest in agriculture export and oil discovery as well as its consequences overtime. Section three focuses on the major reforms since independence in 1960 with specific attention to the pre-SAP, SAP and Post-SAP reforms. The section also considers the sectoral effect of SAP in the Nigeria economy. Section four centres on the macroeconomic policies in Nigeria over the period of the study with special attention to the exchange rate, interest rate and trade policies. Also, the section examines the relationships between the policies' performances and their effects on the economy within the specified period, especially the SAP. Section five concludes the chapter.

2.2 Overview of the Nigerian Economy

Nigeria has been classified by the World Bank as a mixed economy as well as an emerging market with middle income status (Onuah, 2006). The Nigerian economy, according to the IMF, has a per capita growth rate of 2.5 percent and GDP growth of 5.4 percent in 2013 against the 1.4 percent and 4.3 percent respectively in 2012. Nigeria is mostly known for its oil and gas wealth. However, it is rich in many other resources such as lead, zinc, kaolin, gold, topaz, sapphire, aquamarine, and rock salt.

At the beginning of the 1960s, Nigeria was the world's major producer of groundnut, the second biggest producer of cocoa and palm crop, and a key producer of rubber, cotton, and hides and skin. Over 90 percent of the Nigeria's overall export earnings were derived from the primary sector prior to the 1970s. At independence in 1960, the country's GDP, valued at 1977 constant prices, amounted to N11369.5 million, the equivalent of N220 (US$341.5) per head. Agriculture accounted for 56 percent of GDP while Transport and Communication, the second largest sector, contributed about 5 percent. Mining, including Petroleum, contributed 4 percent, construction accounted for 3 percent and manufacturing accounted for 2 percent.

The oil price revolution of 1973 suddenly changed the balance of political and economic power in the world and gave power to the relatively small number of countries that had reserves of oil – many of the Third World countries. Among the Organization of the Petroleum Exporting Countries (OPEC) that welcomed this sudden change in their fortune was Nigeria. For example, between 1958, which is the year that Nigeria first exported crude oil, and 1973, Nigeria earned over ₦5 bn from petroleum exports; but in the next ten years it earned over ₦70 bn. The most direct result of the impact of this has been its devastating effect on the traditional tradable sector, agriculture. Nigerian economy became deeply dependent on oil, especially for exports. Figure 2.1 shows that the non-oil sector has been declining relative to oil while the oil sub-sector has been growing.

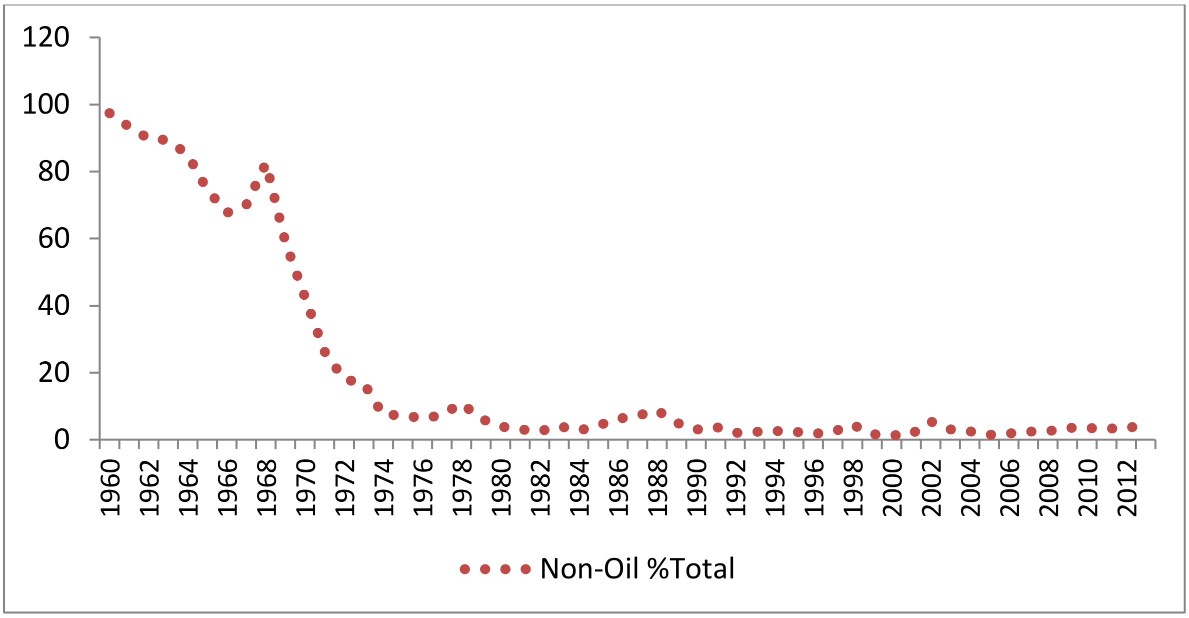

Figure 2. 1: Non-Oil Exports as Percentage of Total Export (1960 – 2013)

From figure 2.1 above, it is clear that;

- From 1974 up till 2013, the percentage of crude oil exports as share of total export earnings was never below 90 percent. The only year between 1992 and 2013 that it fell below 95 percent was in 2002, when it stood at 94.6 percent of total export earnings.
- The non-oil (mainly agricultural) sector was hard hit as its contribution to export earnings fell from about 99 percent in 1960 to less than 5 percent in 2013.
- In the early 1970s, oil started to play an ever more important role in exports.
- The volume of agricultural exports started to decline in absolute terms from 1973.
- By the mid-1970s most agricultural produce such as palm oil, cotton, groundnuts, etc. had virtually disappeared from the export scene.
- Agricultural exports had been completely displaced from the prominence they had occupied at the time of independence.

In the beginning of 1980s, the percentage of agriculture to the growth of the economy was 48.23 percent but by the middle of the decade it had fallen to about 21 percent. The percentage of agriculture to total exports was 20.7 percent in the beginning of the 1980s but declined to 5.71 percent in the middle of the decade. Farming products were the leading export component and the prime activity in the early years of independence but had declined dramatically within three decades. During the 1980s there was a world economic slow-down, which led to an oil glut and contributed to the steep decline in Nigeria's oil production for most of the 1980s. This subsequently led to a great domestic problem given the economy's dependence on oil revenues and the weakened agriculture sector (evidence from low investment and saving in figure 2.2).

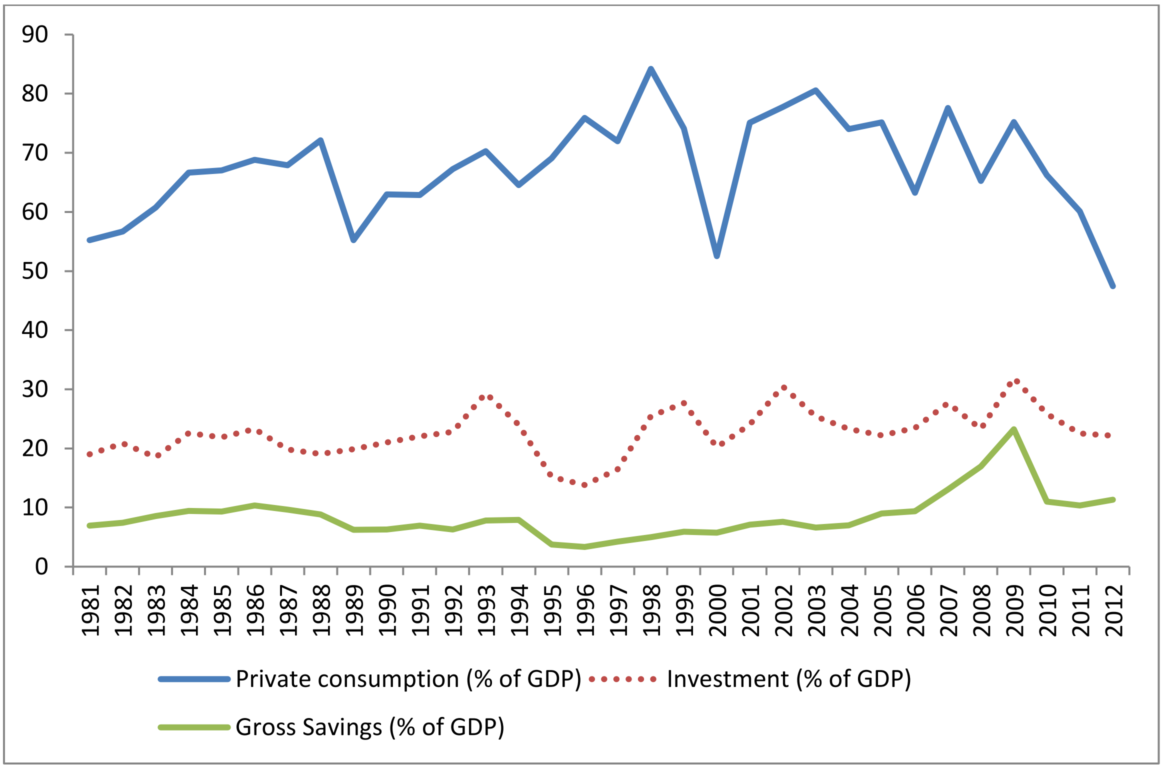

Figure 2. 2: Consumption, Saving and Investment as share of GDP (1981–2013)

From figure 2.2 above:

- In the presence of an abrupt decline in oil revenue in the 1980s, the propensity to consume remained high,
- Savings remained small whereas
- Investment remained slightly higher than 20 percent on average.
- Between 1988 and 1995, the average propensity to consume declined with no substantial changes in savings and investment share of GDP.

- The spikes in consumption between 1994 and 1996 may be attributed to high inflation experienced at that period. The overall change may be the positive effects of SAP.

Due to the high domestic demand and low savings in the above figure, figure 2.3 demonstrates what happened in the external sector by looking at the foreign reserves.

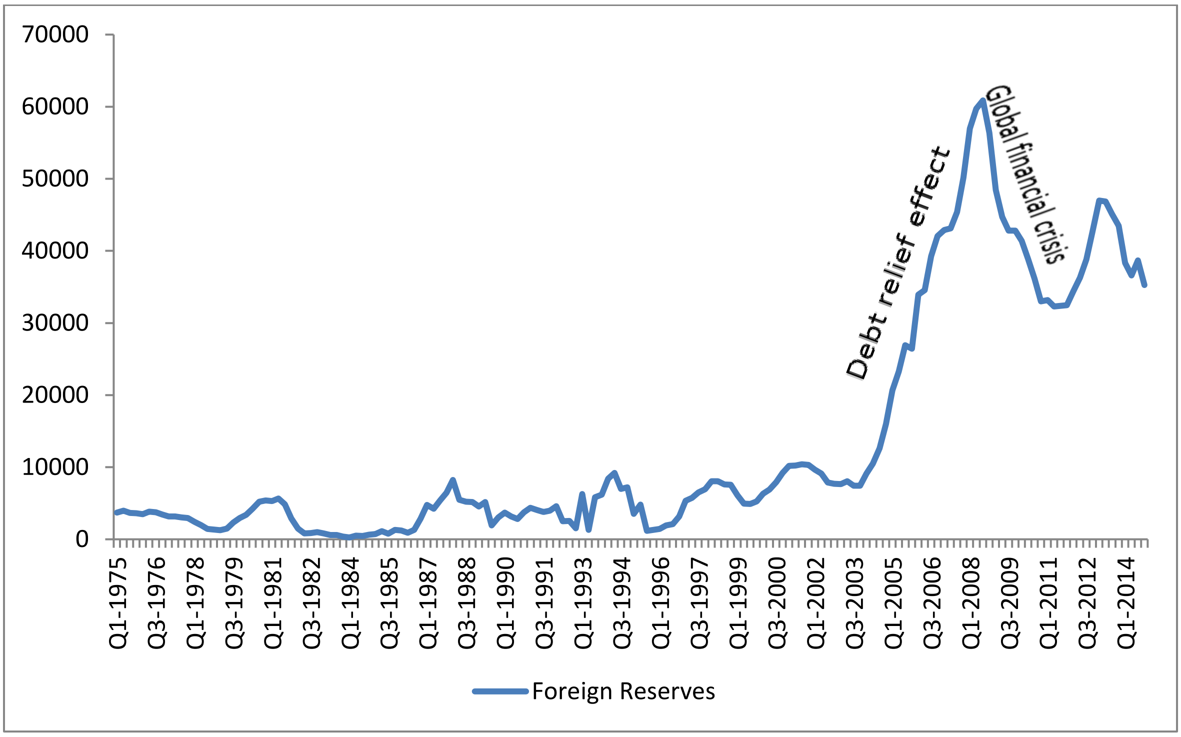

Figure 2. 3: Foreign reserves (in $) 1975Q1–2013Q4

Figure 2.3 demonstrates that:

- There was 'eating up' of foreign reserves between 1982 and 1986, which was before the introduction of the Structural Adjustment Programme (SAP) by the IMF in 1986 (to be discussed in the next section).
- A debt relief was granted to Nigeria in 2003. The impact of the huge debt relief realized from the international organization is found in the figure in 2003.
- This was short-lived as a result of the world economic recession of 2008 as described above. This is represented by the global crisis effect on the figure from 2008 to 2013.

During the oil boom era between 1971 and 1977, the exchange rate policy encouraged imports; the economy was heavily dependent on imports. There was no serious attempt to invest the windfall from oil in viable projects. The industrial sector also depended on imported inputs, machinery and raw materials. It became obvious that the economy was consuming what she was not producing and after fifty years of political independence, the productive base of the Nigerian economy remains weak, narrow and externally oriented.

2.3 Nigeria's major Reforms since Independence in 1960

Over the past couple of decades in the face of a lasting economic and financial crisis, Nigeria has introduced a wide range of developmental policies, plans, programmes and projects (including trade and exchange rate reforms) to address the above economic distortions as well as guarantee globally competitive and stable economy. It is very common to examine macroeconomic policies in the Nigerian economy under three sub-periods, Pre-SAP (before 1986), SAP Period (1986-1998) and Post-SAP; distinguished majorly by structural conditions.

2.3.1 Pre-SAP Reforms

The 1st National Development Plan (1962-1968) was the first post-independence plan, which aimed at putting the economy on the path of faster growth through the industrial and agricultural development prioritization as well as intermediate and high-level manpower training.[8] The basic object of the plan was to accelerate the rate of economic growth and the rate of the citizenry standard of living as well as increase its measure of control and with no external sources dependence for capital or manpower. The plan is under-fulfilled as there was absence of effective and acceptable leadership committed to internal reforms, which can ameliorate the foreign control.

[8] National Assembly Department of Information & Public Affairs Welcome to Nigeria: Inter-Parliamentary Union spring Meetings, April 12 – 17, 1982. Third Press International, Lagos 1982. P 11

The 2nd National Development Plan (1970-1974) was designed for making Nigeria a self-reliant economy. The key objectives of the plan were to establish Nigeria as; a united nation, a great dynamic economy and a free and democratic society. The plan recorded substantial overall growth. The fall of GDP of about 7 percent in 1972-73 was a result of the drastic fall in agricultural production due to drought. The impressive overall growth was attributed to the post-war reconstruction programmes of the Federal Government and the emergence of oil fortunes. The plan therefore witnessed a structural change in the economy with the emergence of crude oil as the major contributor to the GDP and the growing dominance of building and construction as an item of capital formation. Other sectors of the economy maintained their relative GDP positions while contributions of agriculture and manufacturing fell.

On the fiscal policy, price became stable during the period as inflation fell from 12.6 percent in 1971/72 to 9.0 percent in 1973/74 due to price control policy, import liberalization policy and wage freeze policy. While on the monetary policy, the Nigerian currency maintained its confidence. According to Usoro (1983), the second National Development Plan was both radical and revolutionary.

The 3rd National Development Plan (1975-1980) was devoted primarily to diversify the economy and indigenize the economic activities. The plan was a continuation of the preceding plan and it was more of implementation process than in objectives. However, due to the change of Government in July 1975, creation of new states in February 1976 and the decline in oil production and price in 1975/76 fiscal year, the plan was reviewed to policies that had direct bearing on the citizenry. The total export stood at N6,742.5 million while import was N5,125.5 million. The objectives of the plan were not fully realized as a result of unexpected fall in oil price, rapid increase in recurrent expenditure and increase in inflation rate.

The second and the third National Development Plans were to reconstruct and rehabilitate infrastructure that were destroyed during the civil, otherwise known as Biafra war years (1967 - 1970) which led to massive investment of resources into the rehabilitation and construction of new infrastructural facilities witnessed during the periods.[9] Despite the unrestrained political resurgence during the period (1962-1980), the plans recorded significant growth (average of 3.1 percent increase between the first and the second plan) except during the third plan where the average growth rate dropped (by average of 3.2 percent) due to the failure of the plan, which was occasioned by the unexpected fall in oil price, rapid increase in recurrent expenditure and sudden inflationary pressure. Meanwhile, the growth rate of capital formation (investment ratio) rose from an average of 14.1 percent in the first plan to 26.7 percent in the third plan. Thus, this period experienced a gradual shift in economic policy from solely being external to domestic management.

The 4th National Development Plan (1981 – 1985) is a deliberate instrument for harnessing the country's national resources for the benefit of her people aiming at increasing the real income of the average citizen, reducing the dependence of the economy on a narrow range of activities, achieving balance in the development of the different sectors of the economy, achieving greater self-reliance and broaden the economic base as well as develop the technological base. The extent of implementation of the plan was not clear as all the sectors of the economy except agriculture, government services, real estates and business, and housing sectors recorded negative growth rate including mining sector. The failure of the plan might be attributed to large scale corruption, high level of inflation, late feedback and progress report, lack of effective database and plan formulation, optimistic financial projections and over-valuation of the Naira exchange rate and indiscipline.

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[9] Sanusi Lamido Sanuso, CBN Governor Central Bank of Nigeria. Nigeria's Economic Development Aspirations and the Leadership Question: Is there a nexus? A Paper delivered at the 2nd General Dr. Yakubu Gowon Distinguished Annual Lecture October 19, 2012 at page 3

2.3.2 Structural Adjustment Program (SAP) and Macroeconomics Shocks

The economic downturn (structural inequalities, fiscal and debt burden as well as FX and balance of payment problems) of the early 1980's necessitated the implementation of the Structural Adjustment Programme (SAP) in 1986 by the Ibrahim Babangida's autocratic administration. In principle, the subsequent autocratic regime of Gen. Sani Abacha from 1991 to 1998 also operated on SAP. Although, there were other revolving policies adopted during the Abacha regime, but SAP was in operation. The main aim of SAP was to alter and realign production pattern and domestic expenditure to considerably reduce imports dependence, improve non-oil export contribution and achieve stable and well-adjusted growth. As emphasized in the original document and reported in World Bank, (1994), page 9, SAP's aims were to be achieved through:

"adoption of a market-determined exchange rate (supported by prudent fiscal and monetary policies); liberalization of trade policy and prices and markets; and liberalization of private investment regulations."

The sectoral focuses of SAP in Nigeria as reported by the World Bank are outlined below:

i. Agricultural Sector

The agricultural sector required immediate attention due to its total neglect and consequent poor performance in its contribution to the GDP, raw material for industrial production and exports. The reform intends to revamp the sector in order to:

a. increase domestic industrial raw materials and food supply;
b. increase cash crops production to intensify export base diversification;
c. raise opportunities for rural employment to generate income;
d. attain regional crop production mix.

To attain these goals, the policy steps below were taken:

a. suspension of agricultural commodity imports and scrapping of Commodity Boards (CBs),

b. creation of price incentives through floating exchange regime relying on introduction of Second Tier Foreign Exchange Market (SFEM).
c. re-examination of Land Use Decree to remove its impediments to agriculture production.

Despite the objectives, there was no explicit agricultural policy in the reform to achieve them. For instance, although the Second-Tier Foreign Exchange Market (SFEM) presented price inducements to farmers, it also generated increases in the input costs (such as fertilizers, tools, insecticides and equipment). So, to make SAP a valuable program for farmers, the incentives in prices must have produced a broad margin against the input costs. Also, scrapping the CBs encouraged exportation of poor-quality cash products like cocoa, palm and groundnuts products that were not long rejected abroad. However, the established and funded Directorate of Food, Roads and Rural Infrastructure (DFFRI) remains one of the reform's commendable policy thrusts regarding agricultural sector.

ii. The Industrial Sector

SAP identified the following problems in the industrial sector:

a. inadequate supply of imported raw materials, which resulted in capacity under-utilization of human capital and plants, unstable price and increased unemployment,
b. inadequate official import licenses together with its narrow allocation for industrial inputs' purchase,
c. poor and defective infrastructures and unsuitable tariff structure,
d. largely weakened industrial sector, and
e. unstable cost of Naira.

The above challenges in the sector were to be addressed through the SAP's policy instruments by aiming at:

a. accelerating development and utilizing domestic inputs in the sector,

b. promoting export-oriented industries within the sector,
c. generating employment by promoting small and medium scale businesses,
d. facilitating indigenous and foreign investment through liberalization controls, and
e. removing infrastructural, human capital and administrative blockages in structural reformation of the sector.

To attain the above objectives, the following policies and strategies were proposed in the SAP reform:

a. adopt floating exchange rate policy (ERP) to reflect the insufficient FX, and
b. introduce accelerated depreciation, duty drawbacks and FX earnings retention.

Supporting the rationale for the adoption of SAP, Anyanwu (1993) affirms that SAP was designed to effectively alter and restructure the consumption and productive patterns of the Nigerian economy, as well as to eliminate price distortions and heavy dependence on exports of crude oil and imports of consumer and producer goods. The persistence of BOP deficit (external imbalance) and huge fiscal deficits (internal imbalance) were also part of the factors that led to the adoption of SAP.

Meanwhile, the BOP problem was identified to be a consequence of the over-valuation and variability of the naira. The devaluation of the naira was proposed to enhance the level of non-oil exports, discourage import and as a result reduce the nominal value of imports while increasing the value of exports. Thus, SAP reform is a bulk reflection of the Nigerian exchange rate (a reflection of scarcity value of the national currency) and the non-oil export. Overall, SAP was adopted to modify the monetary policies, and the trade policies.

The economy performed slightly better in terms of overall GDP growth rates during SAP. The better performance is owing to positive developments in the agriculture, oil and financial sectors. Agriculture boosted the growth rate as a result of favourable climate, conscious adoption of a floating exchange rate which had a positive impact on agricultural prices, the early stage of scraping agricultural boards and implementation of key agricultural programmes' leading to agriculture contributing the largest share in GDP with an annual average of 40 percent while mining contributed 13.3 percent. The percentage share of both mining and manufacturing sectors to GDP fell under SAP while the contribution of both Services in general and Insurance and Finance to the GDP rose.

The real investment was negatively affected by the reform, which was due to the rapidly declining foreign investment, which had been projected to complement domestic savings. SAP is observed to give rise to a large measure of disinvestment and a high incidence of plant closures, especially in industries that had relied solely on imported raw materials. On the other hand, both the Gross National Saving (GNS) and the institutional savings increased at the earliest stage of the reform (see figure 2.2). The early increase is attributable to the interest rate deregulation and the liberalization of rules for establishing banks and financial houses which enhance financial intermediation. However, the growth in savings did not translate into an increase in investment.

The reform promotes the development of trade and services as merchandise exports increase at the earliest stage of the reform which was due to oil exports and the positive effect of the scraped CBs. Even though, the non-oil exports fell during the same period (see figure 1.2), the BOP position improved under SAP because of the manageable size of the growth in imports during the period. This means that, though imports increased under the reform as compared to the pre-SAP period, but the increase was manageable. According to Adeyemi (1996), this was due to the high proportion of foreign exchange earnings (even after exchange rate devaluation) used to service debts which considerably reduce importation of capital and consumer goods. The higher import is contrary to the fundamental objective of the SAP and apart from the agricultural sector, non-oil exports did not improve but rather suffered. Also, the expected reduction in importation, owing to devaluation of the naira, failed to materialize. This appears difficult in the face of a trade liberalization policy.

2.3.3 Post Structural Adjustment Program (SAP) Reforms

The year 1999 witnessed the birth of a democratic regime headed by Olusegun Obasanjo. The first reform of the regime was the National Economic Empowerment and Development Strategy (NEEDs) (1999-2007), which aimed at redressing the distortions in the economy and restoring economic growth. The major policy thrusts of NEEDs regarding trade are to; adopt a common trade as well as competition policy, remove non-tariff obstacles to trade, and introduce common external-tariff regime. The main objective of NEEDs was to develop the external trade regime for the Nigerian economy with exports as the key engine of growth. This was straightway stablished with;

- export promotion and exports diversification from oil,
- continuing imports liberalization by harmonizing tariffs with ECOWAS's common external tariff (CET),
- using import prohibition and special levies to safeguard the local industries,
- rationalizing and enforcing tariffs to attain policy targets,
- market-determined regime for nominal rate of exchange
- prevention of real exchange rate overvaluation, and
- active membership of the World Trade Organization (WTO) on relationships that are favorable to Africa and Nigeria especially.

Exchange rate and interest rate policies' strategies under NEEDs are;

- Low real-interest rate regime.
- Competitively established exchange rate regime.
- Restructured credits to private sector, which boost production. This means added credits to private sector – long term credits to develop the real sector,

- Active monitoring and regulatory apparatuses for financial system development,
- Dutch Auction System (DAS) to continue to determine the exchange rate regime, and
- Establish a wholesale Dutch Auction System (WDAS) in the medium/long term.

Policy reversal was introduced by the succeeding regime of Umar Musa Yar'Adua in 2007. Yar'Adua administration reform is tagged the 7-Point Agenda (2007-2011). The reform agenda was maintained up until May 2011 even after the demise of the late President Alhaji Umar Yar'Adua. The successive democratic regime of Goodluck Jonathan in 2011 designed a policy package tagged the Transformation Agenda. This is a 5-year development plan spanning between 2011 and 2015. The agenda focused on non-inflationary growth; employment generation and poverty alleviation and value re-orientation of the citizenry.

As expressed above, the NEEDs, the 7-Point Agenda and the Transformation Agenda were home-grown poverty reduction, value-reorientation and socio-economic development strategy for the country with very little impact on the external sector of the economy. Thus, the external sector in the Post SAP era mirrored the SAP reform.

2.4 Overview of Exchange Rate, Interest Rate and Trade Policies in Nigeria

Several macroeconomic polies are employed to restructure the imbalances in the economy as discussed earlier such as exchange rate, trade, interest rate and fiscal policies. However, this study is more interested in the exchange rate policy, interest rate policy and the trade policy for the period 1986 to 2013.

2.4.1 Exchange Rate Policies and the Structural Adjustment Program in Nigeria

Exchange rate (ER) implies a relative price, which measures the value of a local currency in relation to another country currency, Obaseki (2001). The relativity is due to the fact that it transmits the purchasing power of the local currency as regards what goods and services this can buy compared to the currency of trading partner, within a specified period of time. The

ER policy is an important tool of macroeconomic management because it reveals the performance of the local and foreign sectors of an economy. The strategy and application of ER policy goes to an extent of trailing developments of the economy, which is a key and fundamental policy issue. According to Obaseki (2001), exchange rate policy is consistently significant aide in policy adjustment framework.

On the other hand, exchange rate policy (ERP) means the totality of the institutional framework and measures put in place to move relative prices towards desired levels in order to stimulate the productive sectors, curtail inflation, ensure internal balance, improve the level of exports, and attract direct foreign investment 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 pursued. The key objective of ERP in Nigeria ranges from protecting the local currency value, sustain a favorable international reserves position and guarantee external balance with no compromise on the internal balance as well as the overall macroeconomics stability goal.

The Structural Adjustment Programme (SAP) was introduced in 1986 with a major plank of deregulating the foreign exchange market, which was a key policy measure enunciated principally to boost the international competitiveness of Nigeria's exports. There was massive local currency devaluation at the inception of SAP. Also, the naira free float was inaugurated. Foreign exchange market deregulation was instituted during SAP; the Central Bank of Nigeria (CBN) introduced three-tier markets into the foreign exchange.

The market for official rate is where the government purchases foreign exchange directly from the Central Bank; known as the First Tier Market (FTM). The market where private sectors and individuals sourced required foreign exchange; known as the Second Tier Market (STM) was also instituted. The Autonomous Foreign Exchange Market (AFEM) where export proceeds are sold at exporters' determined rate was also in operation. Also, market for unlicensed individuals who hawk foreign exchange on the streets and mosques existed and still in operation in Nigeria. This is known as the parallel market (PM) or the black market for exchange rate. Exchange rates in the different markets are not the same. Since SAP period and deregulation of exchange rate reform, there had not been a unified exchange rates in Nigeria.

As the Nigerian economy sought to eliminate the influence of parallel market for foreign exchange, Naira depreciated massively. This level of exchange rate instability and its pass-through effects to domestic inflation has led to the move towards the use of foreign currencies in the domestic economy for transactional, unit of account and store of value purposes thereby affecting the international transaction, CBN, (2014). Figure 2.4 depicts the movement of official exchange rate from 1960 to 2014 at different phases.

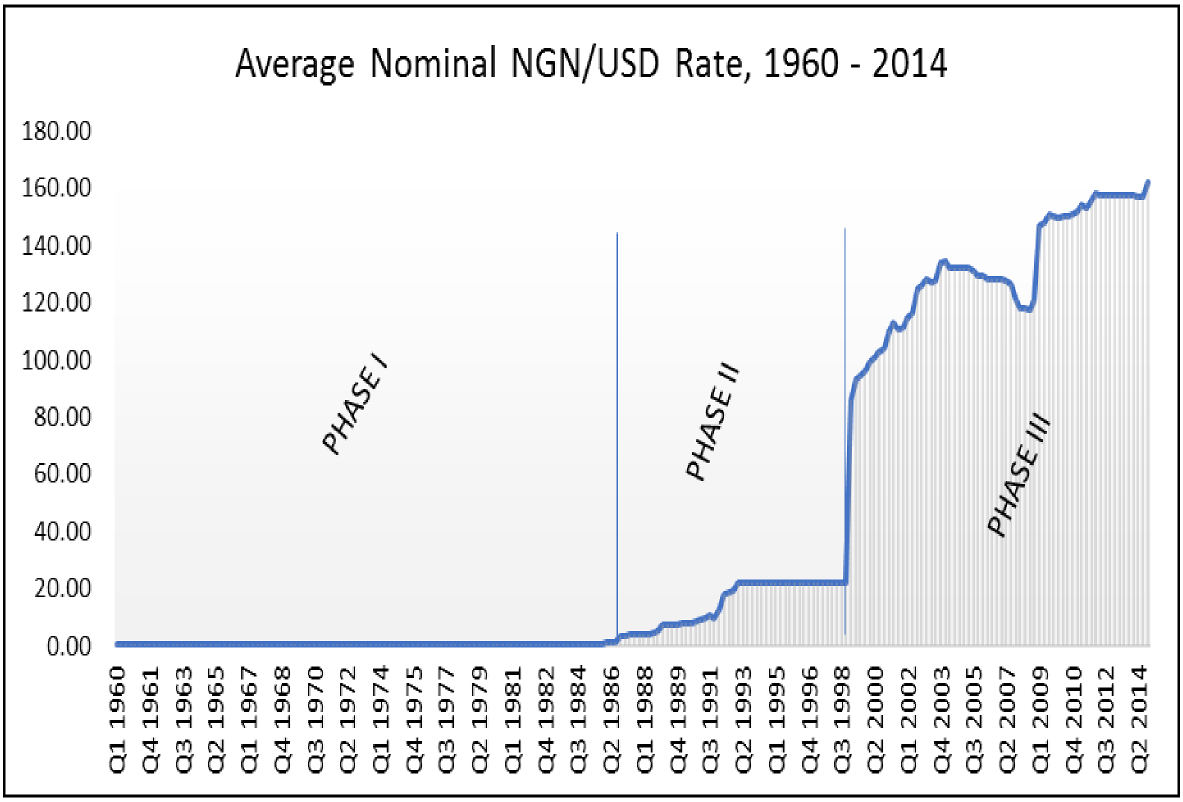

Figure 2. 4: Nominal Exchange Rate between 1960 and 2014

Figure 2.4 captures the three phases of exchange rate in Nigeria from 1960 through 2014. The figure shows the fixed exchange rate regime between 1960 and 1986; which is phase I. The managed/dual exchange rate regime and the start of exchange rate deregulation is the phase II, which begins in 1986 at the inception of SAP. Between 1994 and 1998, the government peg the official rate, although, parallel market remains flexible. Phase III is the flexible exchange rate period in Nigeria. Due to the flexibilities in other means of exchange rate, this study concludes that both phases II and III are managed-floating exchange rate regime periods in Nigeria.

The value for official exchange rate in Nigeria was 160 as of 2013. As the graph shows, over the past forty-one years official exchange rate reached a maximum value of 160 in 2013 and a minimum value of 0.55 in 1971. A closer examination of the three phases illustrated in Figure 2.4 indicates that, there are fluctuations in the last two decades in the nominal exchange rate in Nigeria since the introduction of SAP and its exchange rate deregulation policy.

Since the reform in 1986 till date, the ER has been moving from regulated to guided deregulation to deregulation. The exchange rate policy in Nigeria has moved in a circle, starting from fixed exchange rate system from 1960 – 1986 (Phase I in fig 2.4), a managed float exchange rate system from 1986 – 1993 (Phase II in fig 2.4), 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 liberalization and the institution of a dual exchange rate mechanism from 1998 till date (Phase III in fig 2.4).

The major exchange rate reforms in Nigeria since the adoption of SAP are orchestrated by the introduction of several policy institutions such as, Second-Tier Foreign Exchange Market

(SFEM) in September 1986, Inter-Bank Foreign Exchange Market (IFEM) in 1989, Autonomous Foreign Exchange Market (AFEM) in 1995, Inter-Bank Foreign Exchange Market (IFEM) in 1999, Dutch Auction System (DAS) in 2002 and the Wholesale Dutch Auction (WDA) in 2006. These policies are evaluated to contrive changes and variability of exchange rate in Nigeria.

For example, the cost of Nigerian currency increased to ₦30.50/$1.00 at the end of 1993 as against ₦0.94/$1.00 in the 1970s to the early 80s before the introduction of SFEM. Naira depreciated immediately at the SFEM auction in 1986 from N1.35/ US$1 to N3.61/US$1. In addition, the official rate was gradually adjusted, and the two rates merged in July 1987, reflecting a devalued rate of approximately 66 percent. During this time, the official and parallel market rates had 3.6 percent spread. However, the spread between the auctioned official rate and the parallel market as well as SFEM rates widened to about 60 percent in early 1988 owing to the 1988 expansionary fiscal policy. This was short-lived as fiscal balance was restored soon and the ER depreciated by the end of the year leading to a reduction in the spread between the rates to about 30 percent.

The Central Bank of Nigeria (CBN) introduced IFEM in early 1989, which was followed by a sharp depreciation in both official and parallel market rate. In addition, the government authorized Bureaux de Change (BDC) market to transact business legally in the last quarter of the year. The spread between the rates varied in 1989 and 90, averaging 20 to 30 percent. The IFEM does not mirror an exact market condition due to constraints in its structure. The authorities later reintroduced auction system in 1990, which failed to merge the market clearing rate, although the spread narrowed between parallel and official rates.

The authorities influenced the official rate until the end of 1992, which depreciated the parallel and BDC rates due to inflationary pressures. This resulted in wider spread between the rates to about 83 percent in early 1992 from about 16 percent spread in 1990. The auction system was replaced with a new IFEM system in the first quarter of 1992 and the spread then lessened to about 10 percent. However, by the end of 1992 the spread widened to about 20 percent while the FX reserves became impulsively low with continuous outstripping demand.

AFEM was introduced in 1995 and the policy thrust was retained in 1996 and the dual exchange rate system was retained in 1997 and 1998. The official exchange rate was pegged at ₦21.89/$1.00 from 1995 till 1998 while the market rate treaded above ₦30.00/$1.00 on the average.[10] All official transactions, except those approved by the government were undertaken in AFEM. Thus, transactions at the pegged official exchange rate were relatively slimmer.

The AFEM was replaced again with IFEM in 1999.[11] This reform was introduced owing to market imperfections, reduction in oil prices, depletable foreign reserves and sustained instability in the exchange rate of the naira. In the IFEM, a two-way quoting system is expected to prevail while the market was conducted daily in 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 CBN. The rate at which exchange rate fluctuates from 2000 became worrisome as presented in figure 2.5 below.

[10] AFEM is more of political intervention arising from low oil price.
[11] IFEM is another political era with a new exchange rate reform.

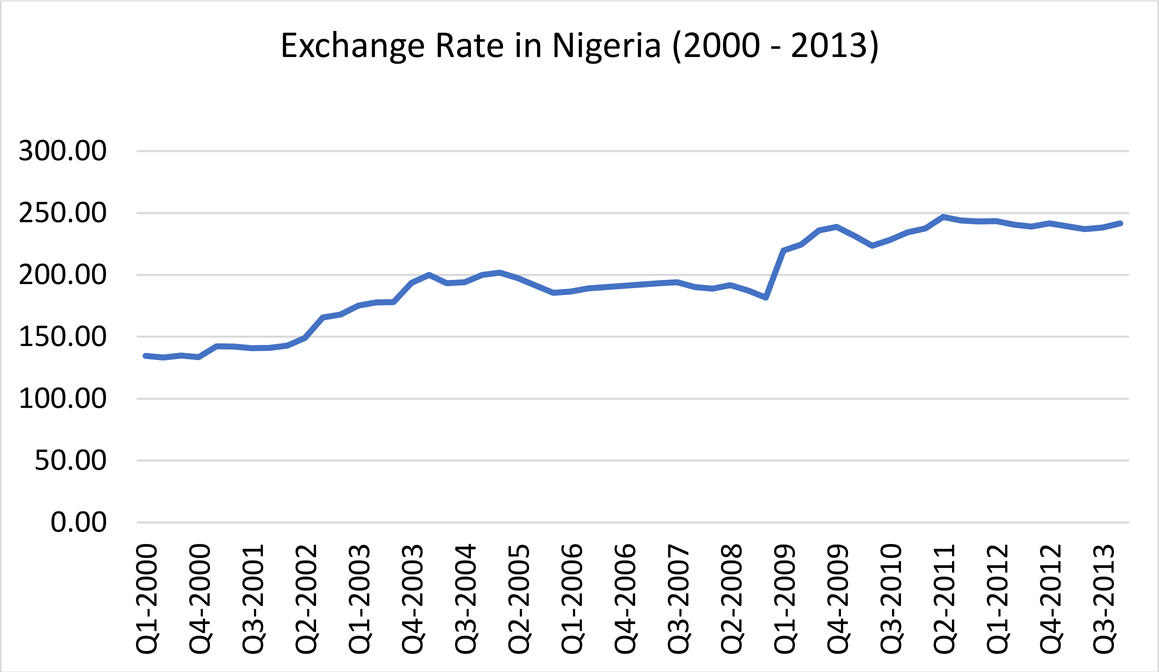

Figure 2. 5: Exchange Rate in Nigeria between 2000 and 2013

As demonstrated in the above figure, the rate stood at ₦118.80/$1.00 in 1999 and by the end of 2001 rate was trading at ₦141.18/$1.00. This shows a rapid depreciation of the Nigerian Naira after the introduction of IFEM.

In 2002, the Dutch Auction System (DAS) of foreign exchange management was introduced to replace the IFEM. The objectives of the DAS were to devalue the naira, moderate imports as well as preserve the international reserve position, and consequently strengthen the balance of payment while at the same time reduce the parallel market premium and also guarantee stability in the naira ER. However, an evaluation of the DAS performance between 2002 and 2006 shows that, the naira has lost value significantly, the parallel market premium narrowed, but it has not limited the appetite of Nigerian's for foreign goods and persistent demand for foreign exchange. The specific achievements of DAS regime in Nigeria are discussed below;

a. The premium among the Central bank (CBN) rate as well as the bureaux-de-change (BDCs-the Authorized dealer) and the parallel market rate improved.

b. The reserve position increased from eight billion US Dollar (USD) in 2002 to thirty billion US Dollar in 2006 reflecting over 300 percent rise and about 30-months of import level.
c. FX transaction professionalism and transparency were encouraged due to discipline introduced, where the end-users pay in line with their bids. This discouraged speculation in the market as the bidders become more realistic in biddings.

According to the CBN (2014), the achievements could be attributed to the CBN better autonomy as well as its improved discretion in monetary control instrument deployment to support the regime programme. The emergence of the inter-bank market for FX also stabilized the supply gaps among auctions. The inflationary pressures reduction and the disciplined fiscal action during the period of the regime contributed to the system's achievements. Coupled with the above is the steady increase in the oil price in 2003 till the peak in 2008 and the Paris Club's debt relief.

Further liberalization of the exchange rate market was achieved through the special auctions in 2005. This fast tracked the operation of the Wholesale Dutch Auction (WDA) where Authorized dealers bought the offers on their accounts. These special auctions succeeded in the revaluation of the Naira ER and WDA System (WDAS) was introduced in early 2006 to replace the retail DAS. The DAS is different from the WDAS in that end-users bid through their banks under the former while Authorized Dealer-banks bid through their accounts and sell to the end-user under the later system.

After the liberalization of the FX market, in 2006 the market witnessed exchange rate unification between the official rates, Interbank rates, wire rates and Bureau de Change (BDC), which also led to multiple currency problem resolution. The introduction of WDAS also facilitated higher market determined exchange rates of the Naira over the other currencies. The achievements of the regime according to the CBN (2014) include appreciated parallel market rate, unified official and inter-bank rates due to their convergence, revised Foreign Exchange Market and increased access of FX to the end users by selling FX to BDC operators thereby bridging the supply gap as well as developing the domestic BDCs.

The liberalized system opened the market for the Authorized Dealers BDC operations which is majorly cash operation with CBN window. However, the official rate traded at ₦120.65/$1.00 at the end of 2008 as against the ₦114.45/$1.00 in 2002 owing to the fall in oil price. Oil prices began to recover in 2009 with official rate trading at ₦157.32/$1.00 while the market rate traded at ₦241.64/$1.00 at the end of 2013.

The naira exchange rate at the time of this study is determined through the foreign exchange market on the basis of demand and supply and the dollar is the intervention currency while the exchange rates of other currencies are based on cross reference to the ₦/$ exchange rate.

Macroeconomic Impacts of Exchange Rate Policy in Nigeria

Several policy guides were introduced into the management of the country’s Foreign Exchange Market in order to accomplish optimum level of its efficiency. Nigeria changed to market oriented economy in 1986 with the aim to stimulate the productive sector and to improve the inflow of the Foreign Direct Investment. The fixed pattern of the Nigerian exchange rate is presented in figure 2.6 (similar to figure 2.4) as “Pegged/Fixed Exchange Rate Regime”.

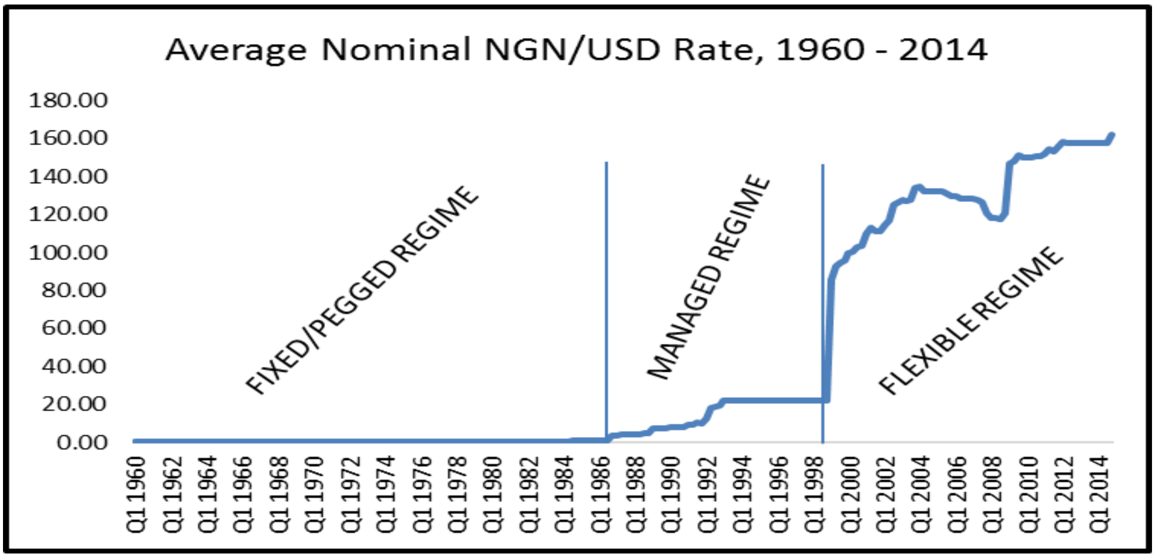

Figure 2. 6: Nigeria Nominal Exchange Rate depicting Regimes (1960-2014)

Before the reform, the ER was fixed while FX was allocated centrally using import licenses. Exchange rate was deregulated in 1986 on the account that the currency was overvalued during the fixed system period showing an impediment to exports. Also, the deregulation was to discourage capital flight and promote foreign investment thereby improve economic growth via a realistic exchange rate system. This led to the “Managed Exchange Rate System” presented in the figure above.

Thus, exchange rate stability has been an issue of concern especially since 1986 when the system of market-determined exchange rates through the Second Tier Foreign Exchange Market was introduced under the Structural Adjustment Programme (SAP). The instability and incessant depreciation of the foreign exchange value of the naira have several implications which have continued to cause great concern to the Nigerian economy. Among these are:

a. deterioration in people’s standard of living, real value of output and assets;
b. increased cost of imported inputs – machinery, spare parts, equipment and raw materials – and hence increased rate of inflation in the economy;
c. planning and projections have become impossible tasks at the micro levels while efficient industries find it difficult to price their products;

d. uncertainties for long-term macroeconomic planning and growth; and
e. 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 (Obadan, 2006).

As earlier discussed, there is virtually no exchange rate system that Nigeria has not tried in order to find the “realistic” exchange value for the Naira.[12] However, none of these exchange rate systems has proffered a practical solution to the problem on ground even as of now 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 towards fueling domestic inflation and contributing to poor macroeconomic policy outcomes, which is also evident through depressed export.

From table 2.1 below, merchandise imports and exports fell considerably between 1980 and 1985. This was the period of economic recession and chronic balance of payments problems actuated by the oil price crash. When the period prior to liberalization, 1980-1985, is compared to 1986-1996 in table 2.1, the indicators of exchange rates increased over the period considerably, indicating depreciation. In addition to that, the volumes of imports and exports have also increased. For example, data presented in table 2.1 shows that the nominal effective exchange rate depreciated by about 90 percent while the exports and imports have increased by 300 percent and 184 percent, respectively for the same set of periods.[13]

[12] Such as inter-bank foreign exchange market (IFEM) in 1989, market regulated exchange rate in 1994, autonomous foreign exchange market in 1995, re-introduction of inter-bank foreign exchange market in 1999, and the introduction of W-DAS in 2006 among others.

[13] Theoretically, exchange rate depreciation will lead to an increase in import prices, resulting into a fall in imports volume under the assumption that purchasing power parity holds. This is expected to correct the problems of balance of payments. However, the volume of trade flows has continued to increase in spite of the depreciation of exchange rate

Table 2. 1: Average Values and Change of some Selected Variables

Average Values of some Selected Variables					
PERIOD	REER (CPI Index)	NEER (Index)	ER (₦/$)	Imports ($)	Export ($)
1980-1985	464.6383333	108.2458333	1.52	9350.94	9508.2
1986-1996	110.7636364	10.33636364	28.37454545	181880.0909	295501.1364
1998-2012	107.14625	1.061753091	123.258125	3600229.735	6163374.924
Percentage change of selected variables (%)					
PERIOD	REER (CPI Index)	NEER (Index)	ER (₦/$)	Imports ($)	Export ($)
1980-1985	11.92670886	-1.064906158	27.93126886	-13.60944489	3.992880168
1986-1996	-5.483838778	-29.57424278	40.38462758	73.03763013	79.46065208
1998-2012	1.382935763	22.17400335	4.523122274	20.65228378	20.96798573

Data Source: CBN (2014), Author's computation

Exchange rate volatility has become too disturbing and challenging over the years, causing great concern for policy makers and analysts, domestic and foreign investors in Nigeria; Bakare & Olubokun, (2011). Exchange rate in Nigeria has been influenced by political regime shift over the period as would be validated in the empirical chapter. Below are the historical shocks and events that fall within the sample period of this thesis.

i. The Abacha Regime

The historical event associated with this period falls under the autocratic regime of government headed by General Sani Abacha from 1991 to 1998. As discussed earlier, the Abacha regime displaced the function of the exchange rate by fixing the official exchange rate throughout the administration. The exchange rate system under the Abacha regime is otherwise known as the regulatory exchange rate system. There is a general increase in the mean of the exchange rate data, which raise its volatility overtime. The exchange rate was particularly influenced by the general rise in the level of price at the time due to several policy reversals by the Abacha government. For example, the government suspended the Structural Adjustment (SAP) reform and the overall increase in foreign exchange demand due to higher importation cost. The higher import value is as a result of banned importation to which the economy could not adjust because Nigeria is an import dependent economy.

Secondly, Abacha government fixed the official exchange rate, although the market rate continued to fluctuate as dictated by the forces of demand and supply in the market. The market rate probably affects the exchange rate because demand increased more than supply because the Central Bank of Nigeria (CBN) could not meet demand at the official rate. Thus, exchange rate was escalated; and on the average, the Nigerian naira depreciated through time against the US dollar over the period.

ii. The Obasanjo Regime

The study considers 1999Q3 as the second historical event in the sample. The third quarter of the year 1999 witnessed the birth of a democratic regime headed by Olusegun Obasanjo with another policy reversal from what the economy has at the end of 1998. After the end of the Abacha regime, the official exchange rates were reverted in 1999Q3, which reveals the second shock in this study. This event is followed by a more depreciated and volatile exchange rates. The first term regime of the Obasanjo administration ended in 2003. The second term started in 2003 and ended in 2007 with no significant change in the economic policies during the second term.

iii. The Yar'Adua/Goodluck Regime

The study considers 2009Q1 as the third historical shock for the sample period. After the Obasanjo regime in 2007, Umar Musa Yar'Adua became the president with Goodluck Jonathan as the Vice-President. The Yar'Adua/Goodluck administration had no influence on the economy regarding policies in place before the demise of Yar'Adua in 2009. However, two major events occurred during the administration, which may be responsible for the structural event in 2009Q1. First is the effect of global financial crisis of 2008 which probably impacted the economy in the first quarter of 2009. Second is the sudden rise in the price of oil during the first quarter of the year to about $140 from $50 per barrel at the end of 2008. Oil price rose and reached its peak of about $140 in 2009 during the Yar'Adua/Goodluck administration. The higher oil price raised prices in the economy, which resulted into a volatile rate of exchange over the period.

2.4.2 Financial Reform and Interest Rate Policy in Nigeria

The financial sector in Nigeria is made up of a wide array of institutions and instruments. It consists of the CBN (that is, the apex financial institution), Commercial and Merchant Banks, Development Finance Institutions, Thrift and Insurance organizations, a Stock exchange and a Securities and Exchange Commission and a virile informal financial sector. The number of commercial and merchant banks increased from 12 in 1960 (at independence) to about 120 at the end of 1992 with a branch network of 2391 out of which commercial banks account for 2275 (with 774 in the rural areas). At the end of 1985, (prior to the commencement of the SAP), the ownership structure of the share capital in commercial banks indicated dominant ownership by government (Federal and State) accounting to 58.6 percent followed by private shareholders (22.5 percent) and foreign interests (18.9 percent). Thus, deregulation reforms of the financial sector in Nigeria started in the fourth quarter of 1986 with the setting up of a foreign exchange market in September 1986.

The first reform in the banking sector was the deregulation of the rate of interest both on loans and on deposits. In addition, there were reforms in the capital market which include the freeing of stock-prices from administrative determination by the Securities and Exchange Commission (SEC) to a market-determined system. However, this study is more interested in the interest rate policies as an instrument of monetary policy.

The main aim of the financial sector deregulation policy was to improve savings for investment thereby increases economic growth. The interest rates behaviour determines the level of investment activities in Nigeria to a large extent, hence, economic growth of the country. In other words, investment depends on the interest rate that is used in getting fund from the market; while the growth of the economy is consequently determined by the level of investment. High interest rate attracts low investment level while low interest rate attracts high level of investment. Thus, there is need to encourage an interest rate structure that will guarantee economical investment spending in Nigeria. Consequently, economic growth is enhanced at a reduced financial cost.

Interest rates policy in Nigeria is discussed along the dividing period of pre-reform (1970-1986) and post-reform (1987-2013) periods. The pre-reform period (1970-1986) is considered as a period of financial repression[14], and was characterized by a highly regulated monetary policy environment in which policies of directed credits, interest rate ceiling and restrictive monetary expansion were the rule. Generally, the behaviour of the interest rate structure is such that there is a widespread margin between deposit and lending rates which may encourage speculative financial transactions. The negative and sometimes very low real interest rates depressed savings in Nigeria. The low rate raises demand for loanable funds, and also leads to misdirection of credit. Subsequently, credit demand later exceeds the funds' supply while important sectors in the economy starve for funds. Thus, the financial system in Nigeria was deregulated at the introduction of SAP in 1986.

Interest Rate Reform since SAP (1986) and its Macroeconomic Impact

The interest rate policy was anchored by the central Bank of Nigeria (CBN). As the key monetary policy instrument, the CBN indirectly influences the direction of change as well as level of interest rate movement. Rates were invented on money market assets particularly on the Minimum Rediscount Rate (MRR). On the other hand, rates for weekly tender on treasury bills were stopped. The MRR is used proactively with the prevalent economic condition, being the nominal measure of interest rate policy as employed by the CBN. The treasury bills rate is made to be market related as well as competitive with similar money market instruments; CBN (2006).

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[14] According to Mckinnon (1973) and Shaw (1973), financial repression arises mostly where a country imposes ceiling on deposit and lending nominal interest rates at a low level relative to inflation. The resulting low or negative interest rates discourage savings mobilization and channeling of mobilized savings through the financial system. This has negative impact on the quantity and quality of investment and hence economic growth in view of the empirical link between savings, investment and economic growth.

After the introduction of SAP, the MRR has gone through several variations since 1987 due to CBN policy changes. This in turn has changed the general economic conditions. The rate was reduced from 15.0% to 12.75% between August and December 1987 with the aim to stimulate investment and consequently growth of the economy. This was raised in 1989 to 13.25% to hold inflation. Interest rate cap was lifted to further liberalize the interest rate management in 1992. In 1994 the government introduced some regulatory measure to interest rate supervision due to excessive variations and irrationally high rate created by the complete deregulation such as cap. Thus, deposit rates were reset again at 12.45% while lending rate was fixed at 21% per annum. Nigeria retained the interest rates cap adopted in 1994 in 1995 with little adjustment for flexibility. Interest rate reform remained flexible and also responsive to modifications in market conditions, which is in line with market-based technique from monetary management adopted.

Interest rates became fully deregulated since 1996. The banks are able to determine the interest rates structure in discussion with their clients. Nevertheless, the CBN reserved its discretionary power and ability to intervene in the money-market to ensure organized improvements in interest rates. In 1999, fully – foreign owned banks were given licenses to operate and by 2000 foreign currency deposits became institutionalized. Banks consolidation through mergers and acquisitions and the N25bn recapitalization exercise reform in the banking industry was instituted in 2004. In 2006 the Central Bank of Nigeria introduced a new monetary policy implementation framework (Monetary Policy Rate (MPR) to replace the Minimum Rediscounted Rate (MRR). The MPR was reduced to about 10% from above 13% MRR. The lending rate was 13% while the deposit rate was 7%. These rates were standing facility, which intend to curtail interest rate volatility especially the interbank rates. Before the deregulation policy, the deposit rate was fixed at 13.5% while the lending rate was fixed at 21%, with a 7.5% spread. With the deregulation policy, interest rates reduced to deposit rate of 2% and 16% lending rate. As at the time of this study, deposit rate ranges between 4 % and 12.5% while lending rate ranges between 18% and 20%. This gives a wider spread compared to the spread before the deregulation policy.

Before the interest rate deregulation policy, investment as share of GDP was 13.18%. The deregulation consequently resulted into improved investment as share of GDP in 1996 to about 16%. Since the deregulation policy, the investment share of GDP fluctuates around 20% and never returned to less than 16% as recorded before the deregulation policy. This implies that, there is an improvement in the growth base of the economy as orchestrated by the deregulated policy.

2.4.3 Trade Policy in Nigeria

Trade policies are essential for ensuring an optimal allocation of scarce resources. The main aim of trade policy in Nigeria is diversification of the export base as well as liberalization of the import trade. Diversification policy for Nigeria's export varies towards promotion of traditional non-oil exports (such as cocoa, palm produce and rubber) and non-traditional exports (such as manufacturing, which emphasizes value-added to export). Other aims of trade policy in Nigeria are to; encourage non-traditional (value-added) export, adapt the informal trading activity to the mainstream formal trade and achieve accelerated economic growth and development. Trade policy broad objectives include;

a. The promotion and development of domestic trade, including intra-trade trade and inter-trade commerce.
b. The development and promotion of oil and non-oil exports
c. Deregulation and liberalization of trade and
d. Promotion of Nigeria's bilateral and multilateral trade interests.

Nigeria's trade policies could be discussed under three broad phases, which is, the period before the introduction of the Structural Adjustment Programme (SAP), the SAP period and the period after SAP. Throughout these regimes, trade policies exhibited identical characteristics of being short-term in nature (operational within each fiscal year and reviewed thereafter), and directed at meeting specific objectives such as, ensuring balance of payments viability and export promotion. Trade policies were also meant to complement other policy initiatives, such as, industrialisation policy, exchange rate policy, employment creation and self-sufficiency policies. The earliest trade policies are not of much interest in this study, thus, this chapter is limited to the period covered by this study, which is the SAP and Post SAP policies.

Trade Policies during SAP and Post SAP Reforms

Several strategies were enunciated in 1986 in Nigeria to achieve the broad objectives of the SAP. Specific to international trade, the primary focus was on liberalization of trade and the pricing system, with emphasis on the use of appropriate price mechanism for the allocation of FX. The application of import and export licensing (Pre-SAP trade policy) became irrelevant in the new reform and were consequently abolished.

At the beginning of the reform, adjustments were made in customs and excise tariff to give advantage to locally assembled agricultural equipment while some items were placed under ban. In 1987, three import duty surcharges earlier abrogated in 1986 were re-introduced while a comprehensive customs excise tariff review was completed in 1987. Though a more liberalized trade regime came into force, some items were placed on import and export prohibition. In 1988, the comprehensive tariff structure was adopted to provide higher degree of protection to local industries and make for continuity. There was a reduction in the number of excisable products from 412 to 182. The harmonized commodity and coding system (H.S) were incorporated into the new tariff structure while anti-dumping tariff came into force.

Prior to the adoption of the SAP, import is only subject to assessable control, which was implemented by combining agriculture and manufacturing-goods outright bans as well as comprehensive licensing system. For instance, in early 1986, there was an imposition of 30% surcharge on all imports, however, by 1991 some of the items were removed from the list of import prohibition. The items were removed because prohibitions distort trade patterns, stimulate smuggling, more so deprived the government on revenue from tariff. The items removed include poultry products, clothing and textiles, furniture, motor vehicles and some kinds of beverages. The absolute prohibition list later covers obscene articles, weapons, second-hand clothing, all meat-kinds imports for wellbeing and certain spirits.

The list of excluded items from imports prohibition list lengthen continuously. In 1995, rice was excluded from the list as it became a staple food in the country. Vegetable, meat, fruits, fish, and fruit juice were freely imported into Nigeria. Moreover, from 1998 frozen poultry as well as live, stout and beer, malt and barley and mineral were also removed from the list. Between 1990 and 1998, import structure in Nigeria changed significantly with no major changes for the rest of the period covered by this study. Notably, the greatest fall in imports was recorded in machinery, clothing, and transport equipment. Fertilizer trades were also liberalized since 1997. Hence, private importers are permitted to import and sell fertilizer in an open market, competitively with the local traders. Moreso, import duty on fertilizers reduced from 10% to 5% since 1998.

On tariffs, import liberalization adopted in 1995 reduced import rates significantly as well as dependence on quantitative limitations. Only ad-valorem tariffs were used. A 7-year tariff policy programme (Customs and Tariff rates) was established in 1995. However, tariff stability was reduced through the yearly tariff changes since then. The tariff review in 1995 led to its reduction by 50%, that is, from 0 - 300% to 0 - 150%. Import duty consists of a simple custom duty rate, which is modified by set rebate annually and adding a 7% surcharge. In 1998, there was an average applied-duty of 23.5% on unweighted basis, while some exceed 100%. The highest level of duty is imposed on consumer products, with lesser rates on capital and intermediate goods.

All the excise duties that are levied on domestically manufactured products were abolished in 1998. This led to substantial increase in the effective protections on the products due to lack of parallel adjustment to tariffs on competing imports. The value added tax (VAT) on most of the domestically produced as well as imported products and services has remained 5% since 1994. The tariff reform program was structured such that competition and productivity is stimulated through tariffs reduction on consumer goods relative to tariff on raw material and capital and intermediate products. The decline in final consumer products' tariff was to expose domestic producers to import competition. Meanwhile, the relatively higher tariff on raw material was to attract investment to raw material as well as intermediate goods production.

On the other hand, export Incentive and Miscellaneous Provisions Decree of 1986 were promulgated to encourage exports. The CBN could then provide refinancing and rediscounting facilities to banks to encourage them to provide export financing to their customers. The Nigerian Export Credit Guarantee and Insurance Corporation were instituted in 1988 and was subsequently renamed Nigerian Export-Import Bank (NEXIM), to provide credit and risk bearing facilities to banks, so as to encourage them to support exports.

Nigeria is a substantial exporter of refined-oil products according to import data from the partners. It was recorded that cocoa beans, cotton and rubber exports alone exceeded US$10 million among other exports in 1996. Many agricultural exports, through which Nigeria would have become a substantial exporter, were prohibited or remained prohibited to boost local processing and satisfy local demand. In 1996, exports ban on cassava products were lifted. A substantial improvement in production followed the action, which implies that some of the other items on the prohibition list could also be advantageously eliminated. Prevailing export incentive arrangements contain the duty draw-back structure, manufacture in-bond systems and export expansion grant.

In addition, the government established the export pre-shipment assessment by private enterprises in 1996. The export pre-shipment assessment is to supplement the roles of Federal Produce Inspection Service (FPIS). The aims are to guarantee a better and improved quality of traditional exports in Nigeria. Also, it aimed at enhancing proper accountability of the value of exports to certify correct repatriation of export incomes. As earlier explained, the post SAP reforms regarding trade have not been different from the SAP agenda. However, the ECOWAS Common External Tariff (CET) regime started to govern Nigeria's tariff policy with the introduction of NEEDs in 1999. Beside tariff barriers, there still exist prohibited imports and exports. In 2008, the trade regime was amended to lower tariffs for a wide range of goods and replaces a number of import bans by tariffs.

As part of moving with the trend of globalization and trade liberalization in the global economic system, Nigeria is a member of, and signatory to, many international and regional trade agreements such as International Monetary Fund (IMF), World Trade Organization (WTO), World Bank, Economic Community of West African States (ECOWAS), among others. The overriding objective of this economic partnership on international trade has been to create a free trade zones by removing the barriers on trade, lessen tariffs, and embark on outward-oriented trade policies. In 2007, Nigeria's trade freedom[15] was rated 56 percent making her the world's 131st freest economy while in 2013, it was ranked 120th freest economy with trade freedom ranking more than 60 percent. This shows that the economy has thrived to arouse growth through world economy openness yet realizing depressing trade freedom.

[15] Freedom from tariffs and non-tariff burdens, which impose barriers to either imports or exports in a country.

The major challenge faced by trade expansion in Nigeria is poorly designed liberal trade policies. Generally, the process of trade liberalization involves the reduction of tariff or trade barriers. This identifies trade liberalization to be a common policy remedy for trade flows increase. However, this has not always worked out since the factors determining imports may differ from those that determine exports. Consequently, agricultural and industrial output could not grow due to factors attributable to the indifferent standard of policy implementation by the various governments as well as absence of executive capacity at the national level. All these grew into a culture robbing the country on development of a self-reliant economy.

Agricultural and industrial expansion for export in Nigeria continued to be generally impaired by low effective demand for locally made goods, occasioned by the continued influx of cheaper and better-quality imported products, lack of institutional framework to grow and develop these sectors and the poor state of infrastructure (such as power and water supply).

2.4.4 Relationship between Interest Rate, Exchange Rate and Trade Policies in Nigeria

During the 1970s and early 1980s a combination of fixed nominal exchange rates and rapidly expanding aggregate demand led to severely overvalued currencies in almost all African economies including Nigeria. This overvaluation resulted in an excess demand for foreign exchange which most countries resolved by imposing a scheme to ration foreign exchange rather than devaluing. Exports declined as the return to export activities fell, and imports became increasingly scarce to the point where macroeconomic performance obviously suffered.

There was rigid exchange rate, non-flexible interest rate control and fixed sectoral allocation of credit to private sector in Nigeria before the inception of SAP in 1986. All these prompted distortion and inadequacies that led to low level of investment. Consequently, funds became inadequate; the Nigerian currency became overvalued while monetary aggregate moved sluggishly. The adoption of SAP results in interest rate deregulation, exchange rate deregulation as well as trade regulation policies, Ogwuma (1993) and Ojo (1993).

The IMF and World Bank have argued strongly against policies that overvalue the exchange rate and ration foreign exchange. Therefore, both institutions generally conditioned their assistance on the reduction or elimination of these distortions. The aim of these reforms is to promote exports (and efficient import substitutes) and, more generally, to open the economy to the benefits of international competition. The presumption is that such policies will promote more rapid growth. The major goals of trade and exchange rate policy reforms, therefore, are macroeconomic in nature: to increase economic openness and in so doing promote export-led economic growth.

As discussed earlier, there are three important changes that took place within the period, which includes the institutions of a flexible exchange rate mechanism, deregulation of financial system and the implementation of a broad based and a comprehensive tariff system. The reform of the foreign exchange sought to improve both pricing and allocation while interest rate reform sought to raise savings for investment, hence economic growth. The trade reform sought to promote export (particularly non−oil) production, reduce import dependence, and strengthen foreign exchange reserve levels in Nigeria.

The devalued exchange rate of the naira in 1986 and at the different shades of the Foreign Exchange Market (SFEM, AFEM or IFEM), was meant to make imports dearer and thus discourage excessive importation and thereby reduce the pressure on the balance of payments while the deregulated interest rate was to accelerate investment and strengthen the production base of the economy, thus encourage excessive exportation and thereby reduce the pressure on the balance of payments. With SAP, import licensing was abolished and reliance was placed on the use of customs tariff for the control of imports. The list of items on the import's prohibition list was also reduced considerably. The productive sectors initially responded positively to the policies, but as the years progressed, the policies could not thrive. The effect of customs and excise duty played a fairly small role in affecting the incentive location. The net effect is to terminate foreign exchange market's pressure and provide a revenue-stream to the government.

The overview of the Nigerian exchange rate, interest rate growth, oil price changes and gross domestic product (which is reflective of the export demand) overtime present a co-movement pattern as presented in figure 2.7 below.

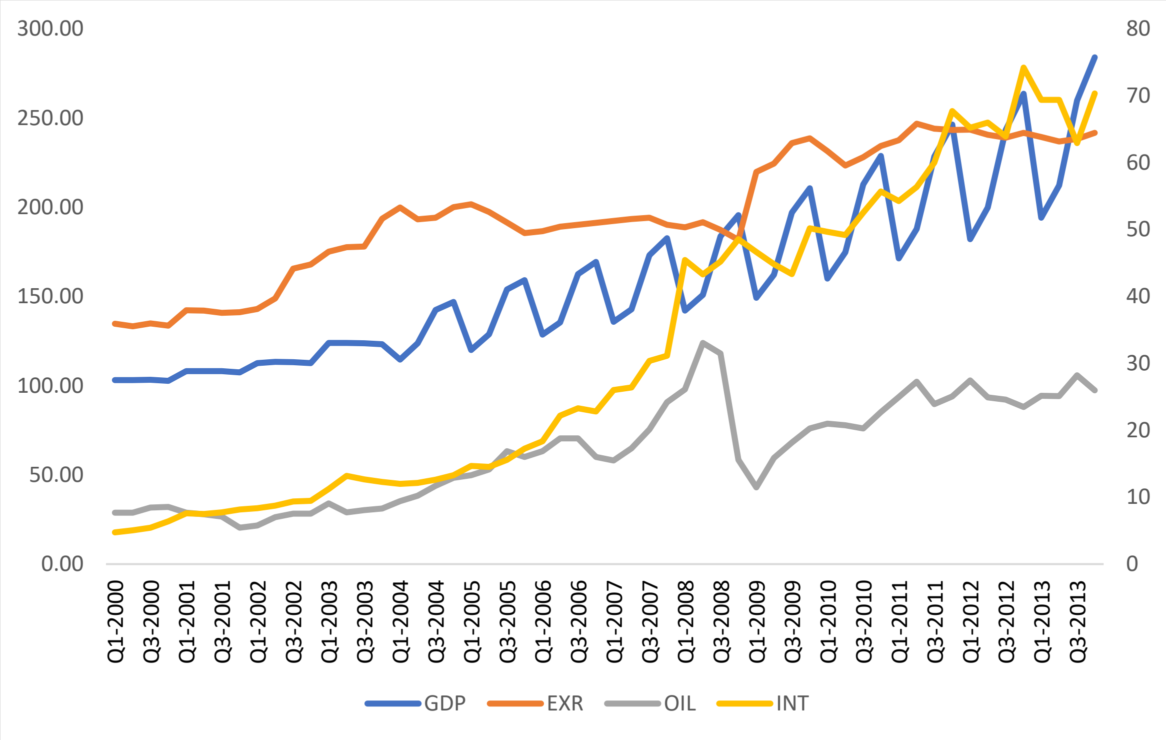

Figure 2.7: GDP, Interest Rate, oil Price and Exchange Rate Relationship (2000-2013)

Given the diagram above, it is imperative for this study to investigate the relationship between exchange rate, oil price changes, interest rate and domestic growth potential of the Nigerian economy. The analysis is important to the development of factors that influence exchange rate volatility in order to investigate the effect of exchange rate volatility on export demand in Nigeria overtime.

2.5 Conclusion

This chapter analysed the macroeconomic policies' performances in Nigeria between 1986 and 2013. The analysis helps to evaluate the different relevant macroeconomic indicators overtime and their relationship in the economy. The focus of the research in investigating the impacts of exchange rate fluctuations as driven by its fundamental factors on trade flows of the economy has been discussed. The analysis of this chapter has also included the Nigerian major economic reform, SAP, which is the anchor of regime shift for the macroeconomic policies in the economy.

The chapter further examined the main macroeconomic indicators as well as policies in Nigeria from 1986 – 2013. The devaluation of Naira is observed to have led to the continuous exchange rate variation and volatility in the economy. Since then the foreign exchange market became unpredictable with the risk of the variation which account for fluctuations in import bills. The foreign exchange and exchange rate management moved from officially pegged exchange rate system between 1970 and 1985 to a market-determined system since 1986 and today still determined through the foreign exchange market on the basis of demand and supply.

Notably, this chapter annexed the relationship that exists between exchange rate policies, interest rate deregulation and trade policies in Nigeria between 1986 and 2013 with special attention to the effect of SAP reform. The study gathers that the major focus of the interest rate and exchange rate policies in Nigeria is to stimulate the non-oil sectoral exports. Stimulating the non-oil sectoral exports is possible through competitiveness in the relative price of the exports, which is caused by the depreciation of the naira. Also, the sector is possibly stimulated through other incentives such as the abolition of export licenses, retention of 25 percent of foreign currency proceeds (later increased to 100 percent) for the exporter’s use. More importantly, the abolition of agricultural commodity marketing boards and the interest rate deregulation which is to enhance stable exchange rate played important role in non-oil sectoral export stimulus.

In conclusion, this study finds that exports demand in Nigeria productive sectors are yet to improve and that raised two important questions which this study seeks to answer. Firstly, it becomes imperative to identify the place of monetary liberalization in ensuring a stable exchange rate system in Nigeria. The need to identify the place of monetary liberalization gives rise to the first research question and hypothesis of this study that persistent shocks in interest rate, productivity growth, and oil price drive exchange rate variability in Nigeria between 1986 and 2013.

Secondly, this study finds that the devalued exchange rate of the naira in 1986 was to make imports dearer and improve production capacity thereby increase exportation. However, from the policy review in this chapter, this study gathers that the response of the economy to the reforms has not been too impressive. As a result, there is need to investigate the direction and effect of unstable exchange rate policy on the export capacity of the various sectors in Nigeria. Thus, it becomes important to investigate the impact of the exchange rate volatility on the Nigeria economy between 1986 and 2013, which is reflected in the second hypothesis of this research work. This study investigates the relationship because the theoretical literature held that exchange rate volatility depresses trade flow. Thus, the study needs to investigate the assertion in the Nigerian context. Also, the study needs to validate the timing and consequences of the policy changes on export over the period. This is where the ARDL technique becomes imperative.

Having examined the macroeconomic policies' failure in ensuring enviable exports in Nigeria, this study reviews and evaluates the literature on the real causes of exchange rate volatility as well the effect of such instability on trade flow in chapters three and four.

CHAPTER THREE: CAUSES OF EXCHANGE RATE VOLATILITY: A LITERATURE SURVEY

3.1 Introduction

The key objective of this chapter is to review and evaluate the theoretical and empirical literatures on the causes of exchange rate volatility (ERV). The focus of the chapter is to review relevant literatures on the exchange rate volatility, especially in the developing countries such as Nigeria. This study gathers from the chapter two that the several reforms and policies on exchange rate in Nigeria led to unstable Naira exchange rate, which deteriorates export as against the objectives of the policies. Given the Nigerian economic situation regarding the impacts of the exchange rate and interest rate policies, this chapter surveys both theoretical and empirical causes of ERV especially in developing countries like Nigeria.

To this end, this chapter first surveys the theoretical determination of exchange rate volatility using both the monetary and non-monetary method of exchange rate determinations in modeling exchange rate. The second aim of this chapter is to examine the empirical contribution of the interest rate, productivity growth and oil price volatility to ERV as discussed in the past studies. This study later provides empirical analysis of the contribution of interest rate, productivity growth and oil price volatility to ERV in the context of Nigerian economy in chapter six.

The third aim of this chapter is to evaluate the methodological issues associated with past empirical studies on determination of exchange rate volatility overtime. To overcome the methodological issues, this study therefore suggests a dynamic model in this chapter, which is multivariate analysis. The theoretical background literature of the model is surveyed in this chapter to declare its suitability over the past methods of determining exchange rate volatility considered in this chapter.

The rest of this chapter is structured as follows; section two reviews the theoretical framework of the factors responsible for ERV. This specifically features the monetary models of ER determination with specific interest in both the flexible-price and sticky-price monetary models. However, since the interest of this study is on the determinants of the second moment of exchange rates (that is exchange rate volatility) and not its first moment (which is exchange rate movement), the section extends to the monetary models of ERV determination. This mirrors the ER models in their second moments or variances. Section three surveys the empirical findings to the contributing factor through which the importance of non-monetary factors (such as Productivity growth, government spending, degree of openness among others) becomes revealing. Notably among the non-monetary shocks is the oil price proposition as it is a relevant factor in this study.

Section four assesses the choice of ERV proxy detailing the different measures of ERV employed by various empirical studies. Section five surveys the multivariate time series (dynamic) analysis with special attention to the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model due to its significance in the study. This section is important because it reveals how this dynamic method of analysis is used to overcome the methodological issues inherent in the previous studies as earlier considered in this chapter. Section six concludes the chapter with special attention to the important methodological issues that can augment the validity of this study.

3.2 Theoretical Models of the Causes of Exchange Rate Volatility

The literature seems to have no consensus on the factors that drive exchange rate volatility probably because they are numerous and dependent on the structure of the economy considered. The lack of uniformity therefore suggests that there is not only one direction for this relationship, perhaps because of different theoretical approaches when determining exchange rate model. According to Balg (2006), several studies proposed many structural models of exchange rate to explain its movements, but none of the models has produced a complete satisfactory result. Past studies also revealed that exchange rate determination is modelled in the developing countries with monetary and non-monetary factors.[16] Thus, both real and monetary shocks serve to press upon the behaviour of exchange rate over the time causing its fluctuations, especially in the developing countries.

Exchange rate volatility in Nigeria has been observed to be accompanied by unstable price and many other macroeconomic issues. The changes in exchange rate behaviour due to policy change and oil boom effect might have been enormous with subsequent negative impact on the Nigerian economic growth.[17] Therefore, it is imperative for this study to first survey the potential factors that drive ERV in the literature. Consequently, the study empirically examines the factors and their relationship with ERV in Nigeria between 1986 and 2013. This forms the basis of the first objective of this research work, which is empirically examined in chapter six.

3.2.1 Monetary Exchange Rate Model

This is one of the oldest approaches to ER determination. The monetary exchange rate model determination advocates a strong association between monetary fundamentals and exchange rate. The model shows that the demand and supply of money in a country determine the price level. When expressed as the same currency, the price levels of different economies should be one and the same, Asab, Abdullah, Nawaz, Shakoor, & Arshad, (2015).

Theoretically, this is an attractive instrument to understand exchange rate fluctuations over time. Also, it provides a long run yardstick for exchange rate among two currencies. Moreover, the monetary model is a clear measure to determine whether a currency is significantly overvalued or undervalued. This study outlines both the theoretical

[16] See section 3.3 for details.
[17] See chapter two for macroeconomic policy review in Nigeria.

fundamentals and the applied interpretations of the monetary models of exchange rate. There are two versions to the monetary model viz the flexible-price and the sticky-price models.

i. The Flexible-Price Model

Exchange rate implies the price of a country's currency in relation to the other. Then, it is practical to consider the causes of such price in relation to the demand and supply of two currencies. This is the basic rationale of the earliest argument on the monetary model of exchange rate (see Frenkel, 1976 and Mussa, 1976). Thus, flexible-price exchange rate determination proposes that there is a strong link between the exchange rate and any set of monetary bases. This relies on the assumptions that:

- ✓ Prices of goods are totally flexible domestically and internationally. Also, transaction cost is negligible. This means the general price level is the same in all countries suggesting that Purchasing power parity (PPP) hold continuously.

$$S_t = P_t - P_t^* \qquad 3.2.1$$

S is defined as spot exchange rate in the log form measured as price of one unit of foreign currency in relation to local currency units. P is defined as the log form of price level. t is defined as time while an asterisk (*) connotes foreign magnitude.

- ✓ Money demand is determined by real interest rates and income while monetary equilibrium determines prices in both economies. Money is assumed to be homogenous in prices:

$$M_t - P_t = \beta_1 Y_t - \beta_2 R_t \qquad 3.2.2$$

$$M_t^* - P_t^* = \beta_1^* Y_t^* - \beta_2^* R_t^* \qquad 3.2.3$$

M is money stock; R is interest rate while Y is income. Except R, all other variables are expressed in their log forms. Thus, β_1 is the income elasticity while β_2 is interest rate semi-elasticity of demand for money.

- ✓ Domestic asset is perfectly substituted for foreign asset, which means that capital mobility is easy and perfect. Economic agents are neutral to risk (or agents can avoid risk in the economy). Also, economic agents rationally form future exchange rate. The assumption is that Uncovered Interest Parity (UIP) hold in the foreign exchange market. In addition, it is assumed that interest rate is determined globally in the long run. Thus, in a situation of risk neutrality or certainty, anticipated change in ER equals to interest rate differential such that:

$$\Delta S^{\mathrm{e}} = \mathrm{R} - \mathrm{R}^* \qquad 3.2.4$$

Rearranging equation 3.2.2 and 3.2.3 for prices gives:

$$\mathrm{P_t} = \mathrm{M_t} - \beta_1 \mathrm{Y_t} + \beta_2 \mathrm{R_t} \qquad 3.2.5$$

$$\mathrm{P_t^*} = \mathrm{M_t^*} - \beta_1^* \mathrm{Y_t^*} + \beta_2^* \mathrm{R_t^*} \qquad 3.2.6$$

P^* is exogenous in the domestic country because the global money supply determines it. On the other hand, P is determined by domestic money supply. Thus, money supplies relatively determine exchange rate. Substituting equation 3.2.5 and 3.2.6 into 3.2.1 gives:

$$\mathrm{S_t} = \mathrm{M_t} - \mathrm{M_t^*} - \beta_1 \mathrm{Y_t} + \beta_1^* \mathrm{Y_t^*} + \beta_2 \mathrm{R_t} - \beta_2^* \mathrm{R_t^*} \qquad 3.2.7$$

Generally, factors of money demand in monetary model are the same both locally and internationally, which the restrictions that $\beta_1 = \beta_1^*$ and $\beta_2 = \beta_2^*$, from equation 3.2.7. To this end, rewriting 3.2.7 becomes:

$$\mathbf{S_t} = (\mathbf{M_t} - \mathbf{M_t^*}) - \boldsymbol{\beta_1}(\mathbf{Y_t} + \mathbf{Y_t^*}) + \boldsymbol{\beta_2}(\mathbf{R_t} - \mathbf{R_t^*}) \qquad 3.2.8$$

The restrictions imposed may be justified due to the presence of multicollinearity, which increases the efficiency of coefficient estimates. Although, this could lead to biased estimate and reversal of sign. The coefficient of $(M - M^*)$ equals unity or money neutrality is another restriction that suggests that there exists a relative relationship between the exchange rate and money supply. In other words, a 1% increase in local money supply (with a constant foreign supply of money) leads to a 1% rise in exchange rate because it is assumed that demand for money is homogenous of degree one in price. Therefore, some researchers relax the constraints and sometimes exclude the differential term in the interest rate to give the simplified form[18]:

$$\mathbf{S_t = \alpha_1 M_t - \alpha_2 M_t^* - \alpha_3 Y_t + \alpha_4 Y_t^* + \alpha_5 R_t - \alpha_6 R_t^*} \qquad 3.2.9$$

Equation 3.2.9 is the flexible monetary model. The model reveals that an increase in domestic relative to foreign money supply will induce domestic economic agents. Inducing domestic economic agents gets rid of the surplus money by expending further on goods and services. Consequently, prices increase leading to domestic currency depreciation through PPP condition. (where S rises). Similarly, a rise in the local relative to foreign interest rate reduces domestic money demand, which leads to the depreciation of local currency (where S rises).

On the other hand, an increase in the local relative to foreign real income increases the local money demand, which reduces spending. Thus, domestic price level reduces till a cleared money market is reached. The reduced local price with a constant international price level means the appreciation of domestic currency (where S decreases). This is established on the PPP theory. Based on the above assumption, therefore, MacDonald, (1984) suggested that the flexible model be perceived as a steady state or long run exchange rate determination model.

ii. Sticky-Price Interest Rate Model

Exchange rate extremely changes in the actual sense but does not change under the assumption of continuous PPP. Thus, Dornbusch, (1976) advanced the sticky-price model. The model permits an extensive overshooting of nominal exchange rate and real exchange rate. The study assumed that both interest rates and exchange rates rise to compensate for other price stickiness, mostly price of goods. The idea follows that prices of goods are sticky

[18] See Rapach and Wohar (2002) and (2004)

in the short run; thus, a decrease in the supply of money means a decrease in the supply of real money. This in turn, increases the interest rates and keeps monetary market in the equilibrium position. Any increase in local interest rates encourages capital inflow, which subsequently leads to nominal exchange rate appreciation (fall). With sticky prices, real exchange rates also fall.

Foreign investors know that they are artificially forcing up the exchange rate and they may be subject to a loss in foreign exchange when they convert their earnings into their domestic currency. Hence, the investors expect the exchange rate to depreciate. Therefore, they continue to buy the foreign assets so long as the capital gain (the interest differential) is higher than their foreign exchange loss (the expected rate of depreciation). When equality between the interest rate differential and the expected rate of depreciation holds, short run equilibrium is achieved; that is, uncovered interest parity holds.

Thus, for a nonzero interest differential, the expected rate of depreciation must be nonzero. Consequently, the exchange rate must have overshot its long-run equilibrium level (PPP). In the longer term and as a response to the money supply decrease, the domestic prices start to fall which results in a decline in the domestic interest rate. Then, the exchange rate depreciates (rises) slowly towards its long run level.

While Dornbusch (1976) emphasized the role of expectations in determining exchange rate behaviour and formulate the expectations mechanism in equation 3.2.10, Frankel, (1979) in equation 3.2.11 assumed that the expected change in the exchange rate is a function of the gap between the current spot rate and the equilibrium rate, and of the expected long run inflation differential between the domestic and foreign countries:

$$\Delta \boldsymbol{S}^{\mathbf{e}} = \boldsymbol{\theta}(\bar{\mathbf{S}} - \mathbf{S}) \qquad \boldsymbol{\theta} > \mathbf{0} \qquad 3.2.10$$

$$\Delta \boldsymbol{S}^{\mathbf{e}} = \boldsymbol{\theta}(\bar{\mathbf{S}} - \mathbf{S}) + (\boldsymbol{\pi}^{\mathbf{e}} - \boldsymbol{\pi}^{\mathbf{e}*}) \qquad 3.2.11$$

where ΔS^e is the expected change in the exchange rate, S is the log of long run exchange rate and θ reflects the sensitivity of market expectations to the proportional over or undervaluation of the currency relative to equilibrium or the speed at which the gap between the spot exchange rate and its long run equilibrium counterpart is expected to close. π^e and π^{e*} are the current rates of expected long run inflation rates at home and abroad respectively.

Equation (3.2.11) shows that in the short run, exchange rate is expected to revert to its long run value at a rate which is proportional to the current gap, and in the long run when $\bar{S} = S$ it is anticipated to change at the long run rate $\pi^e - \pi^{e*}$. In other words, when the exchange rate is at its equilibrium level, it is not necessary to stay constant, but it is expected to depreciate by the difference between the expected domestic and foreign inflation rates. From the uncovered interest parity (UIP), which states that the expected change in exchange rate equals the interest rate differential, $\Delta S^e = R - R^*$, equation 3.2.11 becomes:

$$R - R^* = \theta(\bar{S} - S) + (\pi^e - \pi^{e*})$$

$$\bar{S} - S = \frac{1}{\theta}[(R - R^*) - (\pi^e - \pi^{e*})]$$ [19]

Thus, solving for the Long-Run (LR) exchange rate:

$$\bar{\mathbf{S}} = \mathbf{S} + \frac{\mathbf{1}}{\boldsymbol{\theta}}[(\mathbf{R} - \mathbf{R}^*) - (\boldsymbol{\pi}^{\mathbf{e}} - \boldsymbol{\pi}^{\mathbf{e}*})] \qquad 3.2.12$$

Going by Dornbusch assumption that the monetary model determines only the equilibrium, and not the actual exchange rate, the LR equation (3.2.8) will be:

$$\mathbf{S} = (\mathbf{M} - \mathbf{M}^*) - \boldsymbol{\beta}(\mathbf{Y} - \mathbf{Y}^*) + \boldsymbol{\gamma}(\boldsymbol{\pi}^{\mathbf{e}} - \boldsymbol{\pi}^{\mathbf{e}*}) \qquad 3.2.13$$

In the absence of PPP, the real interest rates must diverge. Therefore, the inflation rate (differential) is reflected in the long-term interest rate (differential), but not necessarily in rates in the short term. Combining (3.2.12) and (3.2.13) yields:

[19] Note: in the LR when $S = \bar{S}$ there should be $R - R^* = \pi^e - \pi^{e*}$. This means that both UIP, $\Delta S^e = R - R^*$, and PPP, $\Delta S^e = \pi - \pi^*$, holds.

$$\boldsymbol{S} = (\boldsymbol{M} - \boldsymbol{M}^*) - \boldsymbol{\beta}(\boldsymbol{Y} - \boldsymbol{Y}^*) + \boldsymbol{\gamma}(\boldsymbol{\pi^e} - \boldsymbol{\pi^{e*}}) - \frac{\boldsymbol{1}}{\boldsymbol{\theta}}[(\boldsymbol{R} - \boldsymbol{R}^*) - (\boldsymbol{\pi^e} - \boldsymbol{\pi^{e*}})] \qquad 3.2.14$$

Or

$$S = (M - M^*) - \beta(Y - Y^*) + \left[\left(\gamma + \frac{1}{\theta}\right)(\pi^e - \pi^{e*})\right] - \frac{1}{\theta}(R - R^*),$$

Then,

$$\boldsymbol{S} = (\boldsymbol{M} - \boldsymbol{M}^*) - \boldsymbol{\beta}(\boldsymbol{Y} - \boldsymbol{Y}^*) + \boldsymbol{\delta}(\boldsymbol{\pi^e} - \boldsymbol{\pi^{e*}}) - \frac{\boldsymbol{1}}{\boldsymbol{\theta}}(\boldsymbol{R} - \boldsymbol{R}^*) \qquad 3.2.15$$

$$\delta = \gamma + \frac{1}{\theta}$$

Equations (3.2.14) and (3.2.15) represent the sticky-price monetary model or the interest differential model, which allow for a slow adjustment in domestic prices, and hence deviations from PPP. This formulation shows the role of expected and real interest rate (the terms between brackets in equation 3.2.14), in determining exchange rate changes (Copeland, 2000). This means that an increase in domestic money supply, a fall in local real income and in domestic interest rates or a rise in local expected inflation rate will depreciate domestic currency.

The difference in the sign of the nominal interest rate differential between the flexible-price and sticky-price equations is worth noting. There is a conflict regarding the relationship between the exchange rate and the interest rate as expressed in the above models. The first view is called the Chicago theory, which assumed that prices are perfectly flexible as stated by Frankel (1979). This is mostly attributed to the orthodox view based on the popular Mundel-Fleming model as reported by MacDonald & Taylor, (1992).

The theory held that as a result of the assumption of flexible prices, movements in the nominal interest rate are caused by changes in the expected inflation rate. Consequently, an increase in the domestic relative to foreign interest rate is due to the expected loss in the value of domestic currency resulting from inflation and depreciation. A higher interest rate as a result of expected loss in the value of money, therefore, leads to fall in the demand for domestic currency. The fall in the demand for domestic currency results in depreciation of the home currency (that is, a rise in the exchange rate). Thus, increase in relative interest rate leads to increase in exchange rate (depreciation of exchange rate). This is a positive relationship between interest rate differential and exchange rate.

The second view, in which prices are assumed to be fixed in the short run, is usually called the Keynesian theory due to its sticky-price assumption. According to this view, changes in the nominal interest rate can be attributed to the tightness of monetary policy. A fall in the home money supply relative to its demand leads to a rise in the home interest rate relative to the foreign rate, with constant prices. In this case, a higher domestic interest rate than its foreign counterpart attracts capital inflows, which result in an appreciation of the domestic currency. In other words, exchange rate falls. Hence, there is a negative relationship between exchange rate and nominal interest rate differential (see Frankel, 1979).

The Frankel-Dornbusch sticky-price model emphasizes the role of expectations and rapid adjustments in capital markets. The model concluded that the exchange rate differs from its equilibrium value by an amount which is proportional to the real interest rate differential, that is, nominal interest rate differential minus the expected inflation rate differential. A high nominal interest differential as a consequence of a high expected inflation rate differential leads to equality between the exchange rate and its equilibrium value, which rises at the rate of the inflation differential over time.

On the other hand, a high nominal interest differential as a result of tight money results in a fall in the exchange rate below its long run value. It is worth noting that Nigeria situation is similar to the former hypothesis. As discussed in chapter two, relative interest rate changes in Nigeria is due to the flexible system (deregulation policy) adopted since 1986 in which the forces of demand and supply determine the rate of interest (see chapter two for details).

iii. Monetary Exchange Rate Volatility Models

The interest of this study is on the determinants of the second moment of exchange rates, and not its first moment. In other words, this research work is interested in changes in the variability of exchange rate rather than changes in the level of ER. Thus, equation 3.2.8 and 3.2.15 are expressed as in Balg (2006) as:

$$\boldsymbol{s = \widetilde{m} - \beta_1 \widetilde{y} + \beta_2 \widetilde{r}} \qquad 3.2.16$$

$$\boldsymbol{s = \widetilde{m} - \beta \widetilde{y} + \delta \widetilde{\pi^e} - \gamma \widetilde{r}}, \qquad \boldsymbol{\gamma = \frac{1}{\theta}} \qquad 3.2.17$$

In addition, assuming that ERV is determined by the volatility of its fundamental determinants, then the variance of both sides of equations (3.2.16 and 3.2.17) are put in terms of volatility rather than level forms. This means that there is the assumption that the variance (the second moment) of exchange rates is determined by the variance of the regressors appearing in the traditional exchange rate models. In other words, since the conventional models assumed that the first moment of the fundamentals determines the first moment of exchange rates, then the second moment of the fundamentals determines the second moment of exchange rates. Therefore, ERV models that are built on the above conventional ER models is formed by taking the variance of equation 3.2.16 and 3.2.17 as:

$$\boldsymbol{Vs = V\widetilde{m} + \beta_1^2 V\widetilde{y} + \beta_2^2 V\widetilde{r} + 2\beta_1 Cov(\widetilde{m}, \widetilde{y}) + 2\beta_2 Cov(\widetilde{m}, \widetilde{r}) + 2\beta_1\beta_2 Cov} \qquad 3.2.18$$

$$\boldsymbol{Vs = V\widetilde{m} + \beta^2 V\widetilde{y} + \delta^2 V\widetilde{\pi^e} + \gamma^2 V\widetilde{r} + 2\beta Cov(\widetilde{m}, \widetilde{y}) + 2\delta Cov(\widetilde{m}, \widetilde{\pi^e}) +}$$

$$\boldsymbol{2\gamma Cov(\widetilde{m}, \widetilde{r}) + 2\beta\delta Cov(\widetilde{y}, \widetilde{\pi^e}) + 2\beta\gamma Cov(\widetilde{y}, \widetilde{r}) + 2\delta\gamma Cov(\widetilde{\pi^e}, \widetilde{r})} \qquad 3.2.19$$

Where V means the variances (volatilities) of the series while Cov means covariances between two variables.

From equation (3.2.16), an increase in the local money supply relative to its foreign counterpart encourages local currency depreciation (increase in exchange rate). There is a positive relationship between money supply differential and exchange rate with a coefficient equal to one. However, all coefficients in equations involving variances are expected to be positive. More precisely, in an equation such as (3.2.16 and 3.2.17), a change (positive or negative) in a regressor leads to a change (positive or negative) in the regressand, that is; the relationship is either positive or negative, means that more variance (volatility) in the regressor should lead to more variance (volatility) in the regressand. Thus, all variables (in their variance form) in the right-hand side of equation (3.2.16 and 3.2.17) should have positive signs.

Mathematically, such expected signs are supported by Gujarati, (2003) that: given a set of two correlated random variable (X and Y);

$$\begin{aligned} \boldsymbol{VAR(X+Y) = VAR(X) + VAR(Y) + 2COV(X,Y)} \\ \boldsymbol{VAR(X-Y) = VAR(X) + VAR(Y) - 2COV(X,Y)} \end{aligned} \qquad 3.2.20$$

However, if X and Y are independent of each other, then $COV(X,Y)$ is equal to zero.

Given the above mathematical support, this study expects that the variances of variables in the empirical model will be positively related to the variance of exchange rate.

On the issue of covariances in the money is determined by income and interest rate in equations (3.2.2) and (3.2.3). Therefore, the covariances between $\tilde{m}$ and $\tilde{y}$ on the one hand, and between $\tilde{m}$ and $\tilde{r}$ on the other hand, are expected to be nonzero. However, such relationships are anticipated to hold in terms of levels but not in the form of differentials between domestic and foreign quantities. This is because $\tilde{y}$ and $\tilde{r}$ are not expected to be related to each other, such that Cov($\tilde{y}$, $\tilde{r}$) = 0.

3.2.2 Non-Monetary Factors in Exchange Rate Model

It is observed that there are many empirical studies of monetary determination of ERV on developing countries, especially Nigeria. However, there are more external shocks, internal shocks and policy changes in developing countries compared to developed countries. As a result, the structural parameters in the developing economies may experience extra movements compared to the developed economies. Thus, the structural elements may limit the ability of the monetary ERV models in developing countries.

Also, the UIP may not hold in most developing countries due to inadequate financial markets or immature markets. This can restrict the effectiveness of the monetary models. This is a signal that it is possible that the monetary exchange rates model is designed to explain ER behaviour that are demand and supply oriented. Meanwhile, exchange rate in developing countries are mostly fixed to a one particular currency or composite currencies of industrialized countries or floated in a controlled/managed floating system (such as exhibited in Nigeria as reviewed in chapter two). Consequently, monetary exchange rates determination may not perform well for developing economy compared to when developed economy is considered.

To this end, the new open economy macroeconomics argued that non-monetary factors (real shocks) inclusion is important in explaining exchange rate volatility (Calderon, 2004). In other words, in addition to monetary shocks, the real shocks, such as, productivity shocks, good demand shocks (government spending shifts) and labor supply shocks, among others should be included in the models of exchange rate determination. Clarida & Gali, (1994) noted that shocks to business cycles are found to influence exchange rate fluctuations.

i. Productivity Growth Differential

The common non-monetary factor in the exchange rate model is the general Balassa-Samuelsson theoretical model. The model is attributed to the important contributions of Balassa (1964) and Samuelson (1964). The model studied the equilibrium of exchange rate and emphasized that increase in exchange rate accompanies improved economic growth because of deferential productivity growth between tradable and non-tradable sectors. The hypothesis assumes that productivity increases tradable sectors hence pushing up sector wages. This in effect puts an upward pressure on wages in the non–tradable sector and the economy as a whole. Because productivity does not increase in response to wage rise, prices of non-tradable goods are expected to rise leading to increase in the relative price of non-tradable to tradable goods, hence, an increase in the domestic exchange rate.

Villavicencio & Bara, (2008) expressed that there is a significant relationship between exchange rate fundamentals which include supply and demand factors. According to the study, the supply factors of exchange rate fundamentals largely relate to the level of output capacity and expected to follow the Balassa–Samuelson hypothesis. On the other hand, the demand factors relate to the role of government expenditure while the external shocks reflect changes in terms of trade, trade openness and capital flows.

ii. Oil Price Effect

In the recent time, more theoretical appraisal on oil exporting economies suggested that price of oil may be considered for oil dependent or oil exporting country as non-monetary factor in the exchange rate model. The proposition is that macroeconomic variables are affected by oil shocks from demand side or supply side, Trung and Vinh (2011). Firstly, on the demand side, oil price increase leads to lower aggregate demand given that income is redistributed between net oil import and export countries. Oil price spike could alter economic activity because household income is spent more on energy consumption. Firms reduce the amount of oil it purchases leading to underutilization of the factors of production like labor and capital.

Secondly on the supply side, the effects are related to the fact that crude oil is considered as the basic input to production process. A rise in oil price will lead to a decline in supply of oil due to a rise in cost of oil production. A decline in supply of oil will lead to a decrease in potential output. Reduction in potential output reduces activities in the tradable sector as well as its wages. Consequently, there is decrease in wages in non-tradable sector as well as in the whole economy. Decrease in wages will lead to decreasing relative prices of non-tradable goods to tradable goods resulting to increase in the value of local money. Hence, an increase in the demand for local currency and consequently a decrease in the rate of exchange, which is currency appreciation.

iii. Non-Monetary Exchange Rate Volatility Models

As earlier noted, the interest of this study is on the determinants of the second moment of exchange rates, and not its first moment. In other words, this research work is interested in changes in the variability of exchange rate rather than changes in the level of ER. Thus, from the above analysis on the non-monetary factors of ER, exchange rate is positively related to productivity growth differential and negatively related to oil price as:

$$\boldsymbol{s = \alpha_1 \tilde{g} - \beta_2 o} \qquad 3.2\ 21$$

In addition, assuming that ERV is determined by the volatility of its fundamental determinants, then the variance of both sides of equation 3.2.21 are put in terms of volatility rather than level forms. This means that there is the assumption that the variance (the second moment) of exchange rates is determined by the variance of the regressors appearing in the traditional exchange rate models. In other words, since the conventional non-monetary model assumed that the first moment of the fundamentals determines the first moment of exchange rates, then the second moment of the fundamentals determines the second moment of exchange rates. Therefore, non-monetary ERV model that is built on the above conventional non-monetary ER model is formed by taking the variance of equation 3.2.21 as:

$$\boldsymbol{Vs = \alpha_1^2 V\tilde{g} + \alpha_2^2 Vo + 2\alpha_1 Cov(\tilde{g}, o)} \qquad 3.2\ 22$$

Where V means the variances (volatilities) of the series while Cov means covariances between two variables. $\tilde{g}$ is the productivity growth differential while $\tilde{g}$ is oil price.

From equation (3.2.21), an increase in the local productivity growth relative to its foreign counterpart encourages local currency depreciation (increase in exchange rate). This means that there is a positive relationship between productivity growth differential and exchange rate. Also, all coefficients in equation involving variances are still expected to be positive.

More precisely, in an equation such as 3.2.22, a change (positive or negative) in a regressor leads to a change (positive or negative) in the regressand, that is; the relationship is either positive or negative, means that more variance (volatility) in the regressor should lead to more variance (volatility) in the regressand.

On the other hand, from equation (3.2.21), an increase in the price of oil encourages local currency appreciation (decrease in exchange rate). This means that there is a negative relationship between oil price and exchange rate. However, in equation involving variances all coefficients are expected to be positive. Theoretically therefore, oil price volatility is expected to be positively related to exchange rate volatility. Thus, all variables (in their variance form) in the right-hand side of equation 3.2.22 should have positive signs. Mathematically, such expected signs are supported by Gujarati (2003) that: given a set of two correlated random variable (X and Y) as presented earlier in this section.

3.3 Empirical Literature on the Causes of Exchange Rate Volatility

3.3.1 Empirical Literature on Monetary Causes of Exchange Rate Volatility

Empirical studies have been carried out using different models of monetary ERV determination. Several studies are carried out on the developed economies against the little carried out on the developing ones to the knowledge of the author. Most of the studies, however, employed the monetary ERV determination. Considering the factors in the monetary model, Razi, Shafiq, Ali, & Khan, (2012); and Saeed, Awan, Sial, & Sher, (2012) showed that monetary factors such as interest rate and money stock are the fundamental factors that drive exchange rate fluctuations in Pakistan. Insah & Chiaraah, (2013) empirically studied the determinant of real ERV in Ghana between 1980 and 2012. The study used ARDL technique to investigate the relationship. The study found that monetary factor such as money supply is negatively related to exchange rate volatility.

Evidence on the subject of ERV determination in Nigeria is observed to be limited. Adeoye & Atanda, (2010) studied the consistency, persistency and degree of exchange rate volatility using monthly time series data from 1986 to 2008. The study used ARCH and GARCH models to analyse the long run consistency of exchange rate volatility in Nigeria. The study employed purchasing power parity model. The results revealed that both nominal and real exchange rate volatility were persistent in Nigeria. The results also indicated that purchasing power parity was not consistent with nominal exchange rate volatility in Nigeria. The study recommended that monetary authority should control the higher demand for foreign currencies.

Ajao & Igbokoyi (2013) examined the degree of influence of real interest rate and money supply on real exchange rate volatility in Nigeria for the period between 1981 and 2008. Using GARCH and ECM, the empirical results indicated that real interest rate have positive impact on exchange rate volatility in Nigeria for the period.

Adamu, Abubakar, & Dantama (2017) also examined the sources of uncertain exchange rate in Nigeria between 1989 and 2015 using quarterly data. The study used Autoregressive Conditional Heteroscedasticity (ARCH) model for volatility measurement and Autoregressive Distributed Lag (ARDL) model and Granger Causality test as estimation techniques. The study found that monetary factor such as interest rate significantly impacts on exchange rate volatility. However, the study found no causality effect between interest rate and exchange rate volatility. The study concluded that the Central Bank of Nigeria should maintain stable interest rate because interest rate volatility will trigger unstable exchange rate.

3.3.2 Empirical Literature on Non-Monetary Causes of Exchange Rate Volatility

Carrera & Restout, (2008) introduced a good survey of the factors that drive ER in the long-run. The analysis suggested that the Balassa Samuelson effect (PROD), government spending (GEXP), the terms of trade (TOT), the openness degree (OPEN), foreign capital flows, and the de facto nominal exchange rate regime, are the potential factors that impact the ER. Similarly, Clark & MacDonald, (1998) found that the equilibrium exchange rate is determined as a function of both the vector of long run economic fundamentals and the interest rate differential. Meanwhile, the later study depended on the theory of Uncovered Interest Rate Parity (UIP). The equilibrium ER in the studies is expressed as:

$$\boldsymbol{ER}^{*} = \boldsymbol{f}(\boldsymbol{PROD}, \boldsymbol{OPEN}, \boldsymbol{TOT}, \boldsymbol{NFA}, \boldsymbol{GEXP}, \boldsymbol{r} - \boldsymbol{r}^{*}) \qquad 3.3.\ 1$$

Many recent studies applied to many developing countries showed that successful economic development can be represented as an improvement in the living standard accompanied by currency appreciation. Therefore, the impact of productivity differentials (Villavicencio and Bara, 2008) is expected to follow the Balassa-Samuelson doctrine. The study considered one of the most important hypotheses with respect to the equilibrium real exchange rate level that real exchange rate appreciation accompanies rapid economic growth.

Al-Samara, (2009) investigated the determinants of real exchange rate volatility in Syria over the period of 1980 to 2008. The objective of the study was to identify the principal factors suggested in many theoretical literatures, which includes relative productivity, government expenditure, terms of trade, trade openness and net foreign assets. To examine these variables, the study employed VECM and ARCH. The study reported that relative productivity has positive impact on exchange rate volatility on ERV over the period investigated.

Also, the literature is not silent about the effect of exchange rate movements and changes in the level of government expenditures as well as its distribution between tradable and non-tradable products. Ravn, Schmitt-Grohe, & Uribe, (2007) investigated the effects of government spending shocks using panel structural VAR analysis and data from four industrial countries. The study found that an increase in government spending leads to an expansion in the output and private consumption, a deterioration in the trade balance and a depreciation of the real exchange rate.

This is further supported by, the empirical study by Insah and Chiaraah (2013) on Ghana which revealed that government expenditure has positive relationship with ERV. The study therefore recommended that government should reduce its expenditure to control the trends in exchange rate variability. Similarly, Ajao & Igbokoyi (2013) found a positive relationship between government expenditure and real ERV in Nigeria.

The openness of economy is another factor considered in the empirical literatures. Stanèík, (2007) investigated the sources of exchange rate volatility among European Union members' countries. The study used threshold autoregressive conditional heteroscedasticity (TARCH) model as a technique of analysis. The study revealed that economic openness, information and flexible exchange rate regimes have positive and statistically significant impact on exchange rate volatility.

On the other hand, Carrera & Restout (2008) empirically showed that the degree of openness is likely to affect the real exchange rate volatility through the theoretical influence. That is, the trade liberalizing reforms contribute in depreciating the long-run real exchange rate level, through a raise in the openness variable, such as a reduction in tariff, leads to a decline in the domestic price of imported goods. This in turn catalyzes an excess demand for imported goods and reduces domestic demand for non-traded goods. As a result, the real exchange rate depreciates to restore the equilibrium in the non-traded market.

Many studies have suggested that oil price might have a significant influence on exchange rate. According to Al-Ezzee (2011), the proposition that oil price might be adequate to explain all the long run movements in real exchange rate appears to be new. Also, for various reason, oil price increases may lead to significant slowdown in economic growth of some countries. Empirically, Gelbard & Nagayasu (2004) have added to the literature on the topic by investigating the causes of real exchange rate in Angola for the period spanning from 1992 to 2002. The results proved that oil prices were the most important sources of exchange rate movements. The study recommended that flexible exchange rate policy is more likely to be the appropriate exchange rate policy for Angola than fixed exchange rate policy.

Englama, Duke, Ogunleye, & Isma'il (2010) examined the relationship between oil price and exchange rate volatility in Nigeria. Monthly series for the period of 1999:1 to 2009:12 were used. The study employed vector autoregressive (VAR) model, cointegration and vector error correction model (VECM) to investigate both short-run and long-run relationship between dependent and independent variables.

The results showed that exchange rate volatility was strongly influenced by changes in oil price at the foreign market both in the long-run and short-run. In the long-run, a 1.0 percent increase in oil price volatility leads to 0.54 percent change in the exchange rate volatility. However, in the short-run, the results showed that 1.0 percent change in oil price at the international market may influence exchange rate volatility to change by 0.02 percent. Aliyu, (2011) also employed index of crude oil price volatility in the empirical analysis. The results showed that long run behaviour of real exchange rate was positively influenced by index of crude oil volatility in Nigeria.

3.3.3 Empirical Literature on Monetary and Non-Monetary Exchange Rate Volatility

Investigating the combined monetary and the real shock effects, studies have revealed that economic openness, terms of trade, net foreign assets, government expenditure, money supply, commodity price, inflation, economic growth, interest rate, fiscal balance among others are the potential influencing factors of exchange rate volatility (Stanèík, 2007; Villavicencio and Bara, 2008; Al-Samara, 2009; Razi *et al.*, 2012; Insah and Chiaraah, 2013). Equally in Nigeria, many empirical studies have been conducted on exchange rate volatility (see Adeoye and Atanda, 2010; Englama *et al.*, 2010; Aliyu, 2011; Ajao & Igbokoyi 2013) but these studies did not consider the internally generated exchange rate volatility modelling in Nigeria.

Alexius (2001) used a VAR model to find out the factors causing fluctuations in the exchange rate of four Nordic countries i.e. Denmark, Finland, Norway and Sweden. The results showed that supply side shocks, that is, productivity shocks played a greater role in the variation of exchange rate in all the countries. However, the study pointed out that the shocks in the exchange rates were temporary not permanent.

A mixed result is found in Dibooglu & Kutan (2001) who investigated the role of nominal and real shocks in the real exchange fluctuations of Hungary and Poland. The study found that real shocks were the main drivers of real exchange rate fluctuations in Hungary, whereas in Poland, the role of nominal shocks were larger than the real shocks in the determination of real exchange rate. The study suggested that the Central Bank of Poland can manage their nominal exchange rate by following an appropriate exchange rate and monetary policies for the improvement of external competitiveness. On the other hand, the government of Hungary was required to focus on the real side of the economy, which is to increase productivity efficiency.

Similarly, Adom, Morshed, & Sharma, (2012) examined the impact of real demand, aggregate supply and monetary shocks on real exchange rates in 13 West African countries. The study revealed that a lot of real exchange rate fluctuations emanated from real demand shocks. The study asserted further that controlling government expenditure and taxes was an appropriate demand management strategy.

Insah and Chiaraah (2013) empirically investigated the factors affecting real exchange rate volatility in Ghana for the period of 1980 to 2012. The variables employed in the study include; government expenditure, money supply, domestic debt and external debt. To examine the relationship, the study employed ARDL model. The study revealed that, there exist positive relationship between government expenditure and exchange rate volatility, while money supply, domestic and external debts were negatively related to exchange rate volatility. The study recommended that government should cut down its expenditure in order to control the persistence trends in exchange rate.

Ajao & Igbokoyi (2013) examined the degree of influence of real exchange rate, productivity, trade openness and government expenditure, real interest rate and money supply on real exchange rate volatility in Nigeria for the period between 1981 and 2008. Using GARCH and ECM, the results of the study indicated that real exchange rate, trade openness, government expenditure, real interest rate have positive impact on exchange rate volatility in Nigeria with exception of money supply and productivity.

Adamu, *et al* (2017) examined the sources of uncertain exchange rate in Nigeria between 1989 and 2015 using quarterly data. The study found that interest rate has positive relationship with ERV. However, the study found that although there are positive relationships between ERV and economic openness, fiscal balance and oil prices but the results are not statistically significant. In addition, the results showed that the domestic income is negatively related to ERV, but the estimate is equally not significant. The study established that interest rate significantly affects ERV in Nigeria over the period.

Given the diverse development in the literature, the real shock factors were added to the earlier monetary models. This study agrees that decomposing exchange rate volatility determinants into monetary and real factors helps in identifying the sources of exchange rate movement and designing appropriate policy response. Of an important consideration in this study is the proposition of the effect of oil price in exchange rate model, which is recently considered by few authors (see Al-Ezzee, 2011).

The empirical applications of the earlier theoretical models show that most of the studies neither focus on complete set of determinants of exchange rate volatility nor incorporate the covariances of the potential determinants of exchange rate volatility in their investigations. However, the tools to be employed in this study differ by modelling the conditional variance, or volatility, of a variable.

This study finds that most of the previous studies on developing countries, especially Nigeria ignored decomposition of exchange rate volatility determinants into monetary and real factors. This study notes that decomposing the determinants of exchange rate volatility helps to identify the sources of exchange rate movement and design appropriate policy response. This study gathers that most of the earlier studies on Nigeria are restricted to the conventional (flexible price and sticky price) exchange rate volatility model. The earlier studies found that monetary (interest rate and money supply) shocks mainly influence ERV ignoring the effect of real (productivity growth and oil price) shocks in the exchange rate volatility.

However, monetary factors alone may not have comprehensive intuition about the determination of exchange rate volatility. Thus, this study considers a model that incorporates the monetary and non-monetary factors that influence exchange rate volatility in Nigeria over the investigated period.

Theoretical Exchange Rate Volatility Model for Nigeria: Monetary and Non-Monetary Model

Modeling exchange rate volatility differs. The difference majorly features in the level of economic development of a nation such as whether it is a developed or developing nation. Monetary exchange rates determination may not perform well for developing economy compared to when developed economy is considered because there are more external shocks, internal shocks and policy changes in developing countries compared to developed countries. The structural elements may limit the ability of the monetary ERV models in developing countries. Therefore, this study considers including some theoretical potential structural or real economic factors that may likely influence exchange rate volatility in Nigeria.

Firstly, this study emphasizes the importance of adding productivity growth differential shocks into the model. In the context of productivity growth differential shocks, ER is positively related to domestic productivity growth relative to foreign productivity growth. The hypothesis assumes that productivity increases tradable sectors hence pushing up sector wages. Pushing up sector wages puts an upward pressure on wages in the non–tradable sector and the economy as a whole. Since productivity does not increase in response to wage rise, prices of non-tradable goods are expected to rise leading to increase in the relative price of non-tradable to tradable goods. An increase in relative price reduces the value of money in the economy. Reduction in the value of money leads to a fall in the demand for domestic currency, hence, a depreciation of the domestic exchange rate (that is, a rising exchange rate). This is a positive relationship between productivity growth and exchange rate changes.

Secondly, the study includes price of oil in the ER model by assuming that on the demand side, oil price increase leads to lower aggregate demand given that income is redistributed between net oil importing and exporting countries. Oil price spike alters economic activity because household income is spent more on energy consumption, and firms reduce the amount of crude oil it purchases which then leads to underutilization of the factors of production like labor and capital.

On the demand side, crude oil is considered as the basic income generating commodity in the Nigerian economy. A rise in oil price will lead to an increase in income and consequently on relative prices. An increase in relative price reduces the value of money in the economy. This leads to a fall in the demand for domestic currency, hence, a depreciation of the domestic exchange rate (that is, a rising exchange rate). This is a positive relationship between oil price and exchange rate changes. Overall, this impact output base positively.

This study therefore proposes that increase in potential output increases activities in the tradable sector as well as its wages. Increase in the wages leads to increase in relative prices of non-tradable goods to tradable goods resulting to decrease in the value of local money. Hence, a decrease in the demand for local currency and consequently an increase in the rate of exchange, that is currency depreciation. As earlier suggested, this study incorporates oil price in the exchange rate model due to Nigerian economy dependence on oil proceeds as the major source of revenue. To this study, this situation is capable of raising suspicion about the impact of oil price volatility on macroeconomic volatility in the country, especially on the price of exchange being the main product of exchange.

Given the above theoretical significance of interest rate, productivity growth and oil price on exchange rate, this study proposes a model of exchange rate that comprises monetary and non-monetary factors that comprises the exchange rate, interest rate, productivity growth and oil price.

However, assuming that ERV is determined by the volatility of its fundamental determinants, then the variance of both sides of equation 4.3.1 are put in terms of volatility rather than level forms. This means that there is the assumption that the variance (the second moment) of exchange rates is determined by the variance of the interest rate differential, productivity growth differential and oil price as discussed in the traditional exchange rate models above.

In other words, since the conventional models assume that the first moment of the interest rate, productivity growth and oil price determine the first moment of exchange rates, then the second moment of the interest rate, productivity growth and oil price determine the second moment of exchange rates.

3.4 Exchange Rate Volatility Measurement

One of the important issues in the empirical study is how to measure exchange rate volatility. In measuring volatility, various methods have been developed across time which exhibits innovative changes on econometric techniques. However, a prevailing approximation for variability is yet to emerge. Using measure of variance has been the most common measure, with different measurement construction by different studies. Also, the decision of the type of variable differs from study to study, which is either constructed as the level of a variable, the rate of change of standard deviation (SD), moving standard deviation, within period one (NER or real exchange rate-RER). Several studies estimate volatility with the moving SD of monthly ER changes with the stationarity advantage - a desirable property before the introduction of the cointegration analysis (see Kenen & Rodrik, 1986).

Likewise, Bleaney (1992) implemented an analogous analysis adopting the level instead of the ER rate of change. However, many authors later introduced various techniques of calculating volatility that is of benefit in the recent time series techniques. Although, none of the ERV measurements is agreed to be a standard volatility proxy, some of the measurements are commonly used than others. However, this study is interested in modelling and analyzing volatility spillover as orchestrated by economic historical shocks in Nigeria. Therefore, other measurements become secondary importance.[20]

This choice of volatility in this study is motivated by the need to account for time varying shock spillover effect from the factors that drive exchange rate volatility to exchange rate volatility. This study provides the necessary volatility proxy using the multivariate generalized autoregressive conditional heteroscedasticity (MGARCH). This is important in this study because the internally generated volatility is required for the general equilibrium analysis of trade model in chapter seven. Thus, the next section discusses the theoretical properties of the method of analysis to be employed in the exchange rate volatility model in chapter six.

3.5 Survey of the Multivariate GARCH Techniques

This section surveys the theoretical properties of a MGARCH model because of its suitability in the study. This study understands that the starting point of multivariate volatility models is a univariate GARCH. Thus, the simplest MGARCH models can be viewed as direct generalizations of their univariate counterparts. According to Harju & Hussain (2008), univariate ARCH and GARCH models have been used to capture return and volatility spillover effects among different markets by incorporating lagged returns, innovations, volatilities, or a combination of these variables from only a single market as explanatory variables of the other market. Thus, this section examines the univariate models.

3.5.1. Univariate Framework

In modelling volatility, the existence of a conditional variance within a conditional mean equation makes linear econometric models inappropriate for capturing time varying shocks. However, Engle's (1982) autoregressive conditional heteroscedasticity (ARCH) process and its generalization process or GARCH process (Bollerslev, 1986) has been successful in

[20] Table Apx 4 in the appendix summarizes the popularly used exchange rate volatility measures in the literature.

capturing the nonlinearity in financial data. This research work recognizes that there are two major approaches to modelling volatility viz the Autoregressive conditional heteroscedasticity (ARCH) and Stochastic Volatility (SV) models. While this study briefly surveys the ARCH models, the SV model is beyond the scope of this research work and therefore is not included.

i. The ARCH Models

The ARCH models developed by Engle (1982) have the basic ideas that the mean α_t is serially uncorrelated, but dependent and two, the dependence of α_t can be described by a simple quadratic function of its lagged values (Ruey, 2002). According to Khalafalla (2012), ARCH (m) models assume that

$$\boldsymbol{r_t = \sigma_t \xi_t}; \quad \boldsymbol{\xi_t \sim i.i.d\ (0, 1)}; \ \boldsymbol{r_0 > 0} \qquad 3.5.\ 1$$

$$\boldsymbol{\sigma_t^2 = a_0 + a_1 r_{t-1}^2 + \cdots + a_m r_{t-m}^2}; \ \boldsymbol{a_0 > 0}; \boldsymbol{a_i \geq 0}; \boldsymbol{i > 0} \qquad 3.5.\ 2$$

The models are popular volatility models because its variance specification can capture commonly observed features of the time series and financial variables. In particular, it is useful for modelling volatility and especially changes in volatility over time (Hill, et al., 2017).

The above models have been criticized by Ruey (2002) on the assumption that the effects of both negative and positive shocks are the same on volatility since it is determined by the squares of past shocks. Also, the models are restrictive because they are specified in interval, for example, ARCH (1) model should have interval (0,0.333). In addition, the models only offer an automated way of describing the conditional variance behaviour. Therefore, it does not suggest new insight to understand the source of fluctuations in the financial time series. This implies that the models are not able to provide causes of volatility in the series. Also, the models may over predict volatility since they react slowly to large isolated shocks in the return series.

ii. The GARCH Models

The generalized autoregressive conditional heteroscedastic (GARCH) model is the ARCH process generalized by Bollerslev (1986). Bollerslev achieved this by allowing past conditional variances to appear in the current conditional variance equation. The general structure of a GARCH model is;

$$\boldsymbol{r_t = \mu + \varepsilon_t = \mu + \left(\sigma_t^2 \epsilon_t\right)^{1/2}} \qquad 3.5.3$$

where

r_t - return of the asset at time t.

μ - average returns.

ε_t - residual returns, defined as:

$$\varepsilon_t - \sigma_t z_t$$

where z_t is standardized residual returns (i.e. iid random variable with zero mean and variance one).

The usual assumptions of the model are to consider the mean to either be zero, equal to a constant ($\mu_t = \mu$), or follows an ARMA (p, q) process. Meanwhile, Virbickaite, Ausín, & Galeano, (2015) concluded that the process yields GARCH-in-Mean models[21] when the mean is modelled as function of variance, like g (σ_t^2),

In the model above, the equation is written as a function of constant with an error term.

A simple GARCH(1,1) model follows;

$$\boldsymbol{\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \theta_1 \sigma_{t-1}^2} \qquad \text{for } \boldsymbol{t = 1, \ldots, T} \qquad 3.5.4$$

where $\alpha_0 > 0$ and $\alpha_1 \geq 0$ and $\theta_1 \geq 0$ and

[21] See Virbickaite, *et al* (2015) for detail discussion of GARCH in Mean

σ_t^2 is conditional variance.

The constraints $\alpha_1 \geq 0$ and $\theta_1 \geq 0$ are needed to ensure σ_t^2 is strictly positive (Poon, Choong, & Habibullah, 2005). σ_t^2 is known as the conditional variance because it is a one – period ahead forecast variance based on past information. The conditional variance equation is specified as a function of a constant term (α_0); information about volatility from the previous period, which is measured as the lag of the squared residuals from the mean equation, the ARCH term (ε_{t-1}^2) - linear combination of the past mean squared returns; and the last period forecast variance, the GARCH term (σ_{t-1}^2) - a linear combination of the past conditional variances.

The GARCH(1, 1) process in equation 3.5.4 is a parsimonious representation of the ARCH(q) model with substitution of lags of the conditional variance σ_t^2 and assuming $0<\theta_1<1$ means $\theta_1^{\infty}\sigma_{t-\infty}^2 = 0$ which through substitution gives a *restricted infinite* order ARCH process;

$$\boldsymbol{\sigma_t^2 = \alpha_0\left(1 + \theta_1 + \theta_1^2 + \cdots + \theta_1^{\infty-1}\right) + \alpha_1\varepsilon_{t-1}^2 + \alpha_1\theta_1\varepsilon_{t-2}^2 + \alpha_1\theta_1^2\varepsilon_{t-3}^2 + \cdots + \alpha_1\theta_1^{\infty-1}\varepsilon_{t-\infty}^2} \quad 3.5.5$$

Suppose

$$\text{Ɣ}_{\boldsymbol{0}} = \boldsymbol{\alpha_0\left(1 + \theta_1 + \theta_1^2 + \cdots + \theta_1^{\infty-1}\right) = \frac{\alpha_0}{1-\theta_1}} \qquad \boldsymbol{and} \quad 3.5.6$$

$$\text{Ɣ}_{\boldsymbol{j}} = \boldsymbol{\alpha_1\theta_1^{j-1}} \quad 3.5.7$$

where the restrictions are (where *j = 1, 2, …, ∞*)

When restrictions specified in equation (3.5.6 and 3.5.7) are substituted, then the $ARCH$ (∞)process is:

$$\boldsymbol{\sigma_t^2} = \text{Ɣ}_{\boldsymbol{0}} + \text{Ɣ}_{\boldsymbol{1}}\boldsymbol{\varepsilon_{t-1}^2} + \text{Ɣ}_{\boldsymbol{2}}\boldsymbol{\varepsilon_{t-2}^2} + \text{Ɣ}_{\boldsymbol{3}}\boldsymbol{\varepsilon_{t-3}^2} + \cdots + \text{Ɣ}_{\infty}\boldsymbol{\varepsilon_{t-\infty}^2} \quad 3.5.8$$

The GARCH(1, 1) order is only an estimate to a high-order ARCH process (since it implies restrictions on the coefficients).

A comprehensive GARCH specifications, which is the GARCH (p, q) model is written as:

$$\boldsymbol{\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + \cdots + \alpha_q\varepsilon_{t-q}^2 + \theta_1\sigma_{t-1}^2 + \theta_2\sigma_{t-2}^2 + \theta_p\sigma_{t-p}^2} \qquad 3.5.\ 9$$

$$\boldsymbol{\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_j\varepsilon_{t-i}^2 + \sum_{j=1}^{p} \theta_j\sigma_{t-j}^2} \qquad 3.5.\ 10$$

where, p is the number of lagged σ^2 terms and q is the number of lagged ε^2 terms.

For a comprehensive study on the ARCH/GARCH models, interested readers should see Bollerslev, Chou, & Kenneth, (1992); Bera & Higgins, (1993); Bollerslev, Engle, & Nelson, (1994).

3.5.2. Multivariate Framework

Dynamic interdependent variables are modelled with multivariate time series (MTS) as discussed in the literature.

Tsay (2005) considers a *N*-dimensional MTS as:

$$y_t = (y_{1t}, y_{2t}, \dots, y_{Nt})'$$

with available data on same moments at time t. The study stated that y_t series is *weakly-stationary* when its first moment and second moment are time invariant and that the mean-vector and covariance-matrix of a weakly-stationary series are particularly constant over-time. Tsay (2005) assumed a weakly stationary time series y_t and define the mean-vector as:

$$\boldsymbol{u = E(y_t) = \begin{bmatrix} E(y_{1t}) \\ \vdots \\ E(y_{Nt}) \end{bmatrix} = \begin{bmatrix} u_1 \\ \vdots \\ u_N \end{bmatrix} = constant} \qquad 3.5.\ 11$$

and variance-covariance matrix as:

$$\boldsymbol{\Gamma_0 = \Gamma_{ij}[E(y_t)] = E\left[(y_{it} - u)(y_{jt} - u)'\right] = \begin{bmatrix} var_{11} & cov_{12} & \cdots & cov_{1N} \\ cov_{21} & var_{22} & \cdots & cov_{2N} \\ \vdots & \vdots & \vdots & \vdots \\ cov_{N1} & cov_{N2} & \cdots & var_{NN} \end{bmatrix}}, \qquad 3.5.\ 12$$

u is the mean with a N-dimensioan vector containing unconditional expectations of $y_t's$ components. An expectation of each element of the joint distribution y_t, is taken. Γ_0 is a N

x N variance-covariance matrix with the main diagonal elements as variance of y_t and the minor diagonal elements as the covariances between y_{it} and y_{jt},Tsay (2005).

i. Multivariate GARCH Models

The univariate ARCH/GARCH models discussed earlier have been extended to accommodate multivariate GARCH (MGARCH) models. The MGARCH models have the ability to capture many salient features of market returns such as leverage effects[22] and volatility clustering, which cannot be captured with univariate ARCH/GARCH models (see Brooks, 2014). Recently, MGARCH models have been used to analyze volatility co-movements and spillover effects as well as identify the evidence of volatility spread across various markets (Li, 2007). According to Kim (2000), the common application of MGARCH models is found in the studies that investigate the relationship between volatilities and co-volatilities of several markets.

To consider a multivariate series $\{r_t\}_{t=1}^{T}$ of size K x 1, then;

$$\boldsymbol{r_t = \mu_t + a_t = \mu_t + H_t^{1/2}\epsilon_t} \qquad 3.5.13$$

where μ_t = E[$r_t|\mathcal{I}_{t-1}$] is the conditional mean vector given $\mathcal{I}_{t-1}$, the information up to time $t-1$ and

$$\boldsymbol{a_t = H_t^{1/2}\epsilon_t} \qquad 3.5.14$$

$H_t^{1/2}$ is a matrix of K x Kpositive definite such that H_t is the conditional covariance matrix of r_t,

$$Cov(r_t|\mathcal{I}_{t-1}) = Cov_{t-1}(r_t) = Cov_{t-1}(a_t)$$

$$= H_t^{1/2}Cov_{t-1}(\epsilon_t)(H_t^{1/2})'$$

$$= \boldsymbol{H_t} \qquad 3.5.15$$

[22] Given the same value, negative shocks have greater effect on their volatilities than positive shocks.

and ϵ_t is a K x 1 vector of shock of the series which is:

$$\epsilon_t = H_t^{\frac{1}{2}}(\theta)\, z_t$$

where K x 1 random vector z_t has its first two moments as:

$$\mathrm{E}[\epsilon_t] = 0$$

$$\boldsymbol{Cov}[\boldsymbol{\epsilon_t}] = \boldsymbol{\mathcal{J}K} \qquad 3.5.\ 16$$

where $\mathcal{J}K$ denotes the identity-matrix of order K.

Although, different MGARCH model specifications (regarding the H_t) have been used in the literature, but the most widely used of them are the vector GARCH (VEC) model and the BEKK model. Each of the models is discussed in the subsequent sub-section together with their advantages and disadvantages.

a. The VEC Model

The first MGARCH model known as VEC model was proposed by Bollerslev, Engle, & Wooldridge, (1988). The model is considerably general model compared to other subsequent specifications. The elements of H_t (conditional variances and covariances) in the VEC model are linear functions of each lagged conditional variance and covariance as well as lagged square errors and cross-products of errors. Definition of the general MGARCH (*p*,*q*) model is presented in Bauwens, Laurent, & Rombouts, (2006) as:

$$h_t = C + \sum_{j=1}^{q} A_j(\eta_{t-1}) + \sum_{j=1}^{p} G_j(h_{\mathrm{t-j}}) \qquad 3.5.17$$

where

$$h_t = vec(H_t) \qquad 3.5.18$$

$$\eta_t = vec(\epsilon_\mathrm{t}\, \epsilon_\mathrm{t}{}') \qquad 3.5.19$$

$vec(\cdot)$ is the operator, which stacks the columns of the lower triangular part of a K x K matrix as $\frac{K(K+1)}{2}$ x 1 vector:

$$vec(H_t) = (\sigma_{11t}, \sigma_{21t}, \dots, \sigma_{K1t}, \sigma_{12t}, \sigma_{22t}, \dots, \sigma_{KKt})$$

H_t is the residuals' covariance matrix, K is the number of variables, t is index of t^{th} observation, c is a $\frac{(K+1)K}{2}$ x 1 vector, A_j and G_j are $\frac{(K+1)K}{2}$x$\frac{(K+1)K}{2}$ parameter matrices and ϵ_t is a Kx1 vector.

A useful property of the model as presented in Bauwens, *et al* (2006) is:

$$VEC(AGC) = (C' \oplus A) VEC(G) \qquad 3.5.20$$

The condition that H_t should be positive definite is not restrictive for all t.

The major issue associated with unrestrictive VEC model in equation 3.5.17 is the large number of parameters, which is $(p+q)$x$\left(\frac{(K+1)K}{2}\right)^2 + \frac{(K+1)K}{2}$ (for example when K = 3, the number of estimated parameters is 78. According to Bauwens, *et al* (2006), the above analysis suggests that this model is only suitable for bivariate case in practice.

The over-parameterization in modelling VEC led to some assumptions being imposed in order to simplify the model. Thus, a diagonal VEC (DVEC) model was suggested by Bollerslev *et al*. (1988), where A and G matrices are required to be diagonal and consequently permit H_t to become positive definite for every t. Each of the elements h_{ijt} depends on its own lag alone and on the past values of $\epsilon_{it}\,\epsilon_{jt}$. The dependency results to reduction in parameters to $\frac{(K+5)K}{2}$ (for example, for K = 3, the number of estimated parameters is 12), Bauwens *et al* (2006). Inspite of the diagonality assumption, Bauwens *et al* (2006) opined that in practice, large scale systems are yet highly parameterized and still difficult to estimate.

b. The Diagonal VEC (DVEC) Model

The DVEC model is often used due to its simplification. All its variance and covariance terms are assumed to follow GARCH-type equation. The diagonal VEC model is in the form:

$$\mathrm{H_t} = C_0^* + \sum_{i=1}^{n} A_i^* \circledast (\epsilon_{\mathrm{t-i}}\, \epsilon_{t-i}') + \sum_{j=1}^{s} G_j^* \circledast \mathrm{H_{t-j}}\ , \qquad 3.5.21$$

n and s are non-negative integers, $\circledast$ is Hadamard product,[23] which according to Tsay (2005) is element by element matrix multiplication. Bauwens *et al.*, (2006) describe the asymmetric K x K matrices A_i^* and G_j^* as matrices of the relation:

$$A = diag[vec(A^*)]^2$$

$G = diag[vec(G^*)]$, and

C_0^* is given as $C = vec(C_0^*)$

According to Tsay, (2005), the model in equation 3.5.21 above is the DVEC (*n*,*s*). $\mathrm{H_t}$ would be the parameter matrices where only the lower parts of matrices would be parameterized and estimated. In the words of De Goeij & Marquering (2004), Silberberg & Pafka, (2001) affirm that the sufficient condition, which guarantees the positive definite covariance matrix $\mathrm{H_t}$ in equation 3.5.21 is that C_0^* must be positive definite while other coefficient matrices, A_i^* and G_j^* must be positive semidefinite. Every element in $\mathrm{H_t}$ depends on its own previous value alone and corresponding product term in $\epsilon_{\mathrm{t-1}}\, \epsilon_{t-i}'$. This means that every element present in a DVEC follows a GARCH (1,1) model.

The major shortcoming of the model is that despite the fact that it is simple, it might not yield a positive definite covariance-matrix. Ding & Engle , (2001) and Bauwens *et al*., (2006) assert that the simpler specification of DVEC model still restricts A^* and G^* matrices to be matrices of rank one. In addition, DVEC model does permit dynamic dependency among volatility series, Tsay (2005).

[23] Bauwens et al (2006) explained that $X \oplus Y$ with elementwise products $\mathrm{X_{ij}}$ x $\mathrm{Y_{ij}}$ when $X = (\mathrm{x_{ij}})$ and $Y = (\mathrm{y_{ij}})$ are both m X n matrices

c. The BEKK Model

Positive definiteness is required for all the values of disturbances in $\mathrm{H_t}$ in order to secure a plausible MGARCH model. Meanwhile, to confirm whether the condition of positive definite holds in both VEC and DVEC models, which even have moderate sizes, has been challenging. Therefore, due to the difficulty of ensuring positivity of $\mathrm{H_t}$ in VEC specification without strong parameter restrictions, Engle & Kroner, (1995) proposed the quadratic specification of the parameters that guaranteed positive definiteness for $\mathrm{H_t}$, which is known as BEKK model. BEKK is an acronym from the multivariate models employed by Baba, Engle, Kraft, & Kroner, (1990) (see Brooks, Burke, & Persand, 2003; Bauwens *et al*., 2006).

The BEKK is a special case of the VEC, hence, it is less general. By construction, BEKK has an attractive property which ensures positive definite of the conditional covariance matrices. Definition of the general structure of the BEKK model is presented in Tanattrin (2015) as:

$$H_t = C_0'C_0 + \sum_{j=1}^{q}\sum_{K=1}^{K} A_{kj}\epsilon_{\mathrm{t-j}}\,\epsilon'_{\mathrm{t-j}}\,A_{kj}' + \sum_{j=1}^{p}\sum_{K=1}^{K} G_{kj}H_{\mathrm{t-j}}\,G_{kj}' \qquad 3.5.22$$

A_{kj}, G_{kj} and C_0 are N x N matrices of parameters while C_0 is the lower triangular matrix. The symmetric parameterization in the BEKK model, which is provided by decomposition of the constant (C_0) into product of two matrices, ensures that H_t is mostly a sure positive definite, Tsay (2005). However, Tanattrin (2015) explained that identification problem will occur in the system if $K > 1$ because there is no single parameterization that could obtain the same model representation. As discussed by Hafner & Herwartz (2006), the BEKK specification in equation 3.5.22 is the special case of equation 3.5.17.

Regarding covariances stationarity in the BEKK model, Engle and Kroner (1995) affirmed that the condition for covariance stationarity in the BEKK is that the representative roots of:

$$\sum_{j=1}^{q}\sum_{K=1}^{K}(A_{kj}\oplus A'_{kj})+\sum_{j=1}^{q}\sum_{K=1}^{K}(G_{kj}\oplus G'_{kj}),$$

which are the eigenvalues, must be less than unity in modulus. Therefore, even if an element in the matrix has a value that is greater than one, the process could still render stationary. Pang & Gannon, (2002) further explained that this is a different condition from stationarity condition in the univariate GARCH model in which the total sum of ARCH and GARCH terms must be less than unity.

Bauwens, *et al* (2006) define a BEKK(1,1,K) model as:

$$H_t = C^*C^{*\prime} + \sum_{K=1}^{K} A_k^*\epsilon_{t-1}\,\epsilon'_{t-1}\,A_k^{*\prime} + \sum_{K=1}^{K} G_k^* H_{t-1} G_k^{*\prime} \qquad 3.5.23$$

A_k^*, G_k^* and C^* are N x N matrices of parameters while C^* is the upper triangular matrix. C^* x C^* can equally be written as $\Omega > 0$. The generality of the BEKK process is determined by summation limit, K. Bauwens (2005) confirms that the parameters in the BEKK are 11 compared to 21 in the VEC. Although, Tsay (2005) affirms that the BEKK permits dynamic dependency among volatility series, Bauwens, *et al* (2006) observe that the parameters in the BEKK do not directly represent the impact of different lagged values on elements of H_t as represented in VEC model.

BEKK model estimation still possesses large computation as a result of numerous matrix transpositions. The total parameters in BEKK model is $(p+q)KN^2\frac{(N+1)N}{2}$. In order to reduce the number of parameters and consequently reduce its generality, a diagonal BEKK model could be imposed where A_k^*, and G_k^* in equation 3.5.23 becomes diagonal matrices.

d. The Diagonal BEKK (DBEKK) Model

According to Bauwens (2005) and Franke, Härdle, & Hafner, (2015), when A_k^*, and G_k^* are taken as diagonal matrices, the BEKK model becomes a restricted form of VEC with diagonal matrices. The DBEKK is therefore given as equations 3.5.24 to 3.5.26:

$$\sigma_{11,t} = c_{11}^2 + a_{11}^2 \epsilon_{1.t-1}^2 + g_{11}^2 \sigma_{11,t-1} \quad 3.5.24$$

$$\sigma_{22,t} = c_{11}^2 + c_{22}^2 + a_{22}^2 \epsilon_{2.t-1}^2 + g_{22}^2 \sigma_{22,t-1} \quad 3.5.25$$

$$\sigma_{12,t} = \sigma_{21,t} = c_{11}c_{22} + a_{11}a_{22}\epsilon_{1,t-1}\epsilon_{2,t-1} + g_{11}g_{22}\sigma_{12,t-1} \quad 3.5.26$$

DBEKK exhibits mostly the same difficulties possessed in the full BEKK as none of the parameters in any of the equations absolutely directs any particular covariance equation. This implies that It is may not be clear if the parameters for a_{12} is only the result of the parameter for a_{11} and a_{22} estimates or whether the covariance equation has altered the variance equations' parameter estimates. In addition, the DBEKK may be misspecified because it is not quite flexible. This is argued by Baum (2004) that when another degree of persistence other than volatility is exhibited in the covariance, then, either volatility or covariance process will be misspecified.

DBEKK is a less generalized form of a DVEC model but it ensures positive definiteness of the H_t while DVEC does not. However, even though the total parameters in the DBEKK model is $(p+q)KN\frac{(N+1)N}{2}$, yet it is a large representation. According to Bauwens, *et al* (2006), DVEC contains 9 parameters for bivariate model while DBEKK contains only 7 parameters.

The scalar BEKK (SBEKK) model has been described in Bauwens (2005) as:

$$A_K = a_K \text{ x } U, G_K = g_K \text{ x } U$$

where a and g scalars and U represent matrix of ones.

According to Bauwens (2005), a BEKK model can be a representation of VEC model. For example, given a BEKK(1,1,1) model, $H_t = \Omega + A'\epsilon_{t-1}\epsilon'_{t-1}A + GH_{t-1}G'$, a VEC model can be written (subject to constraints) by using equation 3.5.20:

$$VEC(H_t) = VEC(\Omega) + (A \oplus A)'VEC(\epsilon_{t-1}\epsilon'_{t-1}) + (G \oplus G)'VEC(H_{t-1}) \quad 3.5.27$$

Hence, Bauwens (2005) asserts that the BEKK is weakly stationary when eigenvalues of $(A \oplus A) + (G \oplus G)$ are less than unity in modulus, and therefore

$$VEC(H) = (I_{N^2} - (A \oplus A)' - (G \oplus G)')^{-1} VEC(\Omega) \qquad 3.5.28$$

The classical Maximum Likelihood (ML) method is the main approach to estimate the GARCH models as presented in Bauwens *et al*. (2006).

ii. The comparative analysis of the MGARCH Models

Estimating either a VEC or BEKK model has been characterized with high unknown parameters. Several restrictions imposed have only help reasonably. This is the major reason why the models are hardly used for any series that is more than four, Bauwens *et al.* (2006). The higher the number of stocks used in the model, the more and quickly infeasible the VEC model estimation. This made Bollerslev *et al* (1988) proposed the DVEC model where the A and G matrices become diagonal in order to lessen total number of the parameters.

According to Bauwens (2005), each variance $\sigma_{ii,t}$ only depends on its own previous squared error $\epsilon_{i,t-1}^2$ as well as its own lag $\sigma_{ii,t-1}$ while each covariance $\sigma_{ij,t}$ only depends on its own previous cross products of errors $\epsilon_{i,t-1}\epsilon_{j,t-1}$ as well as its own lag. This decreases the total number of estimated parameters to 9 from 21 for bivariate case and 18 from 78 when $N = 3$. Brooks (2014) and Bauwens (2005) stated that the reduction in the parameter is restrictive and suggest that there will be no spillover effect.

Franke *et al*. (2005) observe that the BEKK model permit conditional variances dependence of a variable on another variable's lagged values. Therefore, Franke *et al*. affirm that variances' causalities can be modelled. The study further stresses that there is an equivalent VEC presentation for each of the BEKK model, but not vice-versa. This implies that the BEKK is the special case of VEC, Franke *et al*. (2005).

Bauwens *et al* (2006) emphasized that modelling in MGARCH should provide a flexible but parsimonious variance matrix specification in order to guarantee its positivity. A trade-off has been analyzed in the study for flexibility and parsimony. BEKK models are observed to be flexible but require voluminous parameters for multiple time-series, which number is above four elements. DVEC and DBEKK models are more parsimonious, but they are too restrictive for cross dynamics. Therefore, they become unsuitable if volatility transmission is of utmost interest, although, Bauwens *et al* confirm that the models are good for variances-covariances' dynamics representation.

a. Advantages and Disadvantages of MGARCH-Type

The major and obvious disadvantage of multivariate method is that total number of estimated parameters in the GARCH system increases rapidly, thereby reducing the number of variables that could be considered in the model. De Goeij *et al.* (2004) suggested that some restrictions have to be imposed on A and G if the estimated parameters should reduce without lowering the model's explanatory power significantly.

The major shortcoming of the VEC is that it could not ensure that the covariance matrix is positive semi-definite. Meanwhile, a correlation or variance-covariance matrix should be positive semi-definite at all times. The implication of this among other things is that variance-covariance matrix must have positive numbers along the principal diagonal and should be symmetric across this principal diagonal, Brooks (2014).

When the model is diagonalized, then its dynamic dependence is constrained, and may introduce biasness into the estimates of other parameters. According to Tse (2000), a major advantage of the DVEC model specification is in its ability to retain the intuition that GARCH model is found to be successful.

The major advantage of BEKK model is in its ability to always guarantee positive definiteness of the conditional variance matrices. This happens to be a significant advantage especially for studies relating to simulation studies, Tse (2000). BEKK model also permits dynamic dependence among the volatility series.

However, the major disadvantage of BEKK model is that the parameters in A_{Ki} and G_{Ki} has no direct interpretations on the shocks or volatilities lagged values. Another disadvantage associated with the use of BEKK model is that number of parameters used, which is $\frac{N^2(p+q)+N(N+1)}{2}$, quickly increases with p and q. According to Tsay (2005), many of the parameter estimates that introduced complications in modelling are statistically insignificant. To overcome these challenges, this study employs the volatility impulse response functions (VIRFs) to provide direct interpretation for the dynamic relationship in the model.

Despite its challenges, most studies have used the BEKK model in which the conditional variance and covariance matrices are positive semi-definite, (see Karunanayake, Valadkhani, & O'Brien, 2010). This view is supported by Boussama, Fuchs, & Stelzer, (2011) that the BEKK model is practically the most common MGARCH model existing.

Among other things, modelling of MGARCH models is challenging because the structure of the model has to be parsimonious and yet flexible. Also, positive definiteness of the conditional variances-covariance matrix should be guaranteed always. Finally, the vector-GARCH process ϵ_t should be stationary (Deistler, 2006).

3.6 Conclusion

In summary, this chapter surveyed and reviewed the theoretical literature on the factors that contribute to ERV. The monetary (flexible price and stick price) models of ERV determination were first considered. Although, there is lack of uniformity in the results from the several studies reviewed, yet, this study concludes that recent work has rekindled hope in the capability of the monetary model in explaining exchange rate movements.

This chapter also examines the brief theoretical properties and background of the estimation techniques (MGARCH) to be employed in the empirical analysis for exchange rate volatility model. The section is included in this chapter because it reveals how dynamic method of analysis is used to overcome the methodological issues inherent in the previous studies as considered in this chapter.

In reviewing the existing literature on the factors that contribute to ERV, this thesis identifies suitable methodologies to be employed. Specifically, there is need to deal with some methodological issues. This is important to improve the validity of this study. In addition, this provides new evidence for the factors that drive exchange rate volatility in the Nigeria overtime. Therefore, this study will;

- Employ historical and random shocks in the sample as applicable to the Nigerian economy in determining exchange rate volatility. This is reviewed in chapter two that unstable political regimes are associated with the volatile exchange rate series.
- Apply a suitable multivariate GARCH analysis to be able to incorporate the variances and covariances of the potential determinants of exchange rate volatility.
- Employ the Volatility Impulse Response Functions (VIRFs) to examine the dynamic impact of the structural shift shock on volatilities. This is a similar approach to Hafner & Herwartz (2006). The volatility impulse response (VIR) analysis is employed to overcome the shortcomings in the BEKK MGARCH modelling.

In conclusion, this study first finds that most of the previous studies on developing countries, especially Nigeria ignored decomposition of exchange rate volatility determinants into monetary and real factors. This study notes that decomposing the determinants of exchange rate volatility helps to identify the sources of exchange rate movement and design appropriate policy response. This study finds that most of the earlier studies on Nigeria are restricted to the conventional (flexible price and sticky price) exchange rate volatility model. The earlier studies found that monetary (interest rate and money supply) shocks mainly influence ERV ignoring the effect of real (productivity growth and oil price) shocks in the exchange rate volatility.

However, monetary factors alone may not have comprehensive intuition about the determination of exchange rate volatility. To fill this gap in the literature, this study incorporates the non-monetary (real) factors to the determination of ERV and thus, provides empirical explanation to an all-inclusive exchange rate volatility model. According to the new open economy macroeconomics, the real shocks, such as productivity shocks among others should be included in the models of exchange rate determination in addition to monetary shocks. This study considers this important because shocks to business cycles arising from unstable political system and production affect variations in exchange rate in Nigeria overtime.

Secondly, inspite of the prominent role of oil price (demand and supply) in Nigeria, most studies on Nigeria failed to incorporate oil price in their models. This suggests that an important part of the exchange rate volatility model in Nigeria has been neglected overtime. Thus, to fill the gap, this study proposes an exchange rate volatility model, which recognizes the effect of oil price in the determination of exchange rate volatility in Nigeria.

Thirdly, this study finds that there are restrictions to most of the analysis in the previous studies due to their methods of analysis. The past studies neither focus on complete set of determinants of exchange rate volatility nor incorporate the covariances of the potential determinants of exchange rate volatility in their investigations. To fill this gap in the literature, this study overcome the restriction by employing different technique, which is capable of modelling the conditional variance, or volatility, of the employed variable. Fourthly, this study differs from past literature on determinants of exchange rate volatility by examining the dynamic impact of the structural shift shock on volatilities. This is particularly important for developing countries, especially Nigeria where structural shocks like unstable political system distorts the overall economy.

Following the theoretical and empirical survey of the factors that drive exchange rate volatility, especially in the developing country, chapter four reviews the trade effect of exchange rate volatility. The exchange rate volatility derived from interest rate, productivity growth and oil price as suggested in this chapter are employed to investigate the trade effect of exchange rate volatility in chapter four using the dynamic method of analysis examined earlier. Meanwhile, chapter five discusses the research methodologies for the study where the above summarized methodological issues are empirically considered with reference to Nigerian economy data series. This is to provide a new insight to the investigation of the determinants of exchange rate volatility as to be examined in chapter six.

CHAPTER FOUR: TRADE EFFECT OF EXCHANGE RATE VOLATILITY: A LITERATURE SURVEY

4.1 Introduction

In chapter three, this study examines the theoretical and past emprical studies on determination of exchange rate volatility. Since this thesis employs the general equilibrium trade model to investigate the relationship between exchange rate volatility and export demand in Nigeria, it became important in chapter three to examine the determination of exchange rate volatility that is appropriate for such general equilibrium trade model. Chapter three is therefore important to this study because the exchange rate volatiliy derived from shocks to volatilities in interest rate, productivity growth rate and oil price are used to model the relationship between exchange rate volatility and export demand as to be considered in this chapter. This chapter therefore depends on chapter three because this thesis focuses on the general equilibrium analysis, where exchange rate volatility derived from BEKK in chapter three is employed to investigate the relationship between exchange rate volatility and export demand in Nigeria.

The key objective of this chapter is to evaluate and review the theoretical and empirical literatures on the trade effect of exchange rate volatility (ERV). The focus of the chapter is to review literatures on how exchange rate volatility affects trade flows, especially in the developing countries, which may be considered as “law of one price”. This study gathers from chapter two that unstable exchange rate could deteriorate export. For example, the official exchange rate continues to depreciate from a minimum of ₦0.55/$1 in 1971 to a maximum value of ₦160/$1 in 2013. On the other hand, percentage change of average total export demand decreased from 79.46 in 1986 to 20.97 in 2012 (see details in table 2.1).

Given the Nigerian economic situation regarding the importance of export demand, this study examines another objective, which is to investigate the direction and timing of the effect of the exchange rate volatility on export demand in Nigeria between 1986 and 2013. The investigation of the direction and timing of the effect is motivated by historical shocks and events as discussed in chapter two.

The economic effects of exchange rate fluctuations are found in the past literatures to differ markedly across countries and regions. For example, Krugman (1989) noted that the effects have generally been less pronounced in industrialized countries than in developing countries. One reason for these regional differences may be that forward coverage to hedge against exchange risk is generally available for OECD currencies but not for the currencies of developing countries.

Another possible explanation is derived from (Inter-American Development Bank, 1995), which noted that real exchange rates have been highly unstable in many developing countries as a result of unsustainable macroeconomic policies in the past. The unsustainable policies raise an important policy issue for those countries that seek to promote growth and development through greater outward orientation. If the trade effects of exchange rate volatility are negative and economically significant, then any policy package designed to enhance outward-orientation and promote international trade should include specific measures that stabilize real exchange rates over time. Thus, this study carefully considers the factors that contribute to volatility of exchange rate in chapter three with empirical application to Nigeria in chapter six. Subsequently, this chapter investigates the impact of exchange rate volatility on export with empirical application to Nigeria in chapter seven. That is, this study examines the significance of exchange rate volatility on foreign trade in Nigeria.

Based on the non-uniformity and ambiguity of findings in the literature (to be discussed later), this thesis decides to follow the broader hypothesis on the relationship between ERV and trade flows. The broader relationship is followed because the hypothesis permits investigation of not only the effect of ERV on trade, but also estimates the effect of causes of ERV as well as other macroeconomic variables on trade. To this end, this study examines monetary and real factors contributing to ERV in the relationship between ERV and trade as discussed in the past studies and provides empirical analysis in the context of Nigerian economy. The empirical analysis is important for Nigeria because all countries do not follow the same exchange rate policies as different shocks dominate other shocks in different countries (Brada, 1998).

The rest of this chapter is structured as follows; section two reviews the theories relating to models of the impact of ERV on trade with special attention to the partial equilibrium theory (PET) and the general equilibrium theory (GET). Section three examines the effect of exchange rate volatility on trade with attention to its positive and negative impact as hypothesized by previous studies. Section four evaluates past empirical studies regarding the effects of exchange rate volatility on trade.

Section five considers the fundamentals of trade flow. The section specifically assesses the issues emanating from employing different forms of trade flows by examining studies on aggregate trade flow, bilateral trade flow and sectoral trade flow. Section six discusses the issues relating to the choice of trade models. The section details the long run export demand trade model and the gravity model. Section seven evaluates the different econometric methods employed by the empirical studies considered. The section specifically examines the time series estimation techniques, panel data techniques and the endogeneity characteristics of ERV. Section eight concludes the chapter with special attention to the important methodological issues that can augment the validity of this study. Effective attention to the methodological issues helps to provide innovative evidences of the impact of ERV on the sectoral exports of Nigerian economy.

4.2 Theories on the Relationship between ERV and Trade Flow

There are numerous theories developed to describe the channel through which ERV affects trade. These propounded theories had been generally classified into two channels as partial equilibrium and general equilibrium theories. A critical survey of the theoretical contributions in the literature regarding the relationship between exchange rate volatility and trade flows is carried out in this chapter.

Earlier studies embrace the partial equilibrium structure with much focus on the risk and option theory. The framework assumed that exchange rate is the sole changing variable and that other factors influencing trade remain constant. On the other hand, modern literature employs general equilibrium structure that focuses on the linkage of the major macroeconomic variables that contribute to exchange rate volatility in providing more comprehensive picture of relationship between exchange rate volatility and trade.

4.2.1 The Partial Equilibrium Theory

The earliest theoretical models of ERV and trade centre on the partial equilibrium (PE) framework in which the ER is the only changing variable while other factors influencing trade are presumed to be constant. As expressed by Côté (1994), the relationship that exists between ERV and trade in the framework therefore depends on the structure of market, presence of adjustment costs, attitudes to risk, hedging opportunities, and accessibility of domestic market.

Many models have affirmed that ERV have negative effect on the trade flow using the partial equilibrium analysis. For instance, Chit, Rizov, & Willenbockel (2010) explained that an increased ERV is expected to raise uncertainty of the gains from export in the foreign currency. As a result of this, the risk-averse exporters therefore reduce supply of exports. The negative effect of ERV rises with the level of the risk aversion by the traders.

On the other hand, other theoretical models demonstrated that a greater increase in ERV might have a direct effect on the trade volume. The models under this category centre mostly on profit opportunities that are created through higher ERV. In these models, exporting is viewed as an option exercised on favourable conditions.[24] This implies that when there is upsurge in ER variability, the possibility of getting more profit increases. Thus, a rise in ERV might lead to a positive effect on the trade volume. However, the unambiguous propositions above are the outcomes of the limiting assumptions upon which various theoretical models are established.

The most popular form of partial equilibrium model is the study by Hooper & Kohlhagen (1978) hereafter refers to as HK. The model analysed the effect of ERV on bilateral trade between United States (US) and Germany as well as with some other industrial economy. The model is a partial equilibrium model, which assumed that change in trade is mainly caused by ERV. Thus, the model determined direct impact of the volatility on volume and price of trade. HK examined the impact of ER risk on the equilibrium prices and traded goods volume. The study modelled different risk bearing agents in the market using a bilateral framework. Unlike the other earlier models, the model focuses on both sides of the market (demand and supply). As a result, the study allowed for differences in risk preferences between importers and exporters, and therefore it is able to analyse the effect of exchange risk on both prices and quantities of trade.

HK assumed that some proportion of the contract is denominated in the foreign currency and a fraction of foreign currency is hedged, in the forward market. Hence, the only source of volatility arises from unhedged foreign currency. In the analytical model, the relative risk preference of agents, the currency denomination of contracts, and the proportion of forward hedging are vital parameters in determining the impact of ERV on

[24] Option pricing is the theory that shows that option value increases when the variability in fundamental asset increases.

the prices and volume of trade. With the assumption that importers and exporters maximize their utility, which is increasing function of expected profits and decreasing function of the standard deviation of the profits, HK demonstrated that an increase in ERV, *ceteris paribus*, will reduce the volume of trade.

The model assumed that increase in ERV reduces trade volume, if firms are risk-averse. This condition holds irrespective of the agent (whether exporting or importing firm) that bears the risk. However, the price is affected in a different way depending on the agent that bears the risk. The price falls as import demand reduces if the importing firm bears the risk. On the other hand, the price increases as exporter charges higher risk premium if the exporting firm bears the risk. When ERV increases, imports and market prices fall *ceteris paribus*.

The model shows that the higher risk averse the importers the lower the import demand, thereby shifts price of foreign currency downward. In the same way, the higher risk averse the exporters, the lower the export supplied with higher price being the risk premium. On the contrary, the higher risk averse the importers or exporters, the lower the volume of trade. The above models show that the negative effect of ERV on trade is due to agent's risk aversion. This means that ER volatility will have no effect on the decision of the firm assuming the agent is risk neutral.

On the other hand, Deilas & Zilberfarb (1993) showed that increase in ERV increases or decreases trade (investment) depending on the nature of the risk aversion parameter of the model. If the coefficient of relative risk aversion is assumed to be less than unity (that is, if profit function is convex) then a rise in risk reduces total exports. However, if profit function is expected to be concave (that is, large value of risk aversion), then it may not be ruled out that ER volatility is associated with trade growth. This implies that higher insecurity leads high risk aversion agents to put more assets in exports in order to be protected against consumption of very low imported products in the future.

To support this, McKenzie & Brooks (1997) formulated a simple trade model, which follows the partial equilibrium theory. The model proposes that a positive relationship exists between ERV and trade. However, after the empirical investigation, McKenzie and Brooks found a negative relationship between ERV and trade flows in German bilateral trade with the US.

According to McKenzie and Brooks, trade is determined by income, price level, and exchange rate and volatility. The model expected the trade flow between the two countries to rise as incomes rise while a rise in domestic prices will reduce trade flow in a less competitive exporting activity. A depreciated exchange rate is also expected to increase exports due to relative price effects. Finally, the model suggests that exchange rate volatility in Germany could impact positively on trade flows.

The partial equilibrium theory has been criticised by the general equilibrium theory. Clark, Tamirisa &Wei (2004) argued that the theoretical models of PET suffer a major weakness because of the assumption that factors that might influence ERV are ignored in examining the relationship between ERV and trade, which means all the factors remain constant as a nature of PET framework. In the words of Clark *et al* (2004), partial models overlook the dynamism relating to the relationship between ERV and trade, also disregard the point that macro economy fluctuations are likely to affect ER and thereby influence demand and/or cash flow task.

4.2.2 The General Equilibrium Theories

Due of the limitations of the partial equilibrium theories, neoclassical trade models employ general equilibrium approach to explain the channel through which ERV affects trade. The main problem with the classical models according to Sercu & Uppal (2003), is the assumption that Commodity Price Parity (CPP) holds for all goods and at all times. General equilibrium models, however, allow for deviations from CPP and changes in real exchange rates. Therefore, it is a question of what causes exchange rate to be volatile that explains the link between exchange rate and trade.

General equilibrium models are founded on the new open economy macroeconomics that combines the impact of the market structure or trade, inflexibilities and intertemporal decision making. The use of the model provides intuition to the relationship between exchange rate volatility and trade by taking into account the response of other macroeconomic variables to variations in exchange rate. It highlights a more complete picture of the relationship between exchange rate volatility and trade (Chit, Rizov & Willenbockel, 2010). In the general-equilibrium framework, the factors that drive exchange rate can lead to changes in other macroeconomic variables. For instance, depreciation in a home country's currency as a result of monetary expansion leads to higher export price and reduces exports. However, higher supply through monetary expansion could offset part or all of the effect of exchange rate depreciation.

Many studies advanced that the GET endogenizes ERV so much that the better perception of the relationship between ERV and trade could be added in the framework (see Barkoulas, Baum & Caglayan (2002), Sercu & Uppal (2003), Clark *et al* (2004), Chit *et* al. (2010) among others). The better perception of the relationship is captured by the GET framework because exchange rate volatility contains the effect of the other macro-economic variables in explaining the relationship between ERV and trade.

For instance, Sercu and Uppal (2003) develop a general equilibrium stochastic endowments economy in which exchange rate and the prices of financial securities are determined endogenously. The study found that, in this general equilibrium setting, impact of exchange rate volatility on international trade may be positive or negative, depending on the source underlying the increase in ERV. If the exchange rate volatility is caused by increase in the volatility of endowments, the expected volume of trade will increase. On the other hand, if higher costs to international trade boost the volatility of the exchange rate, it will decrease trade.

Barkoulas, Baum & Caglayan (2002) examined the impacts of exchange rate on the trade flow volume and variability using a signal extraction framework. The model showed that volatility in exchange rate originates from general microstructure shocks, fundamentals that drive exchange rate process or policy innovation noisy signal. The model suggests that the direction and magnitude of risk-averse agents' optimal trading activities depend upon the source of the volatility. Also, the model showed that agents have no perfect information about the behaviour of future exchange rate in a flexible exchange rate regime since exchange rates are subject to a number of shocks. However, agents use all available past information and a noisy signal about future policies for optimal prediction of future spot rates.

The study showed that an increase in the variance of the general microstructure shock in the exchange rate process arising from the effects of excess speculation, bubbles and rumours, bandwagon effects, or the effects of technical trading by chartists and "noise traders" reduces the volumes of imports and exports. Conversely, the impact of a rise in the variance of stochastic elements of the fundamentals motivating ER process as well as the variance of the signal noise relating to trade flows' future policies remained ambiguous in the model On the trade effect, the model shows that a rise in the variability of microstructure shocks reduces trade, however, volatility in the forces and noise process of ER have no clear impact on trade.

However, Polodoo, Seetanah & Sannassee (2016) had varied views of the impact of ERV on trade using general equilibrium analysis. The study noted that the causes of ERV explain the relationship between ER and trade. The study demonstrated that shipping costs reduction may lead to a decrease in ERV, which is likely to improve trade flows. Likewise, a rise in shipping costs may lead to a rise in ERV, which is likely to depress trade flow. In the same vein, there is increase in ERV from shock to risks linked with output in the economy. The increase in exchange rate volatility raises the proposed trade flow because economic agents are likely to react in trading more with volatility.

Compared with partial equilibrium analysis, theoretical models based on general equilibrium analysis improve the understanding of the relationship between ERV and trade to a certain extent. General equilibrium models have the advantage of considering the other aspects of economic environment affected by developments in fundamentals that generate the ER movements and interaction among them. In a general equilibrium framework, there is no clear relationship between ERV and trade. It depends on the interaction of consumers' preferences and the correlation between the money supply and other sources of shocks, such as fiscal and technology shocks (Bacchetta & van Wincoop, 1998; 2000). So, the utilization of monetary policy for stabilizing an economy is crucial in determining the relationship. This proposition means that credibility of monetary policy is important for developing economy. For countries with a historical shocks and event, the impact of ERV is likely to be more pronounced.

4.3 Empirical Literature Review

4.3.1 Impact of Exchange Rate Volatility on Trade Flows

Having assessed the theoretical literatures on the impact of exchange rate volatility (ERV) on trade, it is clear that the impact of ERV on trade is far from being conclusive theoretically. The implication of this is that magnitude as well as nature of the relationship between ERV and trade flow becomes an important empirical issue. Several studies have tried to examine and quantify the impacts of ERV on trade flow with differs conclusions. Thus, empirical evidence of this relationship is as inconclusive as the theoretical propositions. According to (Sauer & Bohara, 2001), there is currently no clear consensus on the nature and the importance of the relationship between exchange rate volatility and trade.

The lack of a clear and consistent pattern of results make a number of issues apparent empirical investigation evolved. An overview of how existing empirical studies have attempted to deal with these issues and a summary of their findings are presented in table 4.1. Twenty-five (25) of the studies focus on developed and advanced economies, while sixteen of them are on developing and emerging economies. It reveals that about 43% of the studies which focus the developed economies found negative impact of exchange rate volatility on trade. In contrast, about 60% of studies which examined the developing and emerging economies prove that ERV has a significant negative impact on exports. This study found that the combination of economic differences and the techniques of analysis may be responsible for the inconsistency in the literature.

Table 4. 1: Summary of main features and results for the empirical studies

Author(s) (year)	Countries	Sample Period	Trade Flow – Dependent Variable	Measures(s) of ERV	Type of ER	Model Specification(s)	Estimation Techniques	Overall Results
Hooper & Kohlhagen (1978)	US and Germany	1965 - 1975 (quarterly)	Multilateral and bilateral export and import with UK, France and Japan	Average absolute differences between current spot and previous forward rates	Nominal	$X = f(UC, UC^f, P, Y, CU, S, V)$	OLS	No significant impact on the volume of trade
Bahmani-Oskooee (2002)	Iran	1959 – 1989 (annual)	Aggregate export and import (non-oil export)	SD of the percentage change in ER	Black market ER	$M_t = f(Y_t, E_t, V_t, T)$ $X_t = f\left(Y_t^*, E_{t,} V_t, T\right)$	Johansen's cointegratio n	Significant negative impact on import and non-oil export
Dognalar (2002)	Malaysia, Pakistan, South Korea, Indonesia and Turkey	1980 – 1996 (quarterly)	Aggregate export	MASD of ER growth rate	Real	$X_t = f(RP_t, Y_t^*, V_t)$	Engle-Granger cointegratio n ECM	Significant negative effect
Arize, Osang & Slottje (2003)	Ten developing	1973 – 1998 (quarterly)	Aggregate export	MASD	Real effective	$X_t = f\left(Y_t^*, RP_{t,} V_t\right)$	Johansen's cointegratio n ECM	Significant negative effect except South Africa

Bénassy-Quéré & Lahrèche-Révil (2003)	Ten East Asian	1984 – 2001 (quarterly)	Bilateral export - 23 economies	Standard Deviation (SD)	Real	Gravity model	Fixed effect Panel OLS	Negative effect
Bredin, Fountas & Murphy (2003)	Ireland	1978 – 2000 (quarterly)	Sectoral export to the EU countries	MASD	Real effective	$X_t = f\left(Y_t^*, RP_{t,}V_t\right)$	Johansen ECM	Long run posi-tive effect. No short run impact
Grube & Samanta (2003)	Mexico	1980 – 2000 (quarterly)	Aggregate export and import	SD	Real	$X_t = f\left(Y_t^*, E_{t,}V_t\right)$ $M_t = f(Y_t, E_t, V_t)$	OLS	Significant negative impact on volume of import
Baum, Caglayan & Ozkan (2004)	Thirteen industrialize d countries	1990 – 1998 (monthly)	Bilateral export	AR(2) forecast based on previous monthly volatilities from daily data	Real	$X_t = f\left(\begin{matrix} Y_t^*, E_t, V_t, Y^*V_t \\ [V_t X Y^* V_t], ERM_t \end{matrix}\right)$	Non-linear least square	Positive effect on the average
Clark *et al.* (2004)	One hundred and seventy-six countries	1975 – 2000	Aggregate, Disaggregate and Bilateral	SD of monthly differenced GARCH	NEER and REER Bilateral	Gravity model	Fixed and random effect Panel analysis	No significant effect

De Vita & Abbott (2004a)	UK	1993 – 2001 (monthly)	Aggregate and sectoral volume of export to fourteen EU countries	1. MASD 2. ARCH	Real and nominal	$X_t = f(RP_t, Y_t^*, V_t)$	ARDL bound ECM	Significant long run volatility effect. No short run effect on trade.
De Vita & Abbott (2004b)	US	1987 – 2001 (quarterly)	Total Export to Germany, Japan, Canada, Mexico and UK	MASD – level of ER	Real	$X_t = f(RP_t, Y_t^*, V_t)$	ARDL bound ECM	Negative effect on export to Mexico, UK and Japan. Significant positive effect on export to Germany
Poon *et al*. (2005)	5 East Asian countries	1973 - 2002	Aggregate export	MASD	Real effective	$X_t = f\left(Y_t^*, E_{t,} V_t, TOT\right)$	VAR - ECM	Significant negative effect except for Singapore
Byrne, Darby & MacDonald (2008)	European export to US bilateral trade	1989 – 2001 (annual)	Sectoral export and import	Standard Deviation of the log first difference of bilateral ER	Nominal	$lnZ_{ijt} = f\begin{pmatrix} Y_{it}, RP_{ijt}, VOL_{jt}, \\ MPPP_{jt}, VOL_t \end{pmatrix}$	Instrumental Variable Static Fixed effect	Significant negative effect on differentiated goods but insignificant for homogenous goods

Tenreyro (2007)	One hundred and four countries	1970 – 1997 (annual)	Bilateral export	1. SD of monthly ER 2. Probability to peg common anchor	Nominal	$X_{ijt} = f\begin{pmatrix} Y_{it}Y_{jt}, N_{it}N_{jt}, DI_{ij} \\ V_t, BOR_{ij}, FT_{ij}, LG_{ij} \\ COL_{ij}, AR_i, AR_j, LL_{ij} \end{pmatrix}$	PML with IV	No significant effect with IV
Wang & Barrett (2007)	Taiwan export to US	1989 – 1998	Sectoral export	GARCH	Real	$X_t = f(RP_t, Y_t^*, V_t)$	FIML	No significant effect in most sectors but in agric. export
Arize *et al*. (2008)	Eight Latin American countries	1973 – 2004	Aggregate export	ARCH	Real effective	$X_t = f\left(Y_t^*, RP_{t,} V_t\right)$	Johansen's cointegratio n ECM	Short and long run negative effect

Chit *et al.* (2010)	ASEAN[25] members; trade among themselves and to 13 developed countries	1982 – 2006 (quarterly)	Bilateral export	GARCH 1. SD of first difference of ER. 2. The MASD of quarterly bi-lateral ER 3. Estimated conditional ERV	Real	Gravity model $X = f\begin{pmatrix} Y, Y^*, RP, VOL, \\ Dist, CB, AFTA \end{pmatrix}$	Fixed effect Panel OLS GMM-IV	Significant negative effect
Baum & Caglayan (2010)	Eurozone and other industrialized countries	1980 – 2006 (annual)	Bilateral Export and import	MGARCH-BEKK	Real	$X_t = f(s_t, y_t, \sigma^2_{st})$ $\sigma^2_{xt} = f(s_t, y_t, \sigma^2_{st})$	ARDL	No significant trade effect. Significant positive trade volatility effect
Bahmani-Oskooee & Bolhassani (2012)	US – Canada	1960 – 2006 (annual)	Disaggregated export and import	SD of 12 monthly real exchange rate	Real	$lnX^{US}_{i,t} = \begin{matrix} \alpha_i + \beta lnY^C_t + \gamma lnREX_t \\ +\delta lnV_t + \varepsilon_{i,t} \end{matrix}$ $lnM^{US}_{i,t} = \begin{matrix} \alpha'_i + \beta' lnY^{US}_t + \gamma' lnREX_t \\ +\delta' lnV_t + \varepsilon'_{i,t} \end{matrix}$	Bound testing co-integration	Significant negative effect in the short run

[25] Members of Association of South East Asian Nations (Indonesia, the Philippines, Malaysia, Thailand and Singapore)

Lubinga & Kiiza (2013)	Uganda – seven trading partners	1978 – 2012 (annual)	Bilateral trade	GARCH	Real	$lnbtrade = f\begin{pmatrix} lnExt_{gdp}, lnUg_{pop}, \\ lnExt_{pop}, lnUg_{pop}, \\ VolExch \end{pmatrix}$ $Volbtrade = f\begin{pmatrix} lnExt_{gdp}, lnUg_{pop}, \\ lnExt_{pop}, lnUg_{pop}, \\ VolExch \end{pmatrix}$	Panel data analysis	Significant negative effect
Kurihara (2013)	Developed and developing countries	2009 – 2011 (annual)	Export	monthly variations in real exchange rates	Real	$TRADE_{IJ,t} = \begin{matrix} a + bTRADE_{IJ,t-1} + \\ cVOL + dMarket + \varepsilon \end{matrix}$	Dynamic panel model	Significant negative effect in developing countries
Bahmani-Oskooee, Hegerty & Xu (2013)	US - Hong Kong	1978 – 2006 (annual)	Disaggregated export and import	SD of 12 monthly real exchange rate	Nominal and Real	$lnX_t = f\begin{pmatrix} lnY_t^{HK}, lnREX_t, \\ lnVOL_t^{HKUS}, lnVOL_t^{CUS} \end{pmatrix}$ $lnM_t = f\begin{pmatrix} lnY_t^{US}, lnREX_t, \\ lnVOL_t^{HKUS}, lnVOL_t^{CUS} \end{pmatrix}$	ARDL	Evidence of third world country effect on US import
Mehare & Edriss (2013)	Ethiopia	1992 – 2010 (annual)	Bilateral export	SD	REER	$X_t = f(REER, GDP, TOT, EV) + \varepsilon$	ARDL	Short run significant negative impact on coffee export. Insignificant long run effect
Odili (2015)	Nigeria	1971 -2012 (annual)	Export and import as a function of Real GDP	ER risk faced by exporters/importers	Real	$EX_t = f\begin{pmatrix} RGDPf_t, TOT_t, RER_t, \\ RERV_t, DUM_t, \mu_t \end{pmatrix}$ $IM_t = f\begin{pmatrix} RGDP_{dt}, TOT_t, RER_t, \\ RERV_t, DUM_t, \mu_t \end{pmatrix}$	Johansen's cointegration VAR and ECM	Negative long run ERV effect on export and import

Demirhan & Demirhan (2015)	Turkey	2001 – 2010 (monthly)	Export	GARCH	Nominal	$E_t = f\left(Y^*{}_{t,} P_{t,} v_{t,}\right)$	ECM	Short and long run significant positive effect
Hock-Tsen & Hock-Ann (2016)	Malaysia – China	2010 – 2013 (monthly)	Disaggregated bilateral export	TGARCH	Nominal	$lnx_t = \begin{matrix} \beta_{11} lne_t + \beta_{12} lny_t \\ +\beta_{13} v_t + \mu_{1,t} \end{matrix}$	DOLS	Significant impact on real export
Bahmani-Oskooee, Hegerty & Xi (2016)	Japanese-US trade	1983 – 2013 (annual)	Export and import	SD	Real	$lnX_t = \begin{matrix} a + blnY_t^{JP} + clnREX_t \\ +dlnVOL_t^{JPUS} + elnVOL_t^{CUS} \\ +flnVOL_t^{JPC} + \varepsilon_t \end{matrix}$ $lnM_t = \begin{matrix} g + hlnY_t^{US} + jlnREX_t \\ +llnVOL_t^{JPUS} + mlnVOL_t^{CUS} \\ +nlnVOL_t^{JPC} + v_t \end{matrix}$	ARDL cointegration analysis	Significant positive effect on export but negative on import
Alegwu, Aye & Asogwa (2017)	Nigeria	1970 – 2013 (annual)	Export	GARCH	Real	$EXCOT = f(RERV, INF, INR, TOP)$	VAR	Significant asymmetric effect. Harmful to agricultural products export

X is volume of export; M is volume of import; Y is income; Y^* is foreign income; Y^e is expected real ER; E is real ER; RP is relative price; V is ER volatility; Y^*V is volatility of foreign income; IP is industrial production; CU is capacity utilization; CU^f is foreign capacity utilization; PC is production cost; PX is export prices; TOT is term of trade; N is population; DI is distance; SD is seasonal dummy; FT is free trade dummy; LG is common language dummy; ERM is ER mechanism dummy; BOR is common border dummy; COL is colonial tie dummy; AR is geographical area; LL is land lock dummy; MS is money supply, I is interest rate; UC is unit costs; S is nominal ER; W is index of world export; ST is strike dummy; OIL.is oil revenue. $rtep$ is real non-oil exports; foy is real foreign income (world income index); $rimp$ is real intermediate import; $nexr$ is real ER; $exrf$ is real ER volatility; VOL is ER volatility; $Dist$ is the distance between two countries; CB is common border sharing; $AFTA$ is Free Trade Area; EX is total exports; IM is total imports; $RGDPf$ is foreign country's real GDP; $RGDP$ is real gross domestic product; TOT is term of trade; $RERV$ is ER risk due to ER fluctuations; RER is real ER; DUM is dummy variable representing fixed and floating exchange rate regimes. where Zijt is the value of US trade for industry i (either imports, M, or exports, X) from country j, deflated by the sectoral value added deflator Pijt, Yi.t is the sectoral value added in US industry i, RPijt is the relative price between country j and the US for industry i, VOL.jt is bilateral US Dollar exchange rate volatility against country j, MPPP.jt is the misalignment term based on deviations from purchasing power parity of the Dollar against currency j, and VOIL..t is the volatility of the oil price. OLS means ordinary least square, IV means instrumental variable, ECM means error correction model, VAR means vector autoregression, GARCH means generalized autoregressive conditional heteroscedascity, FIML means Fully Identified Maximum Likelihood, GMM means Generalised Method of Moments and ARDL means Auto - Regressive Distributed Lag.

4.3.2 Specifications of Trade Models

Another significant aspect of studies on the relationship between ERV and trade flows is the choice of trade model specification. It is obvious that empirical findings are sensitive to the choice of trade model. From the literature, trade models used in empirical studies can be generally classified into two categories; the long run export demand and gravity models.

i. The Long Run Export Demand Model

In a long run export demand model, exports are specified as a function of relative price of export, ER, foreign income and ERV. This model assumes that export supply is infinitely inelastic, and the exporter has little or no market power so that equilibrium export quantity is demand determined (see Sauer & Bohara (2001); Poon *et al*. (2005); Tenreyro (2007); Chit *et al*. (2008); Kurihara (2013); Mehare & Edriss (2013); and Alegwu *et al.* (2017) for example).

Using long run export demand model, Bredin *et al.* (2003) investigated the short-run and long-run effect of real ERV on aggregate and sectoral exports of Ireland to the EU market where export is a function of ERV, foreign income and relative prices. The study found that ERV has no impact in the short run, but a significant positive impact in the long run on both aggregate and sectoral exports. The study revealed that the decline in intra-EU ERV associated with the single currency would lead to a long run fall in Irish exports to the EU. In contrast, by using a similar trade model but for the aggregate exports of eight Latin American countries, Arize *et al* (2008) found that ERV measured by ARCH conditional volatility has a significant negative impact in both short-run and long-run in each of the sample countries.

Mehare & Edriss (2013) employed the ARDL technique of estimation on the standard deviation volatility proxy for Ethiopia. The study found a significant negative relationship in the short run for coffee export in Ethiopia. On the other hand, Demirhan & Demirhan (2015) found a positive relationship between exchange rate volatility and export demand in Turkey over the period 2001 to 2010. The study employed the error correction model on the GARCH volatility proxy of the nominal exchange rate in the economy. In a more recent analysis on the Nigerian economy, Alegwu *et al.* (2017) employed annual data between 1970 and 2013. Using the Vector Autoregressive analysis, the study found a significant relationship between ERV and export demand in Nigeria.

ii. The Gravity model

Another trade model employed in the literature is the gravity model of trade which has been widely used in international economics (see Baum *et al.* (2004) and Tenreyro (2007), for example). Unlike long-run export demand models which focus on a number of purely economic variables, gravity model contemplates a more geographic approach. Gravity model relates bilateral trade among two countries with the size of their markets, their proximity to each other, existence of a common borders and common language between them. It has been argued that the gravity models are among the most empirically successful and widely used relationships in international economics (see Klein & Shambaugh; 2006) for example).

Klein & Shambaugh (2006) reassessed the same subject by using a larger data set of 181 countries and a different classification method to reflect the *de facto* exchange regime. The study found different results suggesting that fixed exchange rate regime encourages bilateral trade whilst the impact of ERV has a small negative impact.

Rose (2000) equally applied the gravity method to measure the effect of currency unions on members' trade. By combining a very large data set involving 186 countries for five years 1970, 1975, 1980, 1985, and 1990, the study found a small but significant negative effect of ERV on bilateral trade. Exchange rate volatility in the study is measured as the SD of the first difference of the monthly logarithm of the bilateral NER, which is computed over the five years preceding the year of estimation. Therefore, it is long run ERV in essence. This result is robust when using three alternative measures of volatility.

Baum *et al.* (2004) introduced foreign income volatility as a variable to investigate the magnitude of the impact of ER volatility when volatility in foreign income level varies. The underlying rationale is higher volatility in foreign income could be a signal of greater profit opportunity for exporters according to the theoretical literature which considers the "real options" of exporting activities. The empirical model includes a proxy for income volatility, as well as the interaction term of foreign income and foreign exchange volatility in addition to the relative price, ERV and foreign income. In the analysis of the impact of ERV on real international trade flows of 13 industrialized countries from 1980 to 1998, the study found that ERV has a significant effect on real exports in all sample countries except Germany and on average the effect is positive.

Tenreyro (2007) addressed a number of the problems associated with the gravity model of bilateral trade, which includes heteroscedascity of the error term, the existence of observations with zero values of bilateral exports, and potential endogeneity. The study used a pseudo-maximum likelihood procedure and instrumental variable method to correct for the relevant biases. By using a gravity model in which exports is a function of distance, per capita GDP, population, area, and dummies for free-trade agreements, contiguity, common language and colonial heritage, Tenreyro (2007) found that nominal ERV has no impact on trade.

4.3.3 Fundamentals of Trade Flow

One of the important parts of this study is the nature of trade flow to be applied in the trade model. That has to do with the choice of aggregate or disaggregate data for the trade model. This section therefore evaluates the empirical literatures according to the category of trade flow involved in the evaluated studies.

Most of the earlier studies examine the impact of ERV on aggregate multilateral trade flows (see for example, Bailey & Tavlas (1988), Chowdhury (1993), Doroodian (1999) and Caballero & Corbo (1989) among others). Caballero & Corbo (1989) study the effect of ERV on aggregate exports of five developing economies. The empirical results of the study showed a strong negative effect of exchange rate volatility on exports: an increase of 5 percent of real exchange rate volatility leads to a decline of exports ranged from 10 to 30 percent. Chowdhury (1993) also found a significant negative impact of exchange rate volatility on aggregate multilateral exports of G-7 countries. On the other hand, Bailey & Tavlas (1988) found no evidence of the significant impact of ERV on the US aggregate exports.

Other studies that employed aggregate trade data also found significant negative impact. Bahmani-Obkooee (2002) employed the Johansen's a cointegration analysis on the set of annual Iran data between 1959 and 1989. The study found a significant negative effect of ERV on the aggregate trade flow series. Dognalar (2002) investigated the effect of ERV on aggregate export of Malaysia, Pakistan, South Korea, Indonesia and Turkey. The study also found a significant negative relationship between ERV and trade. Arize *et al*. (2008) also employed the Johansen's a cointegration analysis on the set of annual data for Eight Latin American countries between 1973and 2004. The study found both short and long run negative effects of ERV on aggregate export among the selected countries.

However, McKenzie (2002) pointed out that using aggregated national trade data implicitly assumed identical effect of ERV across countries of destination and commodities. In reality, the impact is likely to be different depending on type of commodities and market destinations. If a country's bilateral trade flows with different trading partners produce positive and negative effects, these effects are likely to be cancelled each other out at the aggregate level. Therefore, using aggregate trade data may weaken the empirical findings since different impacts of ERV on different commodities and/or different countries offset one another.

According to Klaassen (2004); and Clark *et al.* (2004), one of the reasons of mixed empirical results might be due to the well-known "aggregation bias" arising from using aggregate trade flows. In addition, empirical studies that study the impact of ERV on aggregate exports employ the volatility of multilateral trade-weighted ER. Klaassen (2004) pointed out that this kind of trade-weighted exchange rate is difficult to construct. Recognizing the limitations of analysing the aggregate data, more and more studies shifted their focus on the impact of ERV on exports across different country pairs and over time (see Hooper & Kohlhagen (1978), Baum *et al* (2004), Clark *et al.* (2004), Klaassen (2004) among other).

Some studies employed the bilateral trade analysis. However, such analysis might still suffer a certain level of aggregation bias. To compare the effect of ERV on aggregate and sectoral trade, Doyle (2001) examined the impact of ERV on Ireland's exports to its most important trading partner, UK, between 1979 and 1992 in both aggregate and 2- digits Standard International Trade Classification (SITC) Division levels. By using cointegration and error correction techniques, Doyle's finding suggested that both nominal and real ERV have positive impact on the Irish aggregate exports to the UK. For SITC 2- digits sectoral level, however, some sectors are negatively affected by ERV and some are positively affected. It is obvious that sectoral disaggregation can capture a more complete picture of the effect of ERV on exports.

To overcome the aggregation bias, Cho, Sheldon & McCorriston (2002) examined the effect of ER volatility on the bilateral sectoral trade flow of ten developed countries between 1974 and 1995 using a gravity model. Bilateral trade flow across ten developed countries is disaggregated into four categories viz; chemicals, agriculture, machinery, other manufacturing. Exchange rate volatility is derived by using a moving standard deviation of the first differences in the ER over the ten previous years. This is to capture medium to long run variability of ER. The study suggested that the sign and degree of the impact of ER volatility vary across the different sectors. Exchange rate variability has significant negative impact on total trade as well as agricultural trade. However, the impact is more pronounce on agricultural trade which is around ten times higher than the impact on total trade.

4.3.4 Estimation Techniques and Econometric Related Issues

Most of the studies that focus on the impact of ERV on aggregate exports employed time series data. Along with the advancement of time series econometrics, these studies utilize the developments of estimation methods. However, recent work on this topic focuses on the impact of ERV on exports across different country pairs and over time by utilizing the advancement in the econometrics of panel data analysis. Below are the econometric techniques as evolve in the literature.

i. Time Series Techniques

One of the contentious issues in the empirical analysis of the relationship between ERV and trade flows is choosing the estimation technique. Most of the earlier studies utilized the Ordinary Least Square (OLS) method to estimate time series data (see Hooper & Kohlhagen (1978), for example) but failed to provide conclusive results. De Vitta &

Abbott (2004a and 2004b) pointed out that most of the early studies employed standard OLS regressions by implicitly assuming the stationarity of all the series and ignored the need for investigating the order of integration of relevant variables.

Since the trade variables are likely not to be stationary, the regression analysis employed may give spurious results. This could be a reason that leads to incorrect inferences regarding the impact of ERV on exports in the previous studies. This methodological problem has led the empirical studies to employ cointegration and error correction models in which the stationarity and cointegration of trade variables are taken into account (see Bahmani-Obkooee (2002), Bredin *et al.* (2003); Arize *et al*. (2008); Bahmani-Oskooee and Bolhassani (2012); Odili (2015) among others). The methodology is based on a cointegration technique which attempts to establish whether there is a long run relationship among a set of variables.

Apart from OLS and cointegration estimation methods, VAR (Vector autoregression) models have been used in the empirical studies which employed time series data. Poon *et al.* (2005) employed the VAR model to examine the impact of ERV on exports of five East Asian countries; Indonesia, Japan, South Korea, Singapore and Thailand. The study employed a long run export demand model augmented with ERV which is measured by MASD of REER. The results provided evidence that ERV has significant negative impact on exports of the sample countries except Singapore. Also, Alegwu *et al.* (2017) employed the VAR for a long-run trade model and found significant relationship between ERV and export demand in Nigeria between 1970 and 2013.

As noted by McKenzie (2002), if the measure of ERV is stationary, it cannot be included in cointegration analysis as a determinant of trade. In the empirical analysis of a study, which focused on the demand and supply of UK manufacturing exports, Holly (1995) did not include the measure of ERV in the Johansen's cointegration test because it is stationary. Instead, the study conducted the cointegration test to confirm whether there is long run relationship between other variables that are not stationary.

To overcome the problem of potential stationarity and serial correlation in the series, most studies now employ the autoregressive distributed lag (ARDL) model for cointegrated and not cointegrated series. De Vita & Abbott (2004a and 2004b); Bahmani-Oskooee, Hegerty & Xu (2013); Mehare & Edriss (2013); and Bahmani-Oskooee, Hegerty & Xi (2016) employed the cointegrating autoregressive distributed lag (ARDL) framework. The studies suggested that ARDL bound test is suitable whether the order of integration of volatility measure is *I(1)* or *I(0),* however, when the series were cointegrated. De Vita & Abbott (2004b) estimated the US exports to its five main trading partners and rest of the world over the period of 1985 and 2001. The long run estimated coefficients suggested that long run ERV has a negative impact on the US exports to the UK, Germany and Mexico, as well as a positive effect on the Japan exports. On the other hand, the ARDL without bound test was employed by Baum & Caglayan (2010) because the series were not cointegrated.

ii. Panel Data Techniques

By contrast to the studies that employed time series data, a number of studies have used panel data estimation techniques which combine the cross sectional and time series dimensions of data (see Clark *et al* (2004), Tenreyro (2007); Kurihara (2013); and Lubinga & Kiiza (2013) for example). In their study, Clark *et al.* (2004) analysed the role of ERV in aggregate and sectoral trade by using a panel data set which covers 178 IMF member countries between 1975 and 2000. The benchmark model which used both time and country fixed effects provided evidence of a statistically significant negative effect of ERV on trade. However, there is no evidence of the negative impact of ERV on trade when the study employed a panel model which controls for time varying country specific factors.

Although panel data analysis has particular advantages in examining the effect of ERV on trade, the longer time dimension of panel data (see Baak (2004) for example) may lead to the problem of non-stationarity and spurious regression. Baltagi (2001) noted that for a macro panel with large *N* (total number of countries) and longer *T* (length of time series) non-stationarity deserves more attention. None of the above-mentioned panel data studies conducted a panel cointegration test to verify the long run relationship among the variables. So, these studies might be subject to the problem of spurious regression.

Moreover, the fixed effect specification of panel data approach assumed homoscedasticity of error terms. However, there is the possibility that individual effects may vary over time due omitted macroeconomic shocks. That is, individual countries may respond to the effects of time varying unobservable shocks differently. This could lead to the problem of heteroscedasticity. To overcome this potential problem, later studies utilize Generalized Method of Moments (GMM) approach which is more efficient than OLS in the presence of heteroscedasticity. This argument is supported by Baum, Schaffer & Stillman (2003) that when there is heteroscedasticity, the GMM estimator performs efficiently than simple IV estimator. The empirical study of Tenreyro (2007) for instance, employed a pseudo-maximum likelihood (PML) methodology which is a variation of Generalized Method of Moments approach.

4.3.5 Exchange Rate Volatility's Endogeneity

For the studies that focus on bilateral exports, it has been argued that there is a potential problem of endogeneity, that is, an increase in the level of trade between two countries may lead to a more stable bilateral ER. Bravo-Ortega and Giovanni (2005) demonstrate that a high degree of economic integration between two countries might lead to a more stable real ER. Tenreyro (2007) points out that the potential endogeneity is one of the main problems that cast doubt on the findings of previous empirical studies which utilize OLS regression.

To control such problem, some studies apply instrumental variables (IV) approach by using an appropriate instrument for ERV (see Rose (2000), Tenreyro (2007) for example). Rose (2000) also used inflation and monetary quantity variables as instruments and obtains results consistent with those from OLS. However, Tenreyro (2007) argued that the instrumental variable approach used by Frankel & Wei (1993) and Rose (2000) are driven by factors that are also likely to affect trade flows directly. Therefore, the study employed a dummy variable that indicates whether two countries share a common anchor currency or the propensity of that two countries share a common anchor currency as an instrument for the ERV.

On the other hand, Clark *et al.* (2004) controlled for the potential endogeneity by using two instrumental variable approaches. The estimation results employing Frankel and Wei instrumental method showed that the negative effect of ERV is statistically significant only in two out of six specifications. In these two cases, the study found the negative impact is substantially larger than the results obtained with OLS estimation. When the study employed instrumental variable approach similar to Tenreyro (2007), the coefficients of the ERV measure becomes insignificant across all specifications.

To overcome the endogeneity issues, some studies have employed the internally generated volatility series using the factors that drive exchange rate volatility as a measure of volatility to investigate the relationship between ERV and trade (see Baum & Caglayan, 2010). This is applicable through the multivariate generalized autoregressive conditional heteroscedasticity (MGARCH) techniques as discussed in chapter three.

4.4 Summary and Conclusion

In summary, this chapter surveyed and evaluated the theoretical literature on the relationship between exchange rate volatility and trade considering the partial equilibrium and general equilibrium framework. The partial equilibrium analysis suggested that ERV exogenously affect trade while the general equilibrium hypothesized believes that ERV affects trade through its determinants and other microeconomic shocks. It is worth noting that, applying either of the frameworks does not rule out the fact that there is possibility of positive or negative impact in a study, which is more of the economic situation and econometric application.

Furthermore, the chapter assesses the contributions put forward by empirical studies on the relationship between ERV and trade flow. This study finds that the findings are sensitive to the choice of the proxy for ERV, the fundamental ER, forms of trade flow, trade model specification as well as choice and estimation techniques. It is obvious that one of the most important issues in the empirical literature is to choose an appropriate ERV measure. In the empirical literature, there is no generally accepted ERV measure, which can quantify foreign exchange risk originating from the ER volatility. The common practice so far in the recent literature is to use different types of measure and check the robustness of the results. From this review, empirical studies are not able to provide clear evidences to support the theoretical expectations. The studies could not establish a systematically substantial association between exchange rate volatility and trade flow, either on the aggregate or bilateral basis.

As reviewed in this chapter, empirical studies have not been unanimous in investigating the association between ERV and trade. Studies have reported negative, positive and statistically insignificant relationship between ERV and trade. Propositions two and three of Barkoulas *et al* theoretical model provides a reason for the disputable findings. Also, the propositions justify the intuition to the reason for those contradictory empirical evidences. In general, the direction of the overall change in export depends on the sources and sizes of the volatilities. This study considers two sets of modification as extension to Barkoulas *et al* model.

Firstly, the earlier exchange rate volatility results, which represent the true fundamental factors of exchange rate process is employed for the volatility proxy in this study in chapter seven. This is considered suitable as it mirrors the fundamental drives of exchange rate volatility in Nigeria using the MGARCH analysis.[26] The extension shows that the model follows a general equilibrium proposition. Secondly, this study considers it important to include foreign income into the empirical model. This variable is employed to control for external economy's effect on export demand in Nigeria.

In reviewing the existing literature on the factors that contribute to ERV as well as its impact on trade, it is possible to identify suitable methodologies to be employed. Specifically, following methodological issues are considered to be important to enhance the validity of the current study in order to provide new evidence of the determinants of ERV and its impact on the exports of the Nigerian economy. Therefore, this study will;

- Use bilateral export and bilateral exchange rate to avoid earliest aggregating bias.
- Use sectoral export to avoid the aggregating bias that may not be offset by bilateral export.
- Use the long run export demand model, which is suitable considering the nature of the Nigerian economy to avoid possible misspecification problem. This is important because export supply in Nigeria is infinitely inelastic and Nigeria has no market power such that export quantity equilibrium is determined by demand.

[26] The MGARCH analysis has the ability to model internally consistent variations in the model.

Thus, the exports in this study is specified as a function of relative price of export, ER, foreign income and ERV.

- Employ time series technique as it is suitable to increase the model's efficiency since the study is specifically on country-pair impact and establishing the timing effect of the relationship in the model.
- Employ the usual practice of time series property check which is essential to avoid spurious regression problem.
- Employ an appropriate distributed lag method, which is capable of correcting the problem of serial correlation and permit multiplier analysis of the effect of policy changes. The application of the ARDL is considered suitable for this analysis because of the multiplier analysis and the timing effect of ERV.

In conclusion, this study observes that the partial equilibrium model is deficient, especially for developing country as Nigeria. The model assumed that all other factors that may influence exchange rate volatility remain constant in examining the relationship between ERV and trade. Overall, the partial model overlooks the dynamism relating to the relationship between ERV and trade. However, the causes of exchange rate volatility in most economy especially developing countries are endogenised. Particularly, the influence of exchange rate volatility on trade in Nigeria is likely to be worsened due frequent policy change especially the interest and exchange rate deregulation policies and the SAP reforms in 1986 (as discussed in chapter two).

Despite the shortcomings, this study finds that most studies on Nigeria employed the partial equilibrium analysis and therefore disregard the point that macro economy fluctuations are likely to affect exchange rate movement endogenously.[27] To fill the gap,

[27] See Odili (2015) and Alegwu *et al.* (2017)

this study suggests that determining the role of exchange rate volatility on export demand in Nigeria may not be exogenous, but endogenous. To do this, this study employs the general equilibrium approach to investigating the relationship between exchange rate volatility and export demand in Nigeria. Therefore, unlike the previous studies on Nigeria, this study focuses on a question of what causes exchange rate volatility that may likely explain the link between exchange rate volatility and trade. Consequently, the first objective and first hypothesis of the thesis is specified that volatilities in interest rate, productivity growth rate and oil price do not contribute to exchange rate volatility in Nigeria overtime.

The investigation of the causes of exchange rate volatility provides intuition to the relationship between exchange rate volatility and trade in the general equilibrium framework. The study does this by taking into account the response of other macroeconomic variables to variations in exchange rate. Thus, this study is developed such that the trade model that investigates the relationship between exchange rate volatility and trade is subject to the sources of exchange rate volatility and other macroeconomic shocks. That is, as against the previous studies on Nigeria, this study models exchange rate volatility from the factors that drives exchange rate process in Nigeria.

Secondly, this study finds that there is a potential problem of endogeneity in investigating the relationship between exchange rate volatility and trade. That is, an increase in the level of trade between two countries may lead to a more stable bilateral exchange rate and its accompanied volatility. However, most of the past studies, especially on Nigeria, employed bilateral export analysis and ignored the endogeneity issue. This issue was found to be one of the main problems that cast doubt on the findings of previous empirical studies which utilize Ordinary Least Square (OLS) regression.[28]

To fill this gap, this study controls for and overcome the endogeneity problem, thereby reveals another significance of this study unlike other studies on Nigeria. This study does this by employing the internally generated volatility series using the factors that drive exchange rate volatility as a measure of volatility to investigate the relationship between exchange rate volatility and trade. The study therefore discovers that using the general-equilibrium framework is found to be vital in examining the relationship between exchange rate volatility and trade in Nigeria. So, the second objective and second hypothesis of this study is specified that exchange rate volatility does not reduce export demand in Nigeria overtime using the general equilibrium model. With the model, the exchange rate volatility is so much endogenised that the better perception of the relationship between exchange rate volatility and trade is captured.

Thirdly, the literature survey shows that very few studies on Nigeria have adopted trade models with disaggregated bilateral trade data.[29] Although, their results provided support to the general equilibrium hypothesis, however, this does not significantly improve the results relative to those that used aggregate trade flow. This study notices that such analysis might still suffer a certain level of aggregation bias. Generally, this study finds that most of the previous literature on the impact of ERV on trade employed aggregate trade data. The study finds that there has not been any significant empirical study on oil export and agriculture export demand analysis in determining the relationship between exchange rate volatility and export demand in Nigeria. Meanwhile, using aggregate trade data is likely to ignore the effect of exchange rate volatility, which may vary across sectors because sectors differ in their degree of openness in international trade. Also, level

[28] As pointed by Tenreyro (2007)
[29] see Akinlo & Adejumo (2014); and Odili (2015)

of concentration of industries differs as well as the way they use long term contracts. Furthermore, this study notices that aggregation constrains price, income, and elasticity of exchange rate risk to be the same across sectors. With the differences in markets structure for trade in Nigeria, it is possible that exchange rate volatility will affect each sector differently. However, aggregating across the sectors depicts loss of key information.

To fill the above gap in the literature, this study takes the disaggregating process a step further by examining sector-specific export to avoid the aggregating bias that may not be offset by bilateral export. To do this, the study employs sectoral trade analysis using the two major sectors involved in foreign trade. The different sectors of exchange are employed in this study to explain sectoral trade policy implication, which helps to improve sectoral trade flow and stabilize the overall economy. Moreover, unlike other studies on Nigeria, this research work discerns the multiplier impact of persistent currency instability on the sectoral trade flows (using the deregulation policies, which is peculiar to Nigeria). The multiplier analysis is suitable with sector-specific trade and monetary policies as against the policies based on economic aggregation.

The succeeding chapter discusses the research methodologies for the study where the above methodological issues are considered. This is to provide a new insight to the investigation of the trade effect of exchange rate volatility in Nigeria between 1986 and 2013 as to be examined in chapter seven.

CHAPTER FIVE: RESEARCH METHODOLOGY – MULTIVARIATE GARCH AND AUTOREGRESSIVE DISTRIBITED LAG TECHNIQUES

5.1 Introduction

The main aim of this chapter is to review the methods used in this research work, which are the multivariate generalized autoregressive conditional heteroscedastic (MGARCH) model of Baba, Engle, Kraft and Kroner (1990) (hereafter refers to as BEKK) and the Autoregressive Distributed Lag (ARDL) method of Pesaran, *et al* (2001). In addition to the BEKK modelling techniques, this chapter considers the estimation techniques of Volatility Impulse Response Functions (VIRFs), which deals with the analysis of the effect of policy shocks on the exchange rate volatility in Nigeria overtime. This is employed to provide a comprehensive analysis of the dynamic MGARCH method used for the exchange rate volatility model in Nigeria.

The chapter also discusses the individual strengths and importance of each method to the models in this thesis. In general, the econometric techniques applied to studies relating to exchange rate volatility (ERV) determination are the univariate and the multivariate models.[30] Similarly, the econometric techniques applied to the relationship between trade and exchange rate volatility is generally single and system equation models.

Regarding exchange rate volatility determination, previous studies that employed univariate models usually go through two stages. The first stage involved estimating volatility while the second stage involved estimating single equation for ERV determination (see Klaassen, (2004); Mehare & Edriss (2013); Lubinga & Kiisa (2013); Akinlo & Adejumo (2014). On the other hand, past studies that employed multivariate models had one stage in which volatilities are estimated concurrently with spillover

[30] This research work recognizes that there are two major approaches to modelling volatility viz the Autoregressive conditional heteroscedasticity (ARCH) and Stochastic Volatility (SV) models. While this study focuses on the ARCH models, the SV model is beyond the scope of this research work and therefore is not included.

effects to different variables (see for example, Baum & Caglayan (2010); Hock-Tsen & Hock-Ann (2016). Although, the univariate methods of estimating ERV captures commonly observed features of the time series, it is not able to provide causes of volatility in the series. The multivariate models on the other hand reveal the dynamic interdependence among variables and can conveniently estimate causes of the interested volatility series.

The multivariate analysis is used in this study because it helps in analyzing volatility co-movements and spillover effects in the variables employed. The analysis is important in this study because the Nigeria data employed suggest evidence of volatility spread across various markets like interest rate and exchange rate due to the deregulation policies as reviewed in chapter two. Such statistical property is only measurable with multivariate analysis as employed in chapter five (see Brooks & Henry, 2002; and Li, 2007). Secondly, a multivariate model generates a reliable model than separate univariate models, Tanattrin (2015). Generating a reliable model is important for the Nigeria analysis in this thesis because a reliable model is necessary for the general equilibrium analysis in the second model.

This study employs BEKK MGARCH model with the volatility impulse response functions (VIRFs) for the first analysis. This is to validate hypothesis 1 that one-time shocks and volatility linkages in interest rate, productivity growth and oil price increase exchange rate volatility in Nigeria between 1986Q3 and 2013Q4. The model is employed for four major reasons. Firstly, the model helps in modelling conditional variances and covariances and also captures the joint effect of shocks to oil price, interest rate and productivity growth on exchange rate volatility. Secondly, although there are many forms of multivariate techniques, the BEKK is seen as the most natural way of dealing with multivariate matrix operations. This helps in the application of the theoretical model to the empirical data gathered on Nigeria.

Thirdly, the BEKK MGARCH with VIRFs is employed in this study because its specification allows the conditional variance-covariance of the series to impact each other without estimating large number of parameters. Since the study considers four-variable model, the BEKK with VIRFs seems to be the best multivariate analysis because multivariate approach usually produces large number of parameters (see chapter three for details). Thus, the application of the VIRFs in the MGARCH reduces the number of parameters turn-out without restricting the variables of interest.

Fourthly, BEKK MGARCH helps in investigating volatility transmissions and patterns among two or more economic variables (Peijie, 2009). Therefore, the VIRFs in BEKK technique is employed in this study because the focus of this study is that volatility spillover between interest and exchange rate in Nigeria are strongly linked and well connected (see chapter two for details). The implication is that the study conveniently examines the dynamic effect of the different historical shocks on the volatilities as generated by the data with the use of VIRFs.

Thus, the BEKK MGARCH’s specification with its VIRFs property appropriately fit in examining volatility spillovers between the exchange rate, interest rate, productivity growth and oil price in Nigeria under different historical events. This is important for the Nigerian analysis because of the consistent policy reversal due to political regime changes. This has led to changes in exchange rate and interest rate policies, which might have caused a volatile rates overtime.

On the relationship between ERV and export demand (XD), the earliest time series techniques utilized the Ordinary Least Square (OLS) method (see Hooper & Kohlhagen (1978), for example). These past studies implicitly assumed the stationarity of all the series and ignored the need to investigate the order of integration of relevant variables.

However, trade variables are not likely to be stationary. Therefore, there could be risk of spurious results which gives incorrect inferences on the hypothesis testing.

Given this methodological problem, recent studies now employ cointegration and error correction models or vector autoregressive models in which the stationarity and cointegration of trade variables are taken into account [see Bahmani-Oskooee & Bolhassani (2012); Odili (2015); Alegwu *et al.* (2017)]. To overcome the problem of serial correlation when series are non-stationary and not cointegrated, recent studies have employed the Autoregressive Distributed Lag (ARDL) models. Also, other studies with cointegrated series of a non-stationary system employed the cointegrating ARDL model using the bound test techniques. The method has been found to conveniently deal with the economic analysis through its multiplier analysis property.

This study employs the Autoregressive Distributed Lag (ARDL) method of Pesaran, *et al* (2001) as employed by Baum & Caglayan (2010). This is to validate hypotheses 2a and 2b of this thesis that exchange rate volatility (as derived by its fundamental factors) reduces oil export demand and agriculture export demand respectively in Nigeria between 1986Q3 and 2013Q4. The study employs this method for its ability to overcome statistical challenges in the data and for economic and policy analysis.

Firstly, the ARDL is employed in this study because the Nigeria data employed are non-stationary and not cointegrated. The non-stationary and not cointegrated of the employed data present the danger of serial correlation and a series with no long-run relationship. The study therefore employs the ARDL model because it is a dynamic model. More importantly, its sufficient lags structure in the model helps to eliminate potential serial correlation [see Hill, *et al.* (2017)]. Secondly, the multiplier effect is considered important in this study because it helps to pin down the immediate or delayed effect of the interest rate and exchange rate deregulation policies since the inception of Structural Adjustment Program (SAP) in 1986 in Nigeria.

Thirdly, the ARDL is employed in this study because it effectively deals with economic and policy analysis arising from the empirical application of the theoretical model. The economic analysis is relevant in the study because of the deregulation policy effect of exchange rate volatility on trade over the sample period (see chapter two for details). The relationship between ERV and export demand (XD) in Nigeria requires introduction of lags so as to permit impact multiplier effect in the relationship. Past studies also affirmed that a considerable lag may be related to the effects of ERV on trade flow (see Bahmani-Oskooee, Hegerty & Xu, 2013); and Bahmani-Oskooee, Hegerty & Xi; 2016).

After this introduction is section two, which deals with the description of the methods to be employed in the study as enumerated above. Firstly, the section describes the multivariate GARCH analysis of Baba, Engle, Kraft and Kroner as proposed by Engle & Kroner (1995). Secondly, the section considers the techniques of analyzing the volatility impulse response functions (VIRFs), which is a new methodology. The VIRFs is employed to evaluate the dynamic impact of shocks on volatility on the MGARCH techniques. Thirdly, the section surveys theoretical models associated with Autoregressive Distributed Lag (ARDL) estimation techniques with a specific interest in the impact, delayed and total effect of the multiplier analysis.

Section three comprises of the empirical models employed in this study. It specifically discusses the multivariate GRACH-BEKK including the econometric specification and description of the exchange rate volatility model. Also, the section explains the application of the ARDL detailing the estimation framework and the econometric specification as well as the description of the oil export and agriculture export demand models.

Section four comprises data and indices. The section details data sources, data frequencies, variable identification and description. It also presents the proxies for variables in the study such as; price effect variables (Official Exchange Rate and Unofficial/Market Exchange Rate); Monetary Factor (interest rates); Real Factors (productivity growth and crude oil price); Trade Flow Index (Oil export and Agriculture export values); income variables (Domestic Real GDP and Foreign Real GDP) and transformation variables (Foreign GDP Deflator). The section also describes how the indices used in the study are measured with specific attention to the construction of exchange rate volatility and trade indices. Section five concludes the chapter.

5.2 Description of Methods

5.2.1 Multivariate Generalized Autoregressive Conditional Heteroscedastic (MGARCH) of Baba, Engle, Kraft and Kroner (BEKK)

Various classes of MGARCH were considered in chapter three including theoretical background of MGARCH-BEKK. This study considers BEKK because it is a special case of the VEC, hence, it is less general. By construction, BEKK has an attractive property which ensures positive definite of the conditional covariance matrices. Definition of the general structure of the BEKK model is presented in Tanattrin (2015) as:

$$H_t = C_0 C_0' + \sum_{j=1}^{q} \sum_{K=1}^{K} A_{kj} \epsilon_{\mathrm{t-j}} \, \epsilon'_{\mathrm{t-j}} \, A_{kj}' + \sum_{j=1}^{p} \sum_{K=1}^{K} G_{kj} H_{\mathrm{t-j}} \, G_{kj}' \qquad 5.2.1$$

A_{kj}, G_{kj} and C_0 are N x N matrices of parameters while C_0 is the lower triangular matrix. The symmetric parameterization in the BEKK model, which is provided by decomposition of the constant (C_0) into product of two matrices, ensures that H_t is mostly a sure positive definite, Tsay (2005). However, Tanattrin (2015) explained that identification problem will occur in the system if $K > 1$ because there is no single parameterization that could obtain the same model representation. As discussed by Hafner

& Herwartz (2006), the BEKK specification in equation 5.2.1 is the special case of equation 3.5.17 (see chapter three for details).[31]

Regarding covariances stationarity in the BEKK model, Engle and Kroner (1995) affirm that the condition for covariance stationarity in the BEKK is that the representative roots of;

$$\sum_{j=1}^{q}\sum_{K=1}^{K}(A_{kj}\oplus A'_{kj}) + \sum_{j=1}^{q}\sum_{K=1}^{K}(G_{kj}\oplus G'_{kj}),$$

which are the eigenvalues, must be less than unity in modulus. Therefore, even if an element in the matrix has a value that is greater than one, the process could still render stationary. Pang, Siu, Gannon (2002) further explained that this is a different condition from stationarity condition in the univariate GARCH model in which the total sum of ARCH and GARCH terms must be less than unity.

Bauwens, *et al* (2006) define a BEKK(1,1,K) model as:

$$H_t = C^*C^{*\prime} + \sum_{K=1}^{K} A_k^*\epsilon_{t-1}\,\epsilon'_{t-1}\,A_k^{*\prime} + \sum_{K=1}^{K} G_k^* H_{t-1} G_k^{*\prime} \qquad 5.2.2$$

A_k^*, G_k^* and C^* are N x N matrices of parameters while C^* is the upper triangular matrix. C^* x C^* can equally be written as $\Omega > 0$. The generality of the BEKK process is determined by summation limit, K. Bauwens (2005) confirms that the parameters in the BEKK are 11 compared to 21 in the VEC. Although, Tsay (2005) affirms that the BEKK permits dynamic dependency among volatility series, Bauwens, *et al* (2006) observe that the parameters in the BEKK do not directly represent the impact of different lagged values on elements of H_t as represented in VEC model.

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[31] $h_t = C + \sum_{j=1}^{q} A_j(\eta_{t-1}) + \sum_{j=1}^{p} G_j(h_{t-j})$

Moreso, BEKK model estimation still possesses large computation as a result of numerous matrix transpositions. The total parameters in BEKK model is $(p+q)KN^2\frac{(N+1)N}{2}$. In order to reduce the number of parameters and consequently reduce its generality, a diagonal BEKK model could be imposed where A_k^*, and G_k^* in equation 5.2.2 becomes diagonal matrices. This study ignores this alternative because it does not permit spillover effect of the series employed, which is vital in the analysis. Thus, the study employs the full BEKK, although, with the restriction of employing four variables so as to have economically meaningful output. Estimation is done by maximum likelihood, where the contribution of ε_t to the joint Gaussian log-likelihood of a sample with T observations $\left(logL = \sum_{t=1}^{T} l_t\right)$ which is given by

$$l_t = -\frac{N}{2}ln(2\pi) - \frac{1}{2}ln\ |H_t| - \frac{1}{2}\varepsilon_t' H_t^{-1}\varepsilon_t \qquad 5.2.3$$

Hafner and Herwartz (2006), hereafter refers to as HH, expressed that if the conditional distribution of ε_t is not normal, then maximizing equation 5.2.3 is interpreted as quasi maximum likelihood (QML) estimation. The study noted that conditional leptokurtosis is considered in maximizing sample log-likelihood under the assumption of t-distributed innovations as advocated by Bollerslev (1987). This is important because excess kurtosis has been found in the standardized residuals in empirical studies of univariate GARCH processes. Thus, this study alternatively uses a product of standardized univariate *t* distributions to specify the log-likelihood function. The density of a standardized univariate *t* distribution is given by

$$f_v(x) = \frac{\Gamma(\frac{v+1}{2})}{\Gamma(\frac{v}{2})\sqrt{\pi(v-2)}}\left(1+\frac{x^2}{v-2}\right)^{-(v+1)/2}$$

The joint density is given by

$$g(x) = \prod_{i=1}^{N} f_{vi}(x_i)$$

allowing for different degrees of freedom, vi for each component x_i. Under this assumption the conditional distribution of ε_t is

$$\varepsilon_t \left| I_{t-1} \sim g\left(H_t^{-1/2}\varepsilon_t\right) |H_t^{-1/2}\right|$$

and the contribution of ε_t to the log-likelihood reads as $l_t = ln\, g\left(H_t^{-1/2}\varepsilon_t\right) ln\, |H_t^{-1/2}|$.

5.2.2 Volatility Impulse Response Functions (VIRFs)

Volatility Impulse response Functions (VIRFs) is a new method of analysing the dynamic effect of shocks on volatilities in the MGACH techniques. There are two key approaches by which shock can be generated in a model. First is generating shock by the data generating process (DGP) and second is generating shock as external shocks in the observables. As noted in Hafner and Herwartz (2006), hereafter refers to as HH, shock may be regarded as being generated from the data generating process as employed in the KPP. In this case, there is no difficulty in considering 'realistic' shocks, since they can be drawn from the estimated distribution of the innovations.

On the other hand, shock can also be treated as being added to the data as applied in the Gallant, Rossi, & Tauchen, (1993), hereafter refers to as GRT.[32] In this case, it may be more difficult to construct 'realistic' shocks in combination with 'realistic' baselines in the framework of multivariate volatility models, which is employed in this study. Although, the second approach is of secondary importance, the study briefly considers the two approaches in turn.

i. Independent shocks generated by the Data Generating Process (DGP)

Independent news mirrors ξ_0 at time t = 0. There is no specification to whether this is 'good' or 'bad' news from the sign exhibited by each component. Also, the size does not show the importance of each of the component either. Thus, HH assumed that innovations

[32] See Gallant, *et al* (1993); Hafner and Herwartz (2006) for more details.

ξ_t are i.i.d and considers a shock as being drawn from the distribution of ξ_t. The study noted that in nonlinear models like GARCH, the variance of a normally distributed shock is not symmetric. That is, with nonlinear model, variance or standard deviation is not enough to describe the distribution of a normally distributed shock.

The conditional-covariance matrix H_t is a function of the innovations $\xi_1,\ldots, \xi_{t-1}$ as well as the initial shock ξ_0 and H_0. VIRFs are then defined as the expectation of volatility conditional on an initial shock and history, subtracted by the baseline expectation that only conditions on history, i.e.

$$V_t(\xi_0) = E[vech(H_t)|\xi_0, I_{t-1}] - E[vech(H_t)|I_{t-1}] \qquad 5.2.4$$

Considering a GARCH BEKK (1 1) in equation 5.2.2 with four variables, $V_t(\xi_0)$ is an N*-dimensional vector with N* = 10. The first, fifth, eight and tenth element of $V_t(\xi_0)$ represent the impulse responses of the conditional variances of the first, second, third and fourth variables respectively. The second, third, fourth, sixth, seventh and ninth elements of $V_t(\xi_0)$ are the response of the conditional covariances. The VIRFs is the impact of an infinitesimal change in $vec(\xi_0\xi_0')$ on volatility, scaled by the actual centered (squared) innovation vector $vec(\xi_0\xi_0' - I_N)$.

The general expression for VIRFs as expressed in HH is

$$V_t(\xi_0) = \Phi_t D_N^+ \left(\mathrm{H}_0^{\frac{1}{2}} \otimes H_0^{\frac{1}{2}}\right) D_N \mathrm{vech}(\xi_0\xi_0' - I_N) \qquad 5.2.5$$

In the case of a multivariate GARCH(1 1), have $\Phi_t = (\mathrm{A}_1 - \mathrm{B}_1)^{t-1}\mathrm{A}_1$ with the special case as:

$$V_t(\xi_0) = (\mathrm{A}_1 + \mathrm{B}_1)^{t-1}\mathrm{A}_1 D_N^+ D_N^+ \left(H_0^{\frac{1}{2}} \otimes H_0^{\frac{1}{2}}\right) D_N \mathrm{vech}(\xi_0\xi_0' - I_N) \qquad 5.2.6$$

$$= (\mathrm{A}_1 + \mathrm{B}_1) V_{t-1}(\xi_0) \qquad 5.2.7$$

For the VIRFs in equation 5.2.5;

- $V_t(\xi_0) = V_t(-\xi_0)$. This means the impulse response is an even function of the shock.
- shock linearity does not hold for $V_t(\xi_0)$. This means VIRFs are not homogeneous functions of any degree.
- The elements of $V_t(\xi_0)$ depend on the history, but only through the volatility state H_0 at the time when the shock occurs.
- The decay or persistence of shocks is given by the moving average matrices, Φ_t.

If the shock ξ_0 is randomly drawn from its distribution, VIRF themselves become random functions. The first two moments are given by

$$E[V_t(\xi_0)] = 0 \qquad 5.2.8$$

$$Var[V_t(\xi_0)] = Z_1 H_{gg} Z_1' \qquad 5.2.9$$

Where $Z_1 = \Phi_t D_N^+ \left(H_0^{\frac{1}{2}} \otimes H_0^{\frac{1}{2}} \right)$ and $H_{gg} = Var[vech(\xi_0 \xi_0')]$

ii. External shocks in Observables

Apart from generating shocks through data generating process (DGP), shocks are also generated as being added to the data (external shocks) as discussed in the HH. This case is considered in the GRT, where a shock is assumed to occur in ε_t. This is either directly observable or is obtained after the correction for the conditional mean of the original process. In addition, GRT compared the volatility profile relative to a baseline ε_0^0. However, HH noted that some features make comparing volatility profile to a baseline (as used in the GRT) an inconvenient definition of shock when volatility analysis is considered. Such features are found in the conditional volatility profile and the choice of baseline and shock. This study briefly explores the choice of the baseline and the shock as discussed in GRT. From this, HH pointed out four distinctions to be made as to whether the baseline and shock are fixed or random.

a. Both shock and baseline are fixed

When fixing a shock in one variable, δ_i, the question is how to choose a realistic contemporaneous shock in the other variables, $\delta_j, j \neq i$. If the baseline is set to zero, then the conditional volatility profile simplifies to:

$$v_t(\delta) = \Phi_t vech(\delta\delta') \qquad 5.2.10$$

In standard impulse response analysis for the conditional mean, it is natural to set the baseline ε_0^0 to its unconditional mean zero, because this is the steady state of the process. However, choosing a baseline in volatility analysis is not trivial because there is no natural baseline ε_0^0 for volatility analysis. That is, any given baseline is likely to deviate from the average volatility state. Thus, HH illustrated that a zero baseline represents the lowest possible volatility state and, therefore, volatility forecasts will increase over time, no matter how big the initial shock was. The baseline itself can be viewed as a shock to volatility and it becomes difficult to disentangle the effects of the baseline and the shock vector (see HH for more details).

b. Fixed shock and random baseline

Turning to the second possibility for the choice of $(\varepsilon_0^0, \delta)$, if δ is fixed and ε_0^0 is randomly drawn from the unconditional distribution of ε_t. As GRT noted, this gives the same result for the average of the impulse responses as setting the baseline to zero.

$$E(v_t(\delta) = \Phi_t vech(\delta\delta') \qquad 5.2.11$$

$$Var(v_t(\delta) = \mathrm{Z}_2 \mathrm{H} Z_2' \qquad 5.2.12$$

Where $\mathrm{Z}_2 = 2\Phi_t D_N^{+}(\delta \otimes I_N)$

A minor difficulty of the random baseline perspective in the GRT framework as expressed in HH is that the joint unconditional distribution of ε_t is not known for the class of multivariate GARCH models. Therefore, random baselines would have to be simulated using the estimated model or be drawn with replacement from the observations. Also, one could condition on a specific volatility state H_0 and draw from the innovations ξ_0, as in the VIRF analysis (see HH for more details).

c. Random shock and fixed baseline

This study now addresses the possibility of a random δ. Again, one could use the unconditional distribution of ε_t or, if not available, simulated data from the model. If the baseline is fixed and the unconditional distribution is used to generate δ, then

$$E(v_t(\delta) = \Phi_t vech(H) \qquad 5.2.13$$

$$Var(v_t(\delta) = \Phi_t H_\eta \Phi_t' + Z_3 H Z_3' \qquad 5.2.14$$

Where $H_\eta = Var[\eta_t]$ and $\mathrm{Z}_3 = 2\Phi_t D_N^+(\varepsilon_0^0 \otimes I_N)$. If the baseline is set to zero, then $\mathrm{Z}_3 = 0$ and the variance of v_t reduces to $\Phi_t H_\eta \Phi_t'$. Also, one could condition on the volatility state H_0 and draw δ from the distribution of $H_0^{\frac{1}{2}}\xi_0$. However, a fixed baseline cannot represent the steady state of volatility as discussed earlier.

d. Random shock and random baseline

The final possibility is to let both δ and ε_0^0 be randomly drawn, for example, from the unconditional distribution of ε_t. But then the perturbed scenario $\varepsilon_0^* = \varepsilon_0^0 + \delta$ is the sum of two independent random variables stemming both from the unconditional distribution of ε_t, so that a realization of ε_0^* may be very unrealistic for the distribution of ε_t.

This study follows the more formal approach of directly considering the shock as being drawn from the distribution of the innovation, ξ_t. The study therefore lay a greater emphasis on providing measures of sampling volatility for impulse response functions produced from nonparametric estimates of the distribution of $V_t(\xi_0)$.

5.2.3 Autoregressive Distributed Lag

Given the considerable attention in analyzing long run relationships in the modern time series analysis, this study employs a technique of estimating dynamic relationships using time series data. Two methods have been identified in the literatures as techniques of obtaining consistent and best estimators when distributed lag model is considered. The techniques are the AR(1) error models (Nonlinear LS Estimation and generalized LS estimation) or Autoregressive Distributed Lag (ARDL). This study considers the ARDL techniques because of its appropriateness in a more general form of autocorrelated residual than the AR(1) error models. Also, ARDL is less restrictive and more importantly, it has intuitive economic interpretation useful for the analysis.

The ARDL is a form of DL model. It is a dynamic model in which the dependent variable is regressed against its own lag and the lags of explanatory variables. It is a model that contains the lagged $y_t{}'$s and lagged $x_t{}'$s, such that;

$$y_t = f(y_{t-1}, x_t, x_{t-1}, x_{t-2}) \qquad 5.2.15$$

The general ARDL form with p lag of y and q lag of x; ARDL (p, q) model is written as;

$$y_t = \delta + \theta_1 y_{t-1} + \cdots + \theta_p y_{t-p} + \delta_0 x_t + \delta_1 x_{t-1} + \cdots + \delta_q x_{t-q} + v_t \qquad 5.2.16$$

In the case of non-stationary and not cointegrated series (as applied to the data in this thesis), the dynamic relationship should be employed. The ARDL model has two major area of usage in economic analysis for policy implication; forecasting and multiplier analysis. The most important reason for its application in this thesis is the multiplier analysis property.

Multiplier Analysis of the ARDL

This means the effect and timing of effect of a change in a variable on the result of another. Multiplier analysis is important in economic analysis because most economic changes are not instantaneous. Consequently, policy makers will be interested in when and how an indicator responds to changes in economic activities. There is the distributed lag weight or n-period delay multiplier, impact multiplier, interim multiplier and the total multiplier. To find multiplier for an ARDL model equation 5.2.16 is transformed to infinite DL model such as;

$$y_t = \alpha + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \beta_3 x_{t-3} + \cdots + e_t \qquad 5.2.17$$

The effects of relationship between x and y are;

$$\beta_0 = \frac{\partial y_t}{\partial x_t} = \text{immediate effect or impact multiplier} \qquad 5.2.18$$

$$\beta_s = \frac{\partial y_t}{\partial x_{t-s}} = s \text{ period delay multiplier} \qquad 5.2.19$$

$$\sum_{j=0}^{s} \beta_j = s \text{ period interim multiplier} \qquad 5.2.20$$

$$\sum_{j=0}^{\infty} \beta_j = \text{total multiplier or long run effect of change in } x \qquad 5.2.21$$

In its general form, multipliers for an ARDL model can be derived from;

$$\delta_0 + \delta_1 L + \delta_2 L^2 + \cdots + \delta_q L^q = \left(1 - \theta_1 L - \theta_2 L^2 - \cdots - \theta_p L^p\right) \times (\beta_0 + \beta_1 L + \beta_2 L^2 + \beta_3 L^3 + \cdots) \qquad 5.2.22$$

Given the value of p and q in an ARDL model, equation 5.2.22 is multiplied out and coefficients of like-powers in lag operators are equated to compute the multipliers. This research work considers the multiplier analysis in detail in chapter four[33].

5.3 Description of the Models

5.3.1 Exchange Rate Volatility Modelling

This study employs models of exchange rate variance and not exchange rate changes. As explained in chapter three, the monetary and non-monetary models are incorporated in the exchange rate volatility model. More importantly, this study includes the role of oil price in the model because Nigeria is oil exporting/oil dependent economy.

Exchange Rate Volatility Model for Nigeria

This study proposes a four-variable model of exchange rate volatility for Nigeria using quarterly data from 1986 to 2013. The empirical model for this study comprises of interest rate differential volatility, productivity growth differential volatility and oil price volatility in Nigeria between 1986 and 2013. The interest rate differential volatility, productivity growth differential volatility and oil price volatility are assumed to be positively related to exchange rate volatility in Nigeria between 1986 and 2013. This is because the coefficients of equations involving variances of interest rate differential, productivity growth differential and oil price are expected to be positive (see chapter three for more details).[34]

Given the above ERV model, this study employs a four-variable BEKK multivariate GARCH to investigate the causes of exchange rate fluctuation in Nigeria with the general mean model as;

$$y_t = c + \Gamma y_{t-1} + \epsilon_t \; ; \qquad \epsilon_t | I_{t-1} \sim N(0, H_t) \qquad 5.3.1$$

[33] Interested readers should see Hill et al (2012); pages 372-378 for discussion on the forecasting analysis.
[34] Coefficients of variances are positive

$y_t = [y_{1t}\ y_{2t}\ y_{3t}\ y_{4t}]',$ 5.3.2

$\epsilon_t = [\epsilon_{1t}\ \epsilon_{2t}\ \epsilon_{3t}\ \epsilon_{4t}]',$ and 5.3.3

$$H_t = \begin{bmatrix} h11_t & h12_t & h13_t & h14_t \\ h21_t & h22_t & h23_t & h24_t \\ h31_t & h32_t & h33_t & h34_t \\ h41_t & h42_t & h43_t & h44_t \end{bmatrix} \qquad 5.3.4$$

y_t represents a 4 x 1 vector of the various quarterly series at time t while c is a 4 x 1 vector of constants and Γ represents 4 x 4 matrix of parameters related to lagged values of the monetary and real factors employed in the model. ϵ_t is a 4 x 1 random error vector at time t, which has a 4 x 4 conditional covariance matrix H_t. I_{t-1} is the shock information set at time $t-1$.

This study is set to investigate the effect of interest rate volatility, productivity growth volatility and oil price volatility in Nigeria between 1986Q3 and 2013Q4. As earlier discussed, this study is interested in the variance-covariance equation, which is expressed as:

$$H_t = \mathrm{C'}_0\mathrm{C}_0 + \mathrm{A}_{11}\mathrm{e}_{\mathrm{t-1}}\,\mathrm{e'}_{\mathrm{t-1}}\mathrm{A'}_{11} + \mathrm{B}_{11}\mathrm{H}_{\mathrm{t-1}}\mathrm{B'}_{11} \qquad 5.3.5$$

where H_t is a 4 x 4 conditional variance-covariance matrix of exchange rate determinants while C is a 4 x 4 matrix of constants. A (one-time shock parameter) is a 4 x 4 matrix with diagonal parameters, a_{ii}, measuring the impacts of own past shocks on their individual volatility and off-diagonal parameters, a_{ij}, measuring the effect of variable i's past shock on variable j's volatility. B (Volatility spillover parameter) is 4 x 4 matrix with diagonal parameters, b_{ii}, measuring the impacts of own past volatility on their individual conditional variance and off-diagonal parameters, b_{ij}, measuring the effect of variable i's past volatility on variable j's conditional variance.

For efficient and consistent BEKK system estimation the study employs the full information quasi-maximum likelihood approach (see Hafner and Herwartz; 2006). The quasi-maximum likelihood is used because the series violate the normality condition (more details in chapter five). Thereafter, the study defines VIRFs as the expectation of volatility conditional on an initial shock and history, subtracted by the baseline expectation that only conditions on history as in equation 5.2.4.

5.3.2 The Trade Model

The second major model of this thesis is the trade model. The model tests if export demand (measured by disaggregated exports in the oil and agriculture sectors)[35] is function of the exchange rate volatility (as derived by its fundamental factors), income and exchange rate changes in Nigeria between 1986Q3 and 2013Q4. The special attention on the exchange rate volatility is to realistically define the Nigeria economic situation and suit its macroeconomic condition using the deregulation policies in the interest rate and exchange rate market over the sample period.

The Trade Model for Nigeria

The theory has hypothesized that the exchange rate volatility (as driven by its fundamental factors in Nigeria) will have a contractionary effect on the export demand in the economy. The model therefore focuses on the sectoral export indexes as the dependent variables and presents explanatory variables that attempt to capture the impact and delayed effect of the deregulation policies as detailed in the review chapter for multiplier analysis.

This study specifies a small open economy model that was theoretically and empirically advanced by Barkoulas, Baum & Caglayan (2002) and Baum & Caglayan (2010) respectively. The study employs the Autoregressive Distributed Lag (ARDL) method

[35] According to Yuan & Awokuse (2003), using aggregate trade data tacitly assumed that the effect of ERV is the same across sectors in terms size and direction. Thus, the true picture of the link between ERV and trade may be diluted and the probability of achieving significant results may reduce with aggregate data.

because sufficient lags structure is essential to eliminate potential serial correlation in the model as discussed in section 5.1. More importantly, this model is suitable for non-stationary and not cointegrated series in a dynamic relationship analysis.

The dynamic relationships in the oil and agriculture sectors are specified in equation 5.3.6 and 5.3.7 respectively as:

$$\Delta XDO_t = C_O + \sum_{i=1}^{m} \theta_1 \Delta XDO_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta ERV_{t-i} + \sum_{i=0}^{m} \alpha_i \Delta FY_{t-i} + \sum_{i=0}^{m} \delta_i \Delta ER_{t-i} + \omega_t \qquad 5.3.6$$

$$\Delta XDA_t = C_A + \sum_{i=1}^{n} \emptyset_1 \Delta XDA_{t-i} + \sum_{i=0}^{n} \vartheta_i \Delta ERV_{t-i} + \sum_{i=0}^{n} \rho_i \Delta FY_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta ER_{t-i} + v_t \qquad 5.3.7$$

where XDO is the Nigeria Oil export demand, XDA is the Nigeria Agricultural export demand, ERV is the measure of volatility in the exchange rate as driven by factors of ER process, FY is the foreign income and ER is the real exchange rate. Δ is the difference operator of the level series. m and n are the lag length, which are chosen through maximizing the Akaike Information Criterion (AIC) · The interest of this study in the above dynamic equation is on both the significances and signs of the coefficients of ERV, γ_i or ϑ_i when $i = 1$. The study estimates coefficients associated with XDO, ERV, FY, ER and as expressed in their distributed lag forms $\theta_1, \gamma_i, \alpha_i$ and δ_i respectively in equation 5.3.6. It also estimates coefficients associated with XDA, ERV, FY, ER and as expressed in their distributed lag forms $\emptyset_1, \vartheta_i, \rho_i$ and φ_i respectively in equation 5.3.7.

Since the trade data is reported by Nigeria, the model is specified from Nigeria's perspective. Thus, XDO and XDA in equation 5.3.6 and 5.3.7 are the exports of oil and agriculture products by Nigeria to US. This is assumed to be positively related to US income but negatively related to exchange rate, ER. Increase in the ER shows depreciation of the Nigerian Naira. The internally generated volatility as driven by fundamental factors of ER process is employed (ERV) because the study is considering a general equilibrium analysis. The analysis can probably have positive or negative effect on Nigeria export to US depending on the effects of factors of ER over the period of analysis. Given a non-stationary and a not cointegrated data set in this study, the dynamic ARDL models above is employed in chapter six for the trade analysis.

5.4 Data and Indices

5.4.1 Data Sources and Variable Identification

In analysing the causes of exchange rate volatility in Nigeria, the quarterly exchange rates and interest rates data used for analysis in this study are sourced from the International Monetary Fund (IMF)/International financial statistics (IFS) database. The quarterly data for the oil price were collected from the Thompson Reuters while the quarterly Nigeria Real GDP data are sourced from the Central Bank of Nigeria database. The quarterly US Real GDP is sourced from US Bureau of Economic Analysis. The model that estimates causes of exchange rate volatility in Nigeria is hereafter called model 1.

In examining the causes of exchange rate volatility in Nigeria, this study employs interest rate (IRD), oil price (OIL) and productivity growth (PGD) in Nigeria between 1986 and 2013 (see details in the next section for theoretical and empirical significance of the considered variables) as the potential fundamental factors that drive exchange rate process in Nigeria.[36]

On the relationship between exchange rate volatility ERV and export demand (XD) in Nigeria between 1986 and 2013, this study employs the endogenous exchange rate volatility (hereafter called ERV) series. The study extracted exchange rate volatility from model 1. The extraction is possible because of the multivariate GARCH analysis employed.[37] The series were derived from the exchange rate volatility model above. The

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[36] The construction of IRD and PGD are detailed in the next section.
[37] This is more of software application than manual application.

use of the derived exchange rate volatility series from the BEKK model in chapter six is the general equilibrium property of this thesis (see details in chapters three and five).[38] This means that ERV employed in chapter seven is derived from the factors that influence exchange rate process in Nigeria over the sample period as investigated in the succeeding chapter. The study is interested in employing internally generated exchange rate volatility, which is capable of investigating the general equilibrium relationship of exchange rate volatility and export demand in Nigeria over the considered period.

The quarterly exchange rates (ER) data used are sourced from the International Monetary Fund (IMF)/International financial statistics (IFS) database. The quarterly data on oil export values (XDO) and the agriculture export values (XDA) are sourced from the Nigeria Statistical Bulletin and various issues of the Central Bank (CBN) Annual Report. Quarterly data for US Real GDP (FY) were sourced from US Bureau of Economic Analysis. The model that estimates the relationship between exchange rate volatility and export demand in Nigeria is hereafter called model 2.

The study discussed in chapters one and three that this thesis employs the disaggregated trade model to overcome aggregating bias in the previous literature. For instance, Yuan and Awokuse (2003) expressed that using aggregate trade data tacitly assumed that the effect of ERV is the same across sectors in terms of size and direction. Thus, the true picture of the link between ERV and trade may be diluted and the probability of achieving significant results may reduce with aggregate data.

[38] As discussed in chapter three, this also helps to overcome the endogenous structure of trade and exchange rate

To this end, this study establishes that model 2 of this thesis comprises of oil export demand (XDO) model and agriculture export demand (XDA) model. Oil and agriculture sectors are the major productive sectors with international trade composition in Nigeria. It should also be noted that the two sectors were the focus of the major reforms in Nigeria, especially the deregulation policies in the interest rate and exchange rate markets, which are the focus of this thesis (see details in chapter two). Therefore, this study investigates hypothesis 2a using the oil export demand hereafter called XDO model. Secondly, the study investigates hypothesis 2b using the agriculture export demand hereafter called XDA model.

In examining the relationship between XDO and ERV; and between XDA and ERV in Nigeria between 1986Q3 and 2013Q4, this study incorporates other factors other than exchange rate volatility that affect bilateral trade. The variables identified for utilization in the study are the dependent variable (oil and agriculture export values) and the independent variables (exchange rate volatility series as derived from model 1, foreign income, and the market exchange rate). However, the focus of the analysis is on the relationship between ERV and export demand. Information on all the variables used in the model span between 1986Q3 and 2013Q4, which covers the period of flexible exchange rate system in Nigeria.

5.4.2 Variable Descriptions and Proxies

i. Exchange Rate

In general, ER is the value of a currency relative to another currency. There are several debates in the exchange rate literature on whether nominal or real exchange rates be used, Akhtar and Spence- Hilton (1984); Mckenzie & Brooks (1997). While some studies employed the nominal rates for their analysis (see Bini-Smaghi, 1991; Bayoumi and Eichengreen, 1997; and Medhora,1990), some used the real rates (see Odili, 2015) while others argued that the difference between the rates in practice is negligible although the rates are conceptually different (see Rahmatsyah, Rajaguru and Sieregar, 2002; and Clark, Tamirisa, Sadikov and Zeng, 2004).

This study therefore employs the official exchange rate which is the nominal exchange rates for the exchange rate volatility (ERV) model. The use of this type of exchange rate measure is necessary for the exchange rate volatility (ERV) model because the official exchange rate in Nigeria reveals the structural shift in the sample. This measure of exchange rate is suitable for the model as it helps to pin down the historical shocks that fall within the sample (see the details in chapter two).

ii. Interest rate

One of the major determinants of exchange rates volatility as reviewed earlier (see details in chapter three) is the interest rate differentials volatility. These are frequently used as determinant of exchange rate volatility based on flexible monetary view in the developing countries like Nigeria. This study employs the interest rate because of its importance in Nigeria monetary system overtime. Also, it becomes important to consider the variable because Nigeria operates a deregulated interest rate policy for the period covered by this thesis. The view is that a higher interest rate as a result of expected loss in the value of money leads to increase in relative prices. Consequently, the demand for domestic currency falls. The fall in the demand for domestic currency results in depreciation of the home currency (that is, a rise in the exchange rate).

In this case, increase in relative interest rate leads to increase in exchange rate (depreciation of exchange rate). This is a positive relationship between interest rate differential and exchange rate (see details in chapters three and five). Proxies for the interest rate differ from each other, but in general, they may likely typify money holding cost and more or less move together. This study calculates the interest rate percentage change for Nigeria (NIR hereafter) and US (UIR hereafter) and compute the differential term (IRD hereafter) which is used in the empirical model for volatility measure.

iii. Productivity Growth

According to Balassa–Samuelson effect, consumer price level (CPL) in richer countries is systematically greater than that of the poorer countries (Penn effect), and productivity growth rate differ more in traded sectors than in other sectors. As a result of the Penn effect, exchange rate deviations take place in the same direction; the price of non-tradables increases if productivity growth is intense in tradable sector leading to increase in exchange rate. Therefore, increased productivity is correlated with increased exchange rate since productivity gains are generally in traded sectors (see Maeso-Fernandez, Osbat, Schnatz, 2001). Also, higher productivity growth increases wages which results to increase in relative prices. This leads to loss in the value of money and consequently reduces demand for money in the economy. Consequently, there is increase in the price of exchange.

Productivity is expressed in two ways; as price differential between non-traded goods and traded goods in foreign and home economies, and as the total labor productivity (TLP) differential. The later measures the TLP growth between two countries as change in per capita real GDP while the former only captures the indirect effect of productivity growth in tradables sectors. Thus, this study assumes that one-time shock and volatility spillover from productivity growth differentials will increase exchange rate volatility in Nigeria between 1986Q3 and 2013Q4.

On the measure of productivity growth (PGD hereafter), the study takes the Nigeria real GDP as proxy. The PGD is employed in the model to specifically measure the economy's real shock impact. Since monthly real gross domestic product (RGDP) series does not exist for both US and Nigeria economies, the quarterly real gross domestic product

(RGDP) data were used for US and Nigeria. The US log of RGDP (UGDP hereafter) is subtracted from the Nigeria log of RGDP (NGDP hereafter) to calculate the PGD.

iv. Crude Oil Price

Due to the Nigerian economy structure and nature, it is imperative to introduce the crude oil price to the exchange rate volatility model in this study. As examined in the literature review section, this study finds that the proposition that oil be included in the ERV model is recently considered by few authors (see Al-Ezzee (2011)). This study notes that the oil proposition is particularly important for oil dependent/oil exporting countries. More importantly, it is considered imperative in this study to examine this proposition because the major component and drive of the Nigerian Trade Balance (TB) is from oil contribution. This study therefore expects that the higher the instability of the available natural resources the greater the instability of the exchange rate. Thus, this study hypothesizes a positive sign on the variable. The quarterly series of the West Texas Intermediate (WTI) spot crude oil price (OIL hereafter) employed in this study were gathered from the Thompson Reuters database.

v. Export Demand

This study investigates the impact of ERV on disaggregate exports from oil and agriculture sector. This analysis permits this study to test whether the effect of ERV differs in direction and size across diverse types of goods/sectors.[39] This study observes that the role of ERV is yet to be broadly explored using Nigerian disaggregated trade data. The study employs sectoral disaggregation to capture a more complete picture of the effect of ERV on trade in Nigeria and to avoid generalization of result across the

[39] Yuan and Awokuse (2003) explained that employing aggregate trade data disregards the fact that ERV affects sectors differently.

productive sectors. To proxy export demand, this study employs the disaggregated trade value index by oil and agriculture sectors between 1986Q3 and 2013Q4.

In measuring the trade index, Chit *et al* (2008) suggested two ways of transforming export values denominated in current US dollar to real export (export volume). The first technique is by converting an export value denominated in US dollar to the exporters' currency and thereafter deflate with the exporter country's GDP deflator. Otherwise, a bilateral export value that is denominated in US dollar currency may be expressed as constant price using the US's currency's GDP deflator. Due to data availability, this study uses the second method (as used in Eichengreen & Irwin, 1996; Yao and Zhang, 2003; Clark *et al.*, 2004; Klaassen, 2004 and Chit *et al*, 2008; where the same method of deflating the export value using GDP deflator is adopted). The real oil export from Nigeria to USA (XDO) is described as below:

$$lnXDO_{nut} = ln\left[\frac{OX_{nut}}{UGDPD_{ut}} X100\right] \quad 5.4.1$$

The real agriculture export from $Nigeria$ to USA (XDA) is described as below:

$$lnXDA_{nut} = ln\left[\frac{AX_{nut}}{UGDPD_{ut}} X100\right] \quad 5.4.2$$

where XDO_{nut} is the natural log of real oil export of Nigeria to USA, XDA_{nut} is the natural log of real agricultural export of Nigeria to USA, the nominal value of oil export is OX_{nut} while the nominal value of agriculture export is AX_{nut} and the US GDP deflator is ($UGDPD_{ut}$).

vi. Price Effect Variables - Exchange Rate Volatility

As discussed earlier, the exchange rate volatility model in this study is the internally generated volatility series. It is derived from the fundamental factors of exchange rate process in Nigeria over the sample period using the MGARCH techniques. It is worth emphasizing that the analysis of this model is more of the policy analysis, which has to reflect exchange rate as determined by the policy application. It is hypothesized in this thesis that exchange rate volatility as derived from its fundamental factors reduces export demand in the oil and agriculture sector in Nigeria between 1986Q3 and 2013Q4.

Given the deregulation policies in the interest rate over the sample period, this study expects that exchange rate volatility increases along-side and produces two effects. Firstly, this is expected to raise cost of imported inputs, increases cost of production and thereby reduces productivity in the productive sector. This implies that higher interest rate volatility increases exchange rate volatility and consequently depresses export in the oil and agriculture sector. Secondly, it is expected to make access to credit facilities difficult, especially in the agricultural sector. This leads to production of substandard and expensive product in the sector. Consequently, the sector production base is weakened and that makes its exports less competitive.

vii. Income Effect Variables – Real GDP

An increase in income of the foreign country (US in this case) partnering with Nigeria increases the export value from Nigeria, which consequently expands the trade activities in the oil and agriculture sector of the economy. In the words of Arize *et* al (2000), higher exchange rate means higher relative prices. Therefore, a positive relationship is expected between both oil and agriculture exports and the foreign income over the sample period. This study employs the Nigeria's key importing country (USA, at the time of this study) to be the proxy for foreign income. The Nigeria's major importing country with a close bilateral trade relationship is the United States of America (USA) for the period covered by this study. According to Bureau of African Affairs fact sheet of 2014, the USA established a diplomatic relation with Nigeria since 1960 after Nigeria's independence. The bilateral arrangement is still in place as at the time covered by this study.

5.4.3 Data Frequencies and Sources

Table 5. 1: Variables and Sources - Model 1

Variable	Definition	Type	Frequency	Sample Period	Source
ER	Exchange Rates	Dependent	Quarterly	1986Q3-2013Q4	IMF/IFS
IRD[1]	Interest rate differential	Independent	Quarterly	1986Q3-2013Q4	IMF/IFS
PGD[2]	Productivity growth differential	Independent	Quarterly	1986Q3-2013Q4	CBN&BEA
OIL	Oil price	Independent	Quarterly	1986Q3-2013Q4	Thomson
RGDP	Domestic Real gross domestic product	Transformation	Quarterly	1986Q3-2013Q4	Central Bank of Nigeria
$RGDP_U$	Foreign Real gross domestic product	Transformation	Quarterly	1986Q3-2013Q4	Bureau of Economic Analysis
UGDPD	US GDP deflator	Transformation	Quarterly	1986Q3-2013Q4	Bureau of Economic Analysis
Note: [1] Subtract US's interest rate percentage change from Nigeria's interest rate percentage change. [2] Subtract US's log of real GDP from the Nigeria's log of real GDP.					

Table 5. 2: Variables and Sources - Model 2

Variable	Definition	Type	Frequency	Sample Period	Source
XDO[1]	Real Oil export value	Dependent	Quarterly	1986Q3-2013Q4	CBN Stats & Reports
XDA[2]	Real Agriculture export value	Dependent	Quarterly	1986Q3-2013Q4	CBN Stats & Reports
ERV[3]	Exchange rate volatility	Independent	Quarterly	1986Q3-2013Q4	ERV Model: Model 1
FY	Foreign real income	Independent	Quarterly	1986Q3-2013Q4	Bureau of Economic Analysis
MER	Exchange rates	Independent	Quarterly	1986Q3-2013Q4	IMF/IFS
OX	Oil Export value	Transformation	Quarterly	1986Q3-2013Q4	CBN Stats & Reports
AX	Agriculture export value	Transformation	Quarterly	1986Q3-2013Q4	CBN Stats & Reports

Note: [1] Deflated nominal oil export value

[2] Deflated nominal agriculture export value

[3] Exchange rate volatility as derived from fundamental factors of exchange rate process

5.5 Conclusion

This chapter examined the two techniques (the BEEKK MGARCH and the ARDL) to be employed for the empirical analysis as well as the modelling structure of the two models identified for this thesis. The theoretical and empirical multivariate GARCH model for ERV model and distributed lag model for trade analysis were considered. Also, the chapter discusses the methods of testing properties of univariate and multivariate time series using the unit root tests. In addition, this chapter surveyed the theoretical and empirical modelling structure of the ERV model and trade model as applicable to the Nigerian economy.

Firstly, this chapter discussed the four-variable MGARCH BEKK model as would be applied in the empirical exchange rate volatility model in chapter five. The model is used to validate hypothesis 1 of this thesis that a one-time shock and volatility spillover effect of interest rate differential, productivity growth differential and oil price increases exchange rate volatility in Nigeria between 1986Q3 and 2013Q4. The internally generated volatility from this model is employed in model 2 as the endogenous exchange rate volatility series giving rise to the general equilibrium analysis of model 2.

The BEKK MGARCH is preferred and employed in this study over the other MGARCH analysis because it helps this study to model conditional variances and covariances, which other MGARCH methods are not capable to do. Also, it captures the joint effect of shocks to volatilities in interest rate, productivity growth and oil price on exchange rate volatility. More importantly, the application of BEKK MGARCH helps this study to investigate volatility transmissions between interest rate and exchange rate under the Abacha, Obasanjo and Yar'Adua's regime shocks using the Volatility Impulse Response Functions (VIRFs). As discussed in chapter two, interest and exchange rate market in Nigeria is expected to be linked in the policy analysis of this study. Also, the two markets are expected to have close connection under different regime shifts (that is, Abacha, Obasanjo and Yar'Adua's regimes).

Secondly, this chapter discussed the application of ARDL dynamic model in the second empirical model of this thesis to be applied in chapter six. The model is used to validate hypotheses 2a and 2b of this thesis in section 1.4 of chapter one. The ARDL is used in this thesis because it helps to fix the statistical challenges of the non-stationary data in the study and also help in economic policy analysis using its multiplier property. Fixing the statistical challenges of a non-stationary data is important in this study because the Nigeria's data employed are non-stationary and not cointegrated. The non-stationary data present the danger of serial correlation and a series with no long run relationship. Thus, the study employs the ARDL model because it is a dynamic model and its sufficient lags structure in the model helps to eliminate potential serial correlation.

Also, the ARDL is employed because its lagged property effectively deals with economic analysis, which is important in this study. The economic analysis is relevant in this study because of the deregulation policy effect of exchange rate volatility on trade over the sample period. The relationship between ERV and export demand (XD) in Nigeria requires introduction of lags so as to permit impact multiplier effect in the relationship. In addition, the multiplier effect of the ARDL technique is considered important in this study. The effect helps to understand the immediate or delayed effect of the interest rate and exchange rate deregulation policies since the inception of Structural Adjustment Program (SAP) in 1986 in Nigeria.

Thirdly, the chapter discussed the theoretical and empirical ERV model that is suitable for Nigeria. The theoretical ERV model detailed the flexible price monetary approach. The study proposed an exchange rate volatility model for Nigeria by including the effect of oil price to the general flexible monetary model of exchange rate volatility determination. This is mainly due to the fact that Nigeria is an oil exporting country with the majority of its income from oil. Therefore, the empirical modelling structure of the ERV for Nigeria in this thesis features the inclusion of oil price because of the effect of oil price overtime as detailed in chapter two. The model is considered using the volatility impulse response functions (VIRFs) of the BEKK MGARCH analysis.

Fourthly, the chapter discussed the theoretical and empirical trade model. The study followed the theoretical trade model advanced by Barkoulas, Baum & Caglayan (2002) as empirically investigated by Baum & Caglayan (2010). The empirical model for this study considers a major modification to Barkoulas et al model. In this thesis, the exchange rate volatility derived from model 1, which represent the true fundamental factors of exchange rate process is employed for the volatility proxy. This is considered suitable as it mirrors the fundamental drives of exchange rate volatility in Nigeria using the MGARCH analysis.

The thesis employs oil export demand and agriculture export demand models for model 2 to overcome aggregating bias as noted in the previous literature. Using aggregate trade data assumes that the effect of ERV is the same across sectors in terms size and direction. Thus, the true picture of the link between ERV and trade may be diluted and the probability of achieving significant results may reduce with aggregate data. Oil and agriculture exports are employed in this study because they are the major productive sectors with international trade composition in Nigeria. The study also notes that the two sectors were the focus of the major reforms in Nigeria, especially the deregulation policies in the interest rate and exchange rate market, which are the focus of this research analysis.

CHAPTER SIX: CAUSES OF EXCHANGE RATE VOLATILITY IN NIGERIA: A MULTIVARIATE GENERALIZED AUTOREGRESSIVE CONDITIONAL HETEROSCEDASTICITY (MGARCH) ANALYSIS

6.1 Introduction

The aim of this chapter is to investigate the causes of exchange rate volatility (ERV) in Nigeria using quarterly data from 1986Q3 to 2013Q4. The chapter aims to validate hypothesis 1 of this research: that one-time shock and volatility in interest rate, productivity growth and oil price drive exchange rate volatility in Nigeria between 1986 and 2013. The volatility impulse response functions (VIRFs) is used to analyse the results, given the complexity of the dynamic MGARCH BEKK. The study employs the impulse response analysis to explain the impact of historical shocks and events (Abacha, Obasanjo and the Yar'Adua regimes) on exchange rate volatility (see more details in chapter two).

Understanding the key factors that drive exchange rate volatility as well as the effect of historical shocks in interest rate volatility, productivity growth volatility and oil price volatility on exchange rate volatility in Nigeria between 1986 and 2013 is important in this study. It is important to do these because of the possible intense degree of volatility in exchange rate over the sample period and its effect on the economy (see chapter two for details). This study finds volatility of ER to be of great importance in Nigeria because larger part of the composition of Nigeria's growth is in the oil export, which occurs through exchange of currency. From the review of literature, this study gathers that an unstable exchange rate does not encourage international competitiveness. However, an internationally competitive economy achieves rapid economic growth. To support this, empirical literatures on Nigeria confirm that exchange rate volatility is harmful to the economy (see chapter three for details).

To have a comprehensive analysis of the ERV in Nigeria, the new open economy macroeconomics idea from chapter three is followed that the real shocks, such as productivity shocks, good demand shocks (government spending shifts) and labor supply shocks, among others should be included in the models of exchange rate determination in addition to monetary shocks. This study considers the new open economy macroeconomics idea important because shocks to business cycles arising from unstable political system, oil price and production affect variations in exchange rate in Nigeria overtime. That is, volatilities in exchange rate cannot be determined exogenously. As discussed in the literature review section, many factors such as, interest rate, economic openness, exchange rate regime, inflation, income, money supply, output levels and the random situations can cause volatility in exchange rate. However, the degree of the impact of each of these factors and how they contribute to exchange rate fluctuation vary, depending on the country's economic conditions.

It should be noted that given the theoretical and empirical significance of oil price in Nigeria, this study proposes a model that explicitly assumes the contribution of oil price in ERV determination. Oil is considered important for this study because it largely influences the capacity base of the Nigerian economy (see details in chapter two).[40] Thus, the study focuses on interest rate volatility, output growth volatility and oil price volatility as the key determinants of exchange rate volatility in Nigeria between 1986 and 2013. This study employs the monetary model of Frankel (1979) and the non-monetary idea of Calderon (2004) to explain exchange rate volatility model. The models are also represented in the existing studies on developing countries, particularly Nigeria (see chapter three for details).

[40] Oil is the major product of exchange and the dominant tradables

This study utilizes the GARCH-BEKK model (Baba, Engle, Kraft and Kroner, 1990) as discussed in chapters three of this thesis for three reasons. Firstly, the BEKK has the advantage of dealing with co-movements of interest rate, productivity growth, oil price and exchange rate using multivariate matrix operations. Using the BEKK for the four-variable dataset on Nigeria between 1986 and 2013 helps to estimate the dependency in the co-movement of volatility in a system. That is, the spillover effects from the interest rate, productivity growth and oil price to exchange rate in this study. The Multivariate GARCH model helps with the investigation of how shock transmits from the interest rate, productivity growth and oil price to exchange rate volatility. Also, the patterns of the transmission are comprehensively examined.

Secondly, the GARCH-BEKK approach permits this study to examine the relationships in the proposed model in terms of volatility. In other words, further analysis will be run through exchange rate volatility versus interest rate volatility, exchange rate volatility versus productivity growth volatility and exchange rate volatility versus oil price volatility. Thirdly, the use of BEKK framework makes it possible to combine monetary and non-monetary factors (see chapters three and four for details) in the explanation of ERV. Fourthly, the BEKK MGARCH analysis allows the use of Volatility Impulse Response Function (VIRFs) which captures the shock effects of interest rate, productivity growth and oil price overtime.

The chapter is structured as follows; section two examines the econometric specification and description of the ERV model. The section presents estimation techniques of Multivariate GARCH – BEKK with attention to the empirical specification. It also describes how exchange rate, interest rate, productivity growth and oil price variables are fitted into the BEKK MGARCH model. Section three is designed for the empirical results and analysis of the model using the VIRFs analysis from the MGARCH BEKK model.

The section also considers the preliminary investigations. Section four summarizes the findings and concludes the chapter.

6.2 Econometric Specification and Description of the Model

As discussed in the preceding chapter, this study employs the multivariate generalized autoregressive conditional heteroscedastic (MGARCH) with BEKK (Baba, Engle, Kraft and Kroner) framework as proposed by Engle and Kroner (1995) with the general mean models as[41]:

$$y_t = c + \Gamma y_{t-1} + \mathrm{e}_t \; ; \qquad 6.2.1$$

$$\mathrm{e}_t | I_{t-1} \sim N(0, H_t)$$

$$\mathrm{e}_t = H^{1/2} Z_t$$

$$y_t = [y_{1t}, y_{2t}, y_{3t}, y_{4t}]', \qquad 6.2.2$$

$$\mathrm{e}_t = [\mathrm{e}_{1t}, \mathrm{e}_{2t}, \mathrm{e}_{3t}, \mathrm{e}_{4t}]', \quad \text{and} \qquad 6.2.3$$

$$H_t = \begin{bmatrix} h11_t & h12_t & h13_t & h14_t \\ h21_t & h22_t & h23_t & h24_t \\ h31_t & h32_t & h33_t & h34_t \\ h41_t & h42_t & h43_t & h44_t \end{bmatrix} \qquad 6.2.4$$

When estimation is done by maximum likelihood, the joint Gaussian log-likelihood of a sample with T observations distribution is:

$$logL = \sum_{t=1}^{T} l_t \qquad 6.2.5$$

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[41] See chapter four for details of the specification of the mean equation. y_t represents a 4 x 1 vector of the various quarterly series at time t while c is a 4 x 1 vector of constants and Γ represents 4 x 4 matrix of parameters related to lagged values of the monetary and real factors employed in the model. e_t is a 4 x 1 random error vector at time t, which has a 4 x 4 conditional covariance matrix H_t. I_{t-1} is the shock information set at time $t-1$.

While the contribution of e_t is:

$$l_t = -\frac{N}{2}\ln(2\pi) - \frac{1}{2}\ln\ |\mathrm{H}_t| - \frac{1}{2} e_t' \mathrm{H}_t^{-1} e \qquad 6.2.6$$

However, under the Quasi-Maximum-Likelihood (QML) estimation assumption, the conditional distribution of e_t is:

$$e_t \left| I_{t-1} \sim g\left(H_t^{-1/2} e_t\right) |\mathrm{H}_t^{-1/2}\right| \qquad 6.2.7$$

and the contribution of e_t to the log-likelihood in the assumption reads as:

$$l_t = \ln g\left(\mathrm{H}_t^{-1/2} e_t\right) \ln |\mathrm{H}_t^{-1/2}| \qquad 6.2.8$$

This study investigates the effect of interest rate volatility, productivity growth volatility and oil price volatility in Nigeria between 1986 and 2013. As discussed in chapters three and four, this study is interested in the variance-covariance equation. The BEKK (1 1) for this study is expressed as:

$$H_t = \mathrm{C_0 C'_0} + \mathrm{A_{11} e_{t-1}\, e'_{t-1} A'_{11}} + \mathrm{B_{11} H_{t-1} B'_{11}} \qquad 6.2.9$$

where H_t is a 4 x 4 conditional variance-covariance matrix of exchange rate determinants. $\mathrm{C_0}$ is a 4 x 4 restricted matrix of lower triangular constants. A is a 4 x 4 matrix with diagonal parameters, a_{ii}, measuring the impacts of own past shocks on their individual volatility and off-diagonal parameters, a_{ij}, measuring the effect of variable i's past shock on variable j's volatility. B is 4 x 4 matrix with diagonal parameters, b_{ii}, measuring the impacts of own past volatility on their individual conditional variance and off-diagonal parameters, b_{ij}, measuring the effect of variable i's past volatility on variable j's conditional variance. The variables in this model are arranged in the following order; ER (1), IRD (2), PGD (3) and OIL (4). This is represented in the matrix as:

$$\begin{bmatrix} h11_t & h12_t & h13_t & h14_t \\ h21_t & h22_t & h23_t & h24_t \\ h31_t & h32_t & h33_t & h34_t \\ h41_t & h42_t & h43_t & h44_t \end{bmatrix} = \begin{bmatrix} c11 & c12 & c13 & c14 \\ c21 & c22 & c23 & c24 \\ c31 & c32 & c33 & c34 \\ c41 & c42 & c43 & c44 \end{bmatrix}$$

$$+ \begin{bmatrix} a11 & a12 & a13 & a14 \\ a21 & a22 & a23 & a24 \\ a31 & a32 & a33 & a34 \\ a41 & a42 & a43 & a44 \end{bmatrix} \begin{bmatrix} e_{1,t-1}^2 & e_{1,t-1}e_{2,t-1} & e_{1,t-1}e_{3,t-1} & e_{1,t-1}e_{4,t-1} \\ e_{2,t-1}e_{1,t-1} & e_{2,t-1}^2 & e_{2,t-1}e_{3,t-1} & e_{2,t-1}e_{4,t-1} \\ e_{3,t-1}e_{1,t-1} & e_{3,t-1}e_{2,t-1} & e_{3,t-1}^2 & e_{3,t-1}e_{4,t-1} \\ e_{4,t-1}e_{1,t-1} & e_{4,t-1}e_{2,t-1} & e_{4,t-1}e_{3,t-1} & e_{4,t-1}^2 \end{bmatrix} \begin{bmatrix} a11 & a12 & a13 & a14 \\ a21 & a22 & a23 & a24 \\ a31 & a32 & a33 & a34 \\ a41 & a42 & a43 & a44 \end{bmatrix}'$$

$$+ \begin{bmatrix} b11 & b12 & b13 & b14 \\ b21 & b22 & b23 & b24 \\ b31 & b32 & b33 & b34 \\ b41 & b42 & b43 & b44 \end{bmatrix} \begin{bmatrix} h11_{t-1} & h12_{t-1} & h13_{t-1} & h14_{t-1} \\ h21_{t-1} & h22_{t-1} & h23_{t-1} & h24_{t-1} \\ h31_{t-1} & h32_{t-1} & h33_{t-1} & h34_{t-1} \\ h41_{t-1} & h42_{t-1} & h43_{t-1} & h44_{t-1} \end{bmatrix} \begin{bmatrix} b11 & b12 & b13 & b14 \\ b21 & b22 & b23 & b24 \\ b31 & b32 & b33 & b34 \\ b41 & b42 & b43 & b44 \end{bmatrix}' \qquad 6.2.10$$

This study employs the full information quasi-maximum likelihood approach for efficient and consistent BEKK system estimation. The quasi-maximum likelihood approach is used because the series violate normality condition (details in the next section) and employ the log likelihood contributions of GARCH models in the system (see details in chapters three and four).

Given the complexity of the model, this study employs the volatility impulse response (VIR) analysis for a comprehensive discussion of the factors that drive exchange rate volatility in Nigeria between 1986 and 2013. The study considers shock to be drawn from the distribution of e_t. The conditional covariance matrix H_t is a function of the innovations e_1,…, e_{t-1} as well as the initial shock e_0 and H_0. Considering the GARCH BEKK (1 1) in equation 6.2.9 with four variables, $V_t(e_0)$ is an N*-dimensional vector with N*=10. The first, fifth, eighth and tenth element of $V_t(e_0)$ represent the impulse responses of the conditional variances of the first, second, third and fourth variables respectively. The second, third, fourth, sixth, seventh and ninth elements of $V_t(e_0)$ are the response of the conditional covariances. The VIRFs is the impact of an infinitesimal change in $vec(e_0 e_0')$ on volatility, scaled by the actual centered (squared) innovation vector $vec(e_0 e_0' - I_N)$.

The VIRFs of the BEKK (1 1) for this study is expressed as

$\Phi_t = (\mathrm{A}_1 - \mathrm{B}_1)^{t-1}\mathrm{A}_1$ with the special case:

$$V_t(e_0) = (\mathrm{A}_1 + \mathrm{B}_1)^{t-1}\mathrm{A}_1 D_N^{+} D_N^{+}\left(H_0^{\frac{1}{2}} \otimes \mathrm{H}_0^{\frac{1}{2}}\right) D_N \mathrm{vech}(e_0 e_0' - I_N) \qquad 6.2.11$$

$$= (\mathrm{A}_1 + \mathrm{B}_1) V_{t-1}(e_0) \qquad 6.2.12$$

6.3 Empirical Result and Analysis

6.3.1 The Unit Root Test Results

First, this study carries out the stationarity test on the official exchange rate (ER), domestic nominal interest rate (NIR), foreign nominal interest rate (UIR), domestic productivity growth ($NGDP$), foreign productivity growth ($UGDP$) and oil price (OIL). This is to determine the order of integration of the series and to establish the applicability of the series. The test is important because econometric estimation of model based on time series data demands that the series be stationary, as non-stationary series usually result in misleading inferences (see chapter five for details). The variables employed in the exchange rate volatility model for this study are expressed in their log forms. The study includes an appropriate number of lags for the dependent variable as automatically specified by the t-test statistics in the regression to confirm that disturbance in the equation is white noise. This study employs three popular and commonly used stationarity tests of Augmented Dickey Fuller (ADF), Phillips Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) on the series. The KPSS is employed to cross-check the result using a different null hypothesis statement. The results of the tests without time trend and with time trend are presented in tables 6.1 and 6.2.

Also, given the pattern of the series employed in the proposed model, a structural break unit root test is conducted. This is equally important because conventional unit root tests above might be biased toward a false unit root null when the data are trend stationary with a structural break. The null hypothesis of the additive outlier test employed states that the data series follow unit root process with a break while the alternative depicts that the series is a trend stationary series with break. The test is considered appropriate in this study because the data is first detrended and the unit root test is carried out on the results from the detrending Perron & Vogelsang (1992). Therefore, it becomes easier to test both the series with trend and no-trend break in the same system as most of the series suggest trends than breaks. The Minimize the Dickey-Fuller t-statistic is employed to select break date that gives the utmost evidence that reject the null hypothesis of a unit root in favor of alternative hypothesis of a breaking trend. The results of the test without time trend and with time trend are reported in table 6.3, following the additive outlier test chosen for stationarity test with breakpoint.

i. Augmented Dickey Fuller (ADF), Philip Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) Results

Table 6. 1: Unit root tests at Levels

Type of Tests							
	ADF		PP		KPSS		Stationarity
Variable	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
UGDP	-0.6345 (0.8573)	-1.9592 (0.6165)	-0.6264 (0.8592)	-1.3664 (0.8655)	1.3383 (0.0000)	2.9129 (0.0000)	NS
NGDP	5.8380 (1.000)	-9.5611 (0.9791)	0.8094 (0.9938)	-3.0716 (0.1183)	1.1950 (0.0000)	0.3521 (0.0000)	NS
NIR	-2.1499 (0.2260)	-3.1871 (0.0931)	-2.8821 (0.0507)*	-2.9677 (0.1461)	0.1444 (0.0000)	0.1325 (0.0000)	NS
UIR	-1.7086 (0.4241)	-2.4304 (0.3619)	-1.7487 (0.4041)	-2.8167 (0.1946)	0.6615 (0.0000)	0.1598 (0.0000)	NS
ER	-0.4903 (0.8879)	-1.9041 (0.6457)	-0.5219 (0.8817)	-2.0759 (0.5531)	0.7898 (0.0000)	0.0984 (0.0000)	NS
MER	-0.3189 (0.9174)	-2.1983 (0.4855)	-0.3528 (0.9121)	-2.2758 (0.4432)	1.0553 (0.0000)	0.0957 (0.0000)	NS
OIL	-0.6747 (0.8478)	-2.4775 (0.3386)	-0.4713 (0.8915)	-2.5664 (0.2965)	0.4120 (0.0000)	0.1368 (0.0000)	NS

Notes: i. The Null Hypothesis for the ADF and PP tests is that the series has a unit root.

ii. The Null Hypothesis for the KPSS test is that the series is stationary.

iii. Critical Values for ADF and PP tests (Intercept) are (10 percent) -2.58, (5 percent) -2.89 and (1 percent) -3.49.

iv. Critical Values for ADF and PP tests (Intercept & trend) are (10 percent) -3.15, (5 percent) -3.45 and (1 percent) -4.04.

v. Critical Values for KPSS test (Intercept) are (10 percent) -2.58, (5 percent) -2.89 and (1 percent) -3.49.

vi. Critical Values for KPSS test (Intercept & trend) are (10 percent) -3.15, (5 percent) -3.45 and (1 percent) -4.04.

vii. * indicates that Philip Perron test confirms that the NIR series is statistically significant for intercept specification at 10% level of significance.

viii. The study takes decision of at least 5% significance level.

From table 6.1, the results from ADF, PP and KPSS tests indicate that the series are non-stationary in level forms. The ADF and PP tests statistically fail to reject the null hypothesis that all the series (UGDP, NGDP, NIR, UIR, ER, MER and OIL) have unit roots at 5% level. The result is supported by the KPSS test which shows that the null hypothesis that all the series (UGDP, NGDP, NIR, UIR, ER, MER and OIL) have no unit roots at 5% level is rejected. Only PP test indicates that the NIR series is statistically significant for intercept specification at 10% level of significance. The series are all not I(0) processes based on Schwarz Information Criterion (SIC) automatic lag selection and the MacKinnon (1996) one-sided probability values. This means that there is common stochastic movement in each of the NGDP and UGDP series. We then proceed to first difference.

Table 6. 2: Unit root tests at First Difference

Type of Tests							
	ADF		PP		KPSS		Stationarity
Variable	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Intercept	Intercept & Trend	
UGDP	-6.6861***	-6.6731***	-6.8635***	-6.8488***	0.0402***	0.0403***	S
NGDP	-35.3356***	-51.1271***	-15.1716***	-20.9791***	0.0496***	0.0112***	S
NIR	-5.2538***	-5.4085***	-10.0998***	-10.4146***	0.2729***	0.0875***	S
UIR	-3.9927***	-4.9631***	-4.9415***	-4.9245***	0.0475***	0.0326***	S
ER	-9.4785***	-9.4349***	-9.4785***	-9.4349***	0.0346***	0.0910***	S
MER	-9.7383***	-9.6996***	-9.7365***	9.6976***	0.0308***	0.0829***	S
OIL	-9.6684 ***	-9.6640***	-9.8359***	-13.7663***	0.0692***	0.0320***	S

Notes: i. The Null Hypothesis for the ADF and PP tests is that the series has a unit root.

ii. The Null Hypothesis for the KPSS test is that the series does not have unit root.

ii. Critical Values for ADF and PP tests are as in table 6.1.

iii. *** indicates that both ADF and Philip Perron test confirms that UGDP, NGDP, NIR, UIR, ER, MER and OIL series are statistically

significant for intercept as well as intercept and trend specification at 1% level of significance.

From table 6.2, the results from ADF, PP and KPSS tests show that UGDP, NGDP, NIR, UIR, ER, MER and OIL are all I(1) processes based on Schwarz Information Criterion (SIC) automatic lag selection and the MacKinnon (1996) one--sided probability values at first difference. Given the ADF and PP tests, we easily reject the null hypothesis of a unit root at 5% significance level for the intercept and intercept and trend specification of the series. Similarly using the KPSS, the study fails to reject the null hypothesis of no unit root at 5% significance level for the intercept and intercept and trend specification. The results conform to some other studies, such as Baak (2008) that most macroeconomics variables are expected to possess a unit root. Thus, this study concludes that the series are integrated of order one.

ii. Breakpoint Stationarity Result

Table 6. 3: Breakpoint Unit root tests at Levels

Trend Specification	Intercept	Trend and Intercept	Stationarity
UGDP	-1.4189 (>0.99)	-2.9836 (0.9162)	NS
NGDP	-1.6997 (>0.99)	-3.9015 (0.4347)	NS
NIR	-3.6143 (0.3235)	-4.8316 (0.0543)*	NS
UIR	-3.7870 (0.2419)	-4.2304 (0.2418)	NS
ER	-2.5435 (0.8898)	-2.8372 (0.9486)	NS
MER	-1.9601 (0.9843)	-2.8736 (0.9426)	NS
OIL	-1.2607 (>0.99)	-3.3064 (0.7996)	NS

Notes: i. The Null Hypothesis for the tests is that: the series has a unit root.
ii. * indicates that ADF test confirms that the NIR series is statistically significant for intercept and trend specification at 10% level of significance.

From table 6.3 above, the results from the ADF unit root with break test suggest that UGDP, NGDP, NIR, UIR, ER, MER and OIL are statistically not significant to reject the null hypothesis of unit root at 5% significant levels. However, the ADF test indicates that the NIR series is statistically significant only for intercept and trend specification at 10% level of significance. The series are not stationary in level forms for both intercept and intercept & trend specifications as confirmed by the probability values from the ADF test statistics. That is the series are all not I(0) processes based on Schwarz Information Criterion (SIC) automatic lag selection and the Vogelsang (1993) asymptotic one-sided probability values. This result is like the standard tests conducted earlier in table 6.1, which means that there is common stochastic movement in each of the series. Thus, a higher order differencing is required.

Table 6. 4: Breakpoint Unit root tests at First Difference

Trend Specification	Intercept	Trend and Intercept	Stationarity
UGDP	-7.1251 (<0.01)***	-7.3863 (<0.01)***	S
NGDP	-34.2008 (<0.01)***	-40.4409 (<0.01)***	S
NIR	-14.5235 (<0.01)***	-14.0817 (<0.01)***	S
UIR	-5.4628 (<0.01)***	-5.4939 (<0.01)***	S
ER	-20.3654 (<0.01)***	19.2292 (<0.01)***	S
MER	-18.2789 (<0.01)***	17.3771 (<0.01)***	S
OIL	-12.4774 (<0.01)***	-12.7580 (<0.01)***	S

Notes:
i. The Null Hypothesis for the tests is that: the series has a unit root.
ii. *** indicates that ADF test confirms that UGDP, NGDP, NIR, UIR, ER, MER and OIL series are statistically significant for intercept as well as intercept and trend specification at 1% level of significance.

Table 6.4 above shows that the null hypotheses of unit roots are rejected for UGDP, NGDP, NIR, UIR, ER, MER and OIL in the intercept as well as trend and intercept break specification at 1% significance level. The series are stationary at first difference on intercept specification and intercept and trend specification as confirmed by the probability values from the ADF statistics. This implies that the series are all I(1) processes based on Schwarz Information Criterion (SIC) automatic lag selection and the Vogelsang (1993) asymptotic one-sided probability values. This result is similar to the standard tests in table 6.2, which means no further differencing is required. The implication is that all the series passed the preliminary test. Thus, we conclude that all the series in this study are integrated of order one.

6.3.2 BEKK-MGARCH Estimation, Presentation of Result and Analysis of Factors that Drive Exchange Rate Volatility in Nigeria (1986 – 2013)

This section presents the estimation procedure for the Nigerian exchange rate volatility (ERV) model using the multivariate GARCH methods. The section reports and analyzes the estimated results on the causes of exchange rate volatility (ERV). The study employs a four-variable MGARCH models as the standard practice in the application of BEKK MGARCH approach. A four-variable model is considered because BEKK model estimation possesses large computation as a result of numerous matrix transpositions (see more details in chapters three and four). Thus, the BEKK is limited to maximum of four variables in the system to make computation easier and avoid non-convergence result.

i. Estimation Procedure for Exchange Rate Volatility Model: Multivariate Volatility Dynamics

Before estimating the multivariate volatility model, there is the need to prewhiten the series by estimating univariate AR(1) models for all the series. The process of prewhiten is important because each series must be tested for heteroscedasticity and correlation. The study later uses the univariate residuals for the multivariate volatility modelling. According to Hafner & Herwartz (2000; 2006), conditional heteroscedasticity should be considered for an inference on AR coefficients. The major way to achieve robust inference from the AR coefficients is by specifying univariate volatility models for exchange rate (ER), interest rate (IR), productivity growth (PG) and oil price (OP). The study then employs the Quasi-Maximum Likelihood (QML) standard errors from all the AR(1) parameters.

First, the study defines ERV_t, IRD_t, PGD_t and OIL_t as the logarithm exchange rate, interest rate, productivity growth and oil price, respectively. Thereafter, the study estimates AR(1) representation of the univariate models to prewhiten the series. The prewhiten technique is employed to identify the filter, which can transform the series into white noise. Identifying the filter and transforming the series into white noise helps to construct an appropriate model.

$$ERV_t = \frac{27.2812}{5.7861} + \frac{0.6854ERV_{t-1}}{13.2940} + \hat{e}_{1t} \qquad 6.3.1$$

$$IRD_t = \frac{1.9683}{4.6459} + \frac{0.8837IRV_{t-1}}{37.0728} + \hat{e}_{2t} \qquad 6.3.2$$

$$PGD_t = \frac{0.0010}{0.7232} - \frac{0.2582PGV_{t-1}}{-2.4450} + \hat{e}_{3t} \qquad 6.3.3$$

$$OIL_t = \frac{0.0118}{0.7844} + \frac{0.6897OPV_{t-1}}{11.9921} + \hat{e}_{4t} \qquad 6.3.4$$

The study computes diagnostic statistics using the squared standardized residuals which show that the models above sufficiently capture the essential conditional heteroscedasticity and serial correlation in all the series. However, the residual processes suggest excess kurtosis whereby the assumption of normality is strongly violated.

This study applies the ARCH-LM test to the residual of a univariate AR(1) model as suggested by Engle (1982). The results of the ARCH-LM test show that a higher order model is not required. Thus, the study chooses the BEKK model in equation 5.2.2 with order *K=p=q=1*, which is simplified in equation 5.2.9. The QML estimation for the BEKK model is implemented in this study because the residual processes suggest excess kurtosis. However, the two distributional assumptions for e_t are reported as:

$e_t|I_{t-1} \sim N(0, \mathrm{H}_t)$, and

$$e_t \left| I_{t-1} \sim g\left(\mathrm{H}_t^{-1/2} e_t\right) |\mathrm{H}_t^{-1/2}\right|.$$

ii. Presentation of BEKK MGARCH Results for Determinants of ERV in Nigeria (1986 – 2013)

Table 6.5 presents the estimated parameters. The t-ratios are in parentheses. The estimated degree of freedom as well as the improvement achieved from the $(0, \Omega_t, v)$ model on log-likelihood is regarded as strong evidence that the model is non-Gaussian. Moreover, it favours the leptokurtic innovations ξ_t. Thus, this study concludes that independent innovations to the multivariate exchange rate volatility model for Nigeria are not Gaussian. This justifies the use of VIRFs model.

In addition, the eigenvalue of the estimates of $A_{11} \oplus A_{11} + B_{11} \oplus B_{11}$ are reported in table 6.5. The results show that the two parameterizations confirm stationarity and high persistence of covariance because the largest of the eigenvalues is less than one.

Table 6. 5: Presentation of BEKK MGARCH Result for Nigeria's Exchange Rate Volatility Model

Variable	C_0	$A = a_{ij}$	b_{ij}	p_i	logL
i j	$e_t \mid I_{t-1} \sim N(0, \mathrm{H}_t)$				
1 1	2.5577 (4.5483)	1.4819*** (0.0000)	0.2804*** (0.0000)	0.2921	347.18
2 1	0.4351 (1.6745)	-0.5001 (-1.1067)	-0.2415 (-0.4270)	0.1874	
2 2	-0.2552 (-0.7385)	0.8346*** (0.0000)	0.8764*** (0.0000)	0.1012	
3 1	-0.0040 (-1.0130)	-1.9168 (-0.229)	0.5222 (0.1734)	0.9342	
3 2	-0.0018 (-0.4027)	1.0550 (0.6170)	-0.5100 (-0.2851)	0.5811	
3 3	-	0.5732*** (0.0000)	-0.0795 (-0.4287)	0.4380	
4 1	0.0007 (0.0168)	5.6929 (0.8622)	-7.1151 (-1.4026)	0.4338	
4 2	0.0715 (4.8916)	-5.6548*** (0.0000)	6.9204*** (0.0000)	0.2982	
4 3	-	-0.0220 (-0.9743)	0.0533 (1.5414)	0.4338	
4 4	-	-0.3622*** (0.0000)	0.1445 (0.6188)	0.2982	

The above table shows mixed results. Going by the model specification, the results are grouped into three categories, such as one-time shock effects, volatility effects and GARCH effects. The findings in table 6.5 are summarized in table 6.6 with discussions thereafter.

Table 6. 6: Presentation of BEKK MGARCH Result for Nigeria's Exchange Rate Volatility Model (Cont.)

	$e_t \left\| I_{t-1} \sim g\left(\mathrm{H}_t^{-1/2} e_t\right) \right\| \mathrm{H}_t^{-1/2} \Big\|$				
1 1	0.2542 (4.5353)	-0.5429*** (0.0000)	-0.0594*** 0.0003)	0.7057	294.32
2 1	0.5427 (3.0453)	-0.9632*** (0.0000)	-0.9375*** (0.0000)	0.4695	
2 2	-0.1590 (0.4351)	0.4967*** (0.0000)	0.8308*** (0.0000)	0.3860	
3 1	0.0038 (0.8922)	-0.9745*** (0.0000)	-0.0193*** 0.0003)	0.1879	
3 2	-0.0057 (-1.1829)	0.525 (1.1068)	-0.0562 (-0.0889)	0.1215	
3 3	-	0.8228*** (0.0000)	0.2506*** (0.0000)	0.1219	
4 1	-0.0956 (-3.8100)	-0.1388*** (0.0000)	0.2690 (1.5916)	0.6098	
4 2	0.0032 (0.0473)	0.4581*** (0.0000)	0.9367*** (0.0000)	0.5034	
4 3	-	-0.0122 (-0.3659)	0.0086 (0.3489)	0.3539	
4 4	-	-0.2976*** (0.0000)	0.7061*** (0.0000)	0.1450	

Notes:1. *, ** and *** indicate statistically significant at 10%, 5% and 1% level of significance respectively.
2. '–' means an estimate with 0.0000 coefficient.
3. p_i, i=1,…,10 are the matrix $A_{11} \oplus A_{11} + B_{11} \oplus B_{11}$ engienvalues
4. logL means the value for the log-likelihood function

iii. Summary of BEKK MGARCH Results for Determinants of Exchange rate Volatility in Nigeria (1986-2013)

Considering the exchange rate volatility model estimated above, table 6.6 summarizes the one-time shock and volatility effects of interest rate, productivity growth and oil price on exchange rate volatility in Nigeria over the sample period. It also discusses the GARCH effects.

Firstly, the table shows the shock effects of interest rate, productivity growth, oil price on the exchange rate volatility in Nigeria. This validates the first part of hypothesis 1 of the current research that shock effects of interest rate, productivity growth and oil price raise exchange rate volatility in Nigeria between 1986 and 2013. Secondly, the table shows the volatility effects of interest rate, productivity growth and oil price on the exchange rate volatility in Nigeria. This validates the second part of hypothesis 1 of this thesis that only interest rate and productivity growth have persistent relationship with ERV in Nigeria overtime. Oil price has no persistent relationship with ERV in Nigeria.

Thirdly, the table highlights the GARCH effects in the exchange rate, interest rate, productivity growth and oil price series to ensure their applicability and validity in the MGARCH BEKK model. The results suggest that the analyses associated with all the series are valid. As reviewed in chapter three of this thesis, the parameters in BEKK do not provide comprehensive analysis because it is a dynamic model. Thus, to overcome this challenge, this thesis presents the volatility impulse response functions (VIRFs) analysis in section 6.4. The volatility impulse response (VIR) analysis permits direct interpretations of the parameters in the model. In addition, it provides the degree of association within the system and presents shock effects in the dynamic system.

6.4 Volatility Impulse Response Functions (VIRFs) Analysis

This section analyzes the dynamic relationship of interest rate, productivity growth and oil price on exchange rate volatility, given the historical shocks that fall within the sample period. The study categorized this in chapter two as the Abacha regime, Obasanjo regime and Yar'Adua regime. The analysis is associated with the political regime shift, policy reversal and the sudden oil price shock in Nigeria overtime. These seem to follow the volatility spillover effect over the period (see table 6.6). This study analyzes the volatility impulse response of exchange rate volatility, interest rates, productivity growth and the oil price as related to the BEKK result in section 6.3. The study considers the historical shocks that fall within the sample period and later examines the volatility shocks and their effects on the estimated model.[42]

This study assumes the baseline to be zero (more details in chapter four) while the shock is given by the estimated residual $\delta = e_0$. The study takes both estimated residual e_0 and estimated volatility state H_0 for the quarter during which the shock occurred. The study constructs the standardized residuals ξ_0 from which $V_t(\xi_0)$ is calculated. The empirical analysis in this section is supported by the unrestricted BEKK model with t-distributed error terms (see details in section 6.3). In addition, the impulse responses are scaled with respect to the estimated conditional volatilities at the time the shock occurred. Consequently, this study interprets the scales as percentage deviations of the 'shock scenario' with respect to the 'baseline scenario'.

Figure 6.1 to 6.3 show the impulse responses of ERV, IRD, PGD and OIL over the sample period. The analysis in this study features the responses from the variances of exchange rate, interest rate, productivity growth and oil price to the different random shocks in the sample from section 6.4.1 to 6.4.3.

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[42] See chapter five for details about the choice of shock.

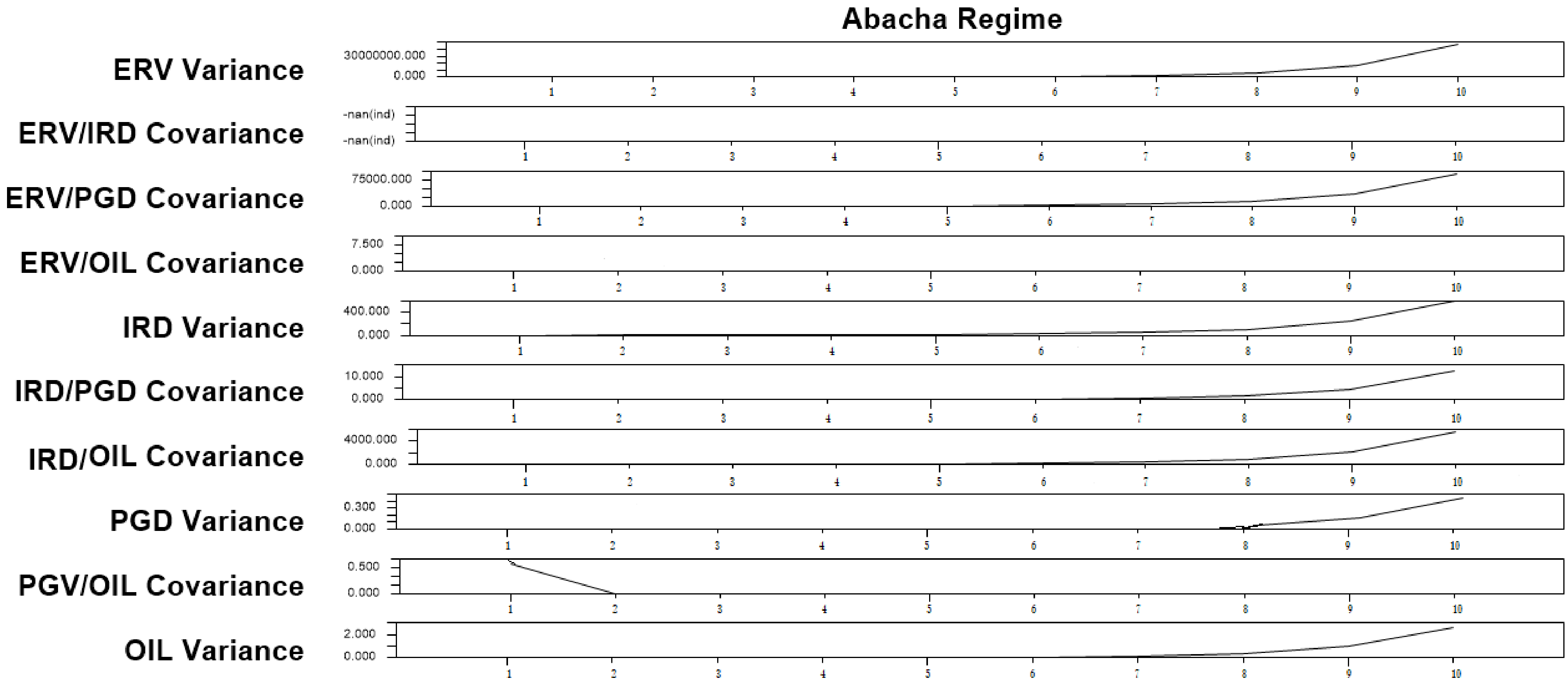

Figure 6. 1: Volatility Impulse Response Functions (VIRFs) for Abacha Regime shocks

Note: The figure relates to the shock in 1991Q1 at the start of Abacha regime. Row 1 is the exchange rate variance, row 2 is the covariance between exchange rate and interest rate, row 3 is the covariance between exchange rate and productivity growth, row 4 is the covariance between exchange rate and oil price, row 5 is the interest rate variance, row 6 is the covariance between interest rate and productivity growth, row 7 is the covariance between interest rate and oil price, row 8 is the productivity growth variance, row 9 is the covariance between productivity growth and oil price, row 10 is the oil price variance.

6.4.1 The Abacha Regime

The shock that occurred in the first quarter of 1991 has estimated residual $e_0 = (0.004659863,\ -0.040473351, 0.020096002, -0.012374741)'$ and estimated volatility state $\text{vech}(H_0) = (3.504, -2.490, 8.133, 0.029, 0.121, -0.004, -0.377, 0.883, 0.013, 0.092)'$ which are expressed in $e + 04$. The shock is strongly positive in exchange rate, interest rate, productivity growth and oil price.

Figure 6.1 above shows the impulse responses to the Abacha regime shock. From this, the study finds that ERV, IRD, PGD, and OIL started at zero (this is subject to the baseline of shock employed). The results confirm that ERV, IRD, PGD and OIL do not react to shocks in the Abacha regime immediately and up till the 3rd period when interest rate began to rise gradually. This study attributes the response of IRD in the third period to the interest rate deregulation policy of SAP. The results suggest that, although there is no immediate response of this shock on the economy, the first response is from the interest rate (although sparingly).

Exchange rate and oil price respond to the shock after period six. This is to further confirm the dynamic effect of interest rate in influencing fluctuations in exchange rate in Nigeria over the considered period. The productivity growth does not respond to the Abacha regime shock until after the eighth period. Meanwhile, IRD, ERV and OIL start to react positively to the shock after the 3rd, 6th and 6th period respectively. This result aligns with the BEKK result in section 6.3, that interest rate influences exchange rate volatility both temporarily and permanently. The BEKK result also demonstrates that both interest rate and exchange rate market are well-connected. This result validates the behaviour of the Nigerian economy in several ways.

Firstly, the early period of SAP does not witness much impact of the shock on exchange rate volatility, interest rate volatility, productivity growth volatility and oil price volatility. This means that SAP does not have spontaneous impact on the Nigerian economy. Secondly, productivity growth has a lingering reaction to the policy shock unlike the interest rate, oil price and exchange rate. This result suggests that even when other economic factors in the model are later influenced by the shock, productivity growth remain unaffected until the eight period. This study finds that interest rate influences both exchange rate and oil price with a later subsequent effect on productivity growth.

Thirdly, interest rate reacts to the shock in the third period. The reaction of interest rate suggests that interest rate is the first economic factor to react to the Abacha regime shock within the system. The result also indicates that the SAP reform first has a positive effect on the general price level and subsequently transmits into exchange rate and later to the real economic factor. The implication of this result as applied to hypothesis 1 of this thesis is that past innovations from interest rate raises exchange rate volatility in Nigeria between 1986 and 2013. This result further demonstrates that the interest rate market and exchange rate market are well-connected in Nigeria.

The result could be attributed to the effect of higher interest rate in Nigeria compared to its foreign counterparts. The adoption of SAP in 1986 led to flexible and rising interest rate in Nigeria and raises volatility in exchange rate. That is, a higher interest rate due to an expected loss in the value of money leads to fall in the demand for domestic currency. The fall in the demand for domestic currency results in depreciation of the home currency (that is, a rise in the exchange rate). The increase in relative interest rate leads to increase in exchange rate (depreciation of exchange rate). Hence, there is a positive relationship between the nominal interest rate and persistence in exchange rate changes since the SAP reform in 1986.

This result is not surprising because surplus money in the economy is cleared when demand for money reduces through higher interest rate. There is increase in the general price level due to higher interest rate and consequently there is decrease in the value of money. A fall in the value of money reduces demand for local currency leading to increase in the price of exchange. That is, higher interest rate raises persistence in the exchange rate changes. Thus, given Nigeria's interest rate deregulation policy, the result establishes that previous shocks in the interest rate raised persistence in changes in the exchange rate overtime. This result supports the earlier findings in the case of Nigeria that interest rate triggers unstable rate of exchange.[43]

The implication of this result as applied to hypothesis 1 of this thesis is that past innovations from interest rate is strongly connected with the volatility in exchange rate in Nigeria during the Abacha regime shock. The persistence and the linkages between interest rate volatility and exchange rate volatility may be attributed to the effect of deregulation policies on both interest rate and exchange rate during SAP and since 1986. This result is not surprising because the policy reform led to increase in the interest rate and exchange rate due to market forces effect. The forces of demand and supply dictate the price in the foreign exchange market. Similarly, the forces of demand and supply dictate price in the financial market. The two markets are linked together through relative prices and thus move together with persistency. Thus, this study concludes that interest rate has both one-time effect and persistent effect on exchange rate volatility in Nigeria between 1986 and 2013.

[43] Ajao & Igbokoyi (2013); Adamu, *et al* (2017)

Theoretically, this result supports the flexible monetary determination of ER model (as discussed in chapter three) that a rise in the local relative to foreign interest rate reduces domestic money demand and causes local currency to depreciate (that is, increase in the rate of exchange). This result confirms that interest rate is an important factor that determines exchange rate in Nigeria. Furthermore, interest rate is found to be indispensable in the growth of the Nigerian economy. Hence, there is a positive relationship between the nominal interest rate and persistence in exchange rate given the Structural Adjustment Programme policy.

However, the result from this study differs from most findings relating to the industrialized economies. For instance, Utami & Inanga (2009) study on Indonesia and Japan may not be relevant to the Nigerian system because interest rate as practiced in the industrialized economies differs from what is obtainable in the developing economies, such as Nigeria.[44] The structure of interest rate in the developed economies is mostly strict and regulated by monetary regulations while market forces determine the rate of interest in most developing countries. Thus, this study confirms that monetary determination of exchange rate volatility is more of flexible model than the sticky price model; given that interest rate in Nigeria has been deregulated since 1986.

[44] Utami & Inanga, (2009) found that interest rate differentials had a statistically significant negative effect on the Indonesian exchange rate cum Japan and no statistically significant relationship on other developed economies

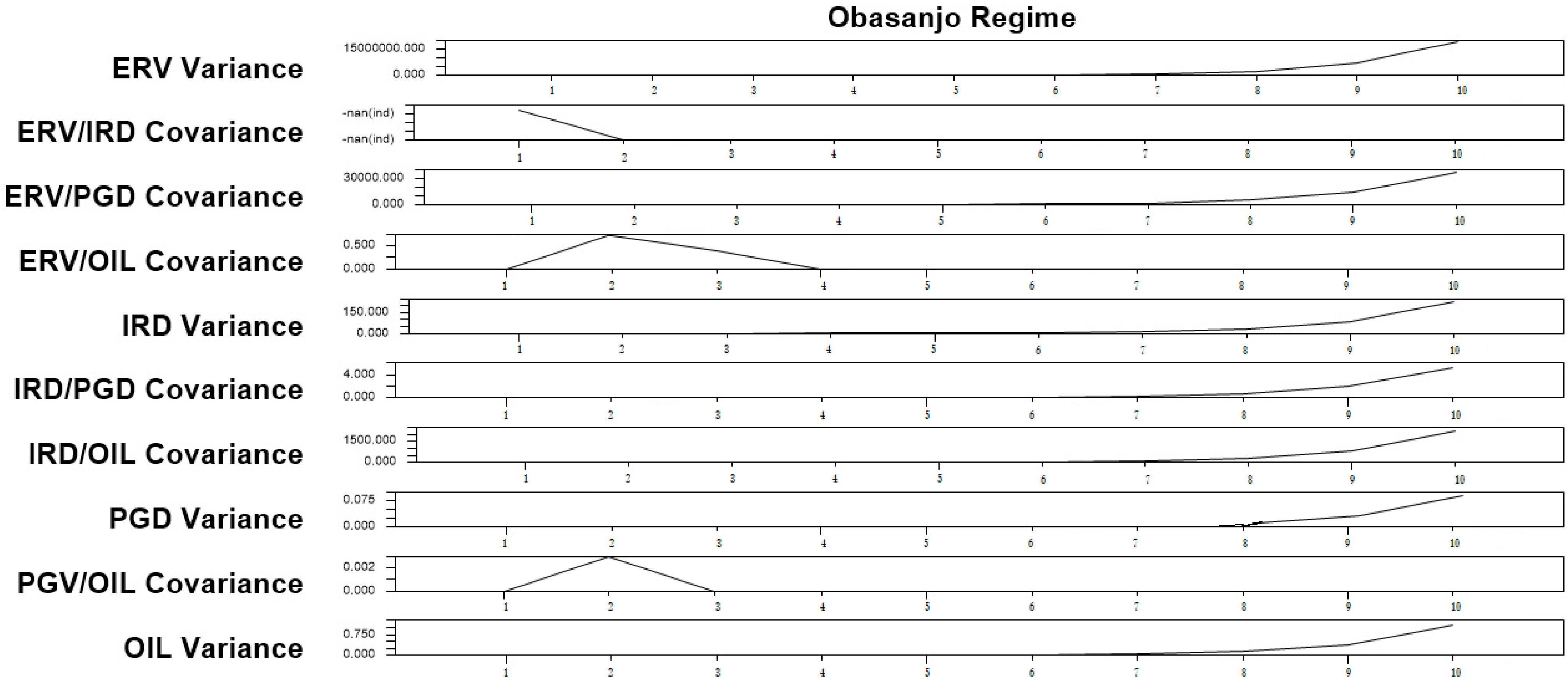

Figure 6. 2: Volatility Impulse Response Functions (VIRFs) for Obasanjo Regime shocks

Note: The figure depicts shock in 1999Q3 at the beginning of Obasanjo regime. Row 1 is the exchange rate variance, row 2 is the covariance between exchange rate and interest rate, row 3 is the covariance between exchange rate and productivity growth, row 4 is the covariance between exchange rate and oil price, row 5 is the interest rate variance, row 6 is the covariance between interest rate and productivity growth, row 7 is the covariance between interest rate and oil price, row 8 is the productivity growth variance, row 9 is the covariance between productivity growth and oil price, row 10 is the oil price variance.

6.4.2 The Obasanjo Regime

This study finds that the 1999Q3 shock has estimated residual $e_0 = (-0.001482313, -0.000526104, -0.010122307, -0.001182517)'$ and estimated volatility state $\text{vech}(H_0) = (1.748, 9.031,\ 46.662, -0.137, 0.708, 0.011, 1.287, 6.650, -0.101, 0.948)'$ which are expressed in $e + 02$. The shock is strongly positive in exchange rate, interest rate, productivity growth and oil price.

Figure 6.2 above shows the impulse responses to the Obasanjo regime shock. The results are close to the Abacha regime shock analysed earlier. This study finds that ERV, IRD, PGD, and OIL started at zero (this is subject to the baseline of shock employed as discussed in chapter 5). The results confirm that ERV, IRD, PGD, and OIL do not react to shocks in the Obasanjo regime immediately. This study finds that interest rate began to rise gradually after the 5^{th} period. This study attributes the response of IRD in the fifth period to the deregulation policy of SAP. That is, although there is no immediate response of this shock on the economy, however, the first response is from the interest rate. The response from interest rate confirms the effect of SAP reversal on interest rate and the subsequent effects on the exchange rate and oil price.

Exchange rate and oil price responded to the Obasanjo regime shock only after the sixth period. The results suggest that with the Obasanjo regime shock, both oil price and exchange rate are influenced by the response of the interest rate. This means that interest rate volatility is an important factor in the determination of exchange rate volatility in Nigeria over the period. On the other hand, productivity growth does not react to the policy reversal shock until after the eighth period. The results suggest that productivity growth remain unaffected and is probably influenced by the response from interest rate, exchange rate and oil price.

The implication of this result as applied to hypothesis 1 of this thesis is that past innovations from interest rate raises exchange rate volatility in Nigeria between 1986 and 2013. This result supports the flexible monetary determination of ER model (as discussed in chapter three) that a rise in the local relative to foreign interest rate reduces domestic money demand and causes local currency to depreciate (that is, increase in the rate of exchange). Given this shock, this result shows that interest rate is an important factor that determines exchange rate in Nigeria.

This result is not different from the effect of the regime shift under Abacha regime. This means that although there are policy reversals by the two regimes, but different policies adopted still mirrored the Structural Adjustment Programme of 1986. Thus, policy reversal under different regimes is found to produces similar effect on the economy.

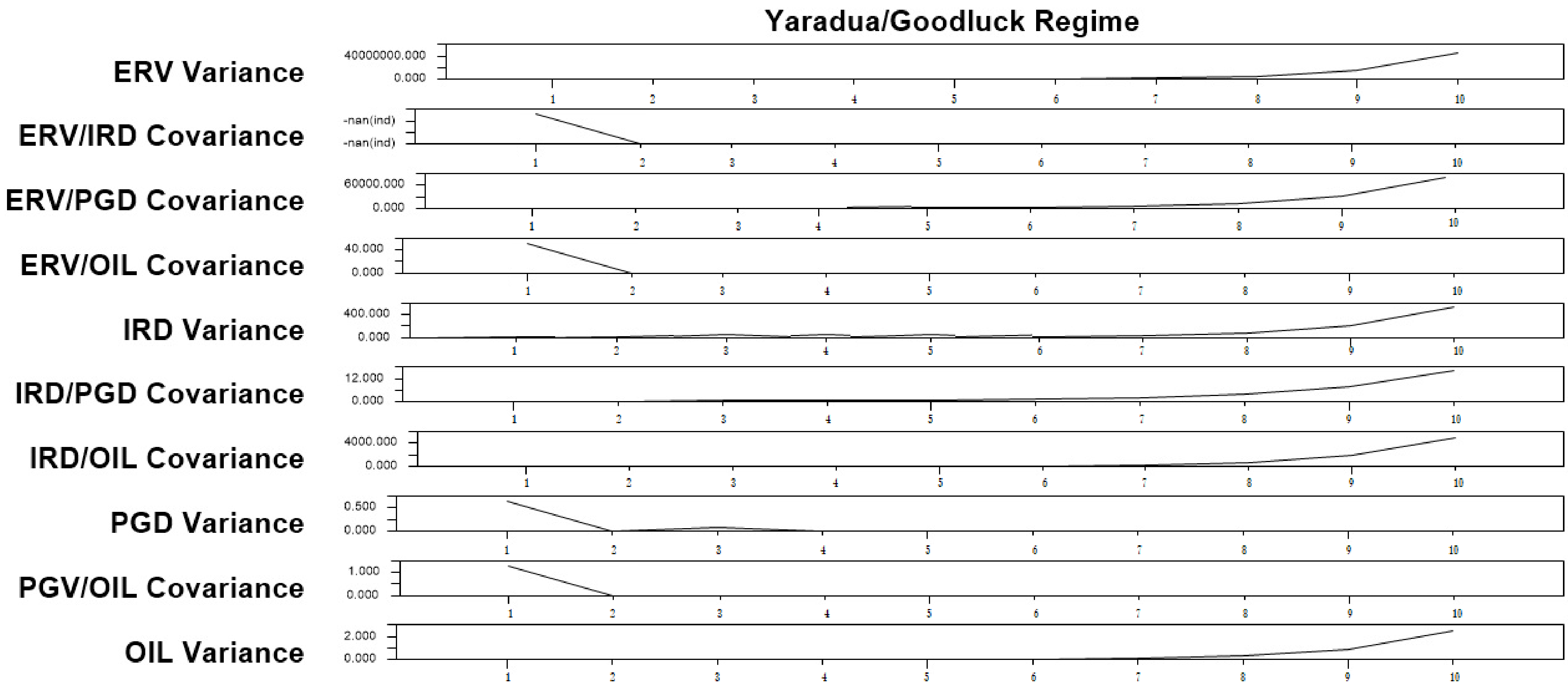

Figure 6. 3: Volatility Impulse Response Functions (VIRFs) for Yar'Adua Regime shocks

Note: Figure 6.3 is for 2009Q1 shock, which falls within Yar'Adua's administration. Row 1 is the exchange rate variance, row 2 is the covariance between exchange rate and interest rate, row 3 is the covariance between exchange rate and productivity growth, row 4 is the covariance between exchange rate and oil price, row 5 is the interest rate variance, row 6 is the covariance between interest rate and productivity growth, row 7 is the covariance between interest rate and oil price, row 8 is the productivity growth variance, row 9 is the covariance between productivity growth and oil price, row 10 is the oil price variance.

6.4.3 The Yar'Adua/Goodluck Regime

This regime shock is connected with the 2009 policy change and the sudden oil price surge in the first quarter of the year. From impulse response estimation, the 2009Q1 shock has estimated residual $e_0 = (-0.091791903,\ 0.011715381, -0.070579298,$ $-0.019101192)'$ and estimated volatility state $\text{vech}(H_0) = (2.397, 1.716,\ 1.228,$ $0.313,\ 0.224,\ 0.041,\ 0.194,\ 0.139, 0.025, 0.016)'$ are expressed in $e + 04$. The shock is strongly positive in exchange rate, interest rate, productivity growth and oil price.

The figure shows the impulse responses to the Yar'Adua/Goodluck regime shock. This result shows that the response of the productivity growth starts at a high positive level but falls within a short period (during the second period). The above results suggest that there is an immediate response from the PGD to shocks in the sudden oil price increase. This study finds that the response from the PGV drops in the second period with no further response for the rest of the periods. This response may be attributed to the effect of the 2008 global financial crisis on the productivity growth (see chapter two for details). At the end of 2008, the economic activities were paralysed due to the financial crisis shock. This probably led to the response from PGD, which start to drop at 1st period.

It should be noted that the sudden increase in the oil price does not have initial considerable effect on the general price level (as reflected in the interest rate), possibly because of the financial crisis. However, this is short-lived as oil price increase has much positive effect on the interest rate later on, which subsequently raised exchange rate volatility. Thus, this study establishes that the effect of the global financial crisis is subsided by the sudden rise in oil price at the first quarter of 2009 under the Yar'Adua/Goodluck administration. In addition, the shock effect of the sudden rise in oil price raised interest rate volatility which drives exchange rate volatility over the period.

The implication of this as applied to hypothesis 1 of this thesis is that past innovations from productivity growth and interest rate raise exchange rate volatility in Nigeria overtime. This result is intuitive and validates the BEKK result in section 6.3. Firstly, the result supports the flexible monetary determination of ER model (see more details in chapter three) that a rise in the local relative to foreign interest rate reduces domestic money demand and causes local currency to depreciate (that is, increase in the rate of exchange).

These results underscore the theoretical monetary determination of exchange rate volatility. In Nigeria, surplus money is cleared when demand for money reduces through higher interest rate. The higher interest rate leads to increase in the general price level and consequently decreases the value of money. In this case, the demand for local currency decreases when there is a fall in the value of money, which leads to increase in the price of exchange. This means that there is higher persistence of exchange rate changes when interest rate increase. Thus, given the Nigeria’s interest rate deregulation policy, the result establishes that previous one-time shocks and volatility in the interest rate raised persistence in changes in the exchange rate overtime.

Secondly, the findings of this study justify the non-monetary determination of exchange rate model for developing countries. The initial rising and positive productivity growth influence the response of exchange rate volatility to the shocks during the Yar’Adua/Goodluck administration. This result confirms that productivity growth influences interest rate and subsequently causes the interest rate to drive exchange rate volatility. Thus, this study concludes that productivity growth has one-time effect and temporary persistent effect on exchange rate volatility in Nigeria between 1986 and 2013.

The findings of this thesis reflect the behaviour of the Nigerian economy on productivity growth as shock to the price of oil in Nigeria means increase in aggregate income.

Consequently, increase in wages leads to higher relative prices in the economy. The rising relative prices reduce value of money and decreases demand for domestic currency. The fall in the demand for domestic currency results in depreciation of the home currency (that is, a rise in the exchange rate and its volatility). The result confirms one-time shock and temporary linkage between productivity growth and exchange rate volatility. This result is supported by Alexius (2001) who affirmed that the effect of productivity growth shock on exchange rates volatility were temporary and not permanent.

This result partly contradicts some past studies on Nigeria. For instance, Adamu *et al.* (2017) found that interest rate influences exchange rate volatility, but that productivity has no statistically significant relationship with exchange rate volatility in Nigeria. The differences in the productivity growth result could be attributed to the fact that this study recognizes the impact of shock from the SAP policy and other historical events over the considered period. As a result, the sample in this study begins from the policy period (that is, 1986) whereas Adamu *et al* (2017) covered 1989 to 2015. The results suggest that shocks to exchange rate are important in determining the factors that drive exchange rate volatility in Nigeria overtime.

Moreover, this study employs a dynamic model that makes it different from previous studies on Nigeria. The analysis of this study permits the introduction of shocks in the model, which accommodate some asymmetrical events in the economy, such as periods of political regime shift and surges in oil price. Two, this analysis provides volatility spillover and the degree of association among the system analysed. The model helps to identify the timing and degree of the effect of interest rate and productivity growth on exchange rate volatility unlike previous studies on Nigeria.

In general, the VIRFs finds that lagged volatility from oil price has no persistence effect on exchange rate volatility. This is confirmed by the BEKK result in section 6.3 where only the random effect of oil price volatility on exchange rate volatility is found. The implication of this result on hypothesis 1 of this thesis is that lagged persistence of oil price is not connected with the current volatility of exchange rate. As discussed earlier, this result supports Alexius (2001) on oil trading economy that the effect of oil price on exchange rate volatility is a random effect. This study therefore concludes that, although, oil price has a past one-time shock effect on the current exchange rate volatility, there is no volatility spillover from lagged oil price to current exchange rate volatility in Nigeria between 1986 and 2013.

This result may be attributed to the incessant spikes and collapses in the world oil price over the period 1986 to 2013. The uncontrollable changes in the price of oil in the world market may be responsible for the non-persistent effect of oil price on exchange rate movement in Nigeria over the period (see chapter two for details). Nigerian economy is hard-heated by the ups and the downs structure of the world market oil price. This is because Nigeria is an oil-dependent economy with the highest components of its trading activities from oil. Thus, the study concludes that oil price only has one-time effect and no persistent effect on exchange rate volatility in Nigeria between 1986 and 2013.

However, this result deviates from Aliyu (2011) who found that there is positive relationship between exchange rate volatility and oil price volatility in Nigeria. The study ignored the timing of the effect as well as the degree of the effect of oil price on exchange rate volatility. On the other hand, the analysis of this study provides both timing and degree of the effect of oil price volatility on exchange rate volatility. Thus, this thesis confirms that oil price volatility only has a random effect and not persistent effect (temporary or permanent) on exchange rate volatility in Nigeria.

Overall, the results from the dynamic model of this study confirm that policy reversal and sudden oil price surge shocks raise volatility in interest rate and productivity growth which subsequently drives volatilities in exchange rate in Nigeria overtime. The impulse response analysis therefore supports the earlier analysis from the BEKK result that volatilities in interest rate and productivity growth are the key determinants of exchange rate volatility in Nigeria, given policy shocks between 1986 and 2013. However, productivity growth volatility effect is temporary.

6.5 Summary, Conclusion and Policy Recommendation

This chapter presented the Multivariate GARCH – BEKK estimation techniques, result and analysis. Firstly, preliminary investigations were carried out to confirm that the model is suitable with the series employed in the study. The study first employs both the traditional unit root test as well as the unit root test with break to establish the unit root property of the series employed in this model. The study confirmed that exchange rate, interest rate, productivity growth and oil price series are not stationary in their level forms. After the first difference, all the series became stationary, which means, the series employed are stationary at first difference.

Before estimating the MGARCH BEKK, the univariate series were prewhiten to establish the suitability of their individual residual for a BEKK analysis. The study finds evidence of heteroscedasticity and serial correlation present in the series and their residuals were tested. This study finds excess kurtosis in the residuals of the series, which suggests that the MGARCH BEKK in this study should follow a quasi-maximum likelihood estimation. Thus, the MGARCH BEKK models was estimated for the effect of volatilities in interest rate, productivity growth and oil price on exchange rate volatility in Nigeria between 1986 and 2013. However, for direct interpretation of the model, this thesis further employs the volatility impulse response functions (VIRFs). The VIRFs is important because the MGARCH BEKK is a dynamic model and the estimation does not provide comprehensive parameters that could permit dynamic analysis.

The VIRFs also has the advantage of introducing underlining effect of shocks to exchange rate in the model. Thus, using the VIRFs, the study examines the historical effect shocks (from political changes) of interest rate volatility, productivity growth volatility and oil price volatility on exchange rate volatility in Nigeria between 1986 and 2013. The analysis showed a strong evidence that interest rate volatility consistently drives exchange rate volatility in Nigeria over the considered period. Whereas, productivity growth temporarily drives exchange rate volatility in Nigeria over the period. However, this study finds no volatility effect on exchange rate volatility from oil price. This means that there is no persistent relationship or linkage between oil price and exchange rate volatility in Nigeria between 1986 and 2013. This confirms that oil price volatility has only random effect on exchange rate volatility in Nigeria over the sample period.

The policy implication of the results is that historical shocks are important in exchange rate volatility determination in Nigeria due to policy reversal from political regime changes, incessant oil price surges and global financial crisis. It was found that interest rate volatility and productivity growth volatility react to these shocks and consequently drive exchange rate volatility over the period. The result further shows that although the responses may not be immediate, however, the shocks later increases volatilities in interest rate and productivity growth with subsequent influence on exchange rate in Nigeria between 1986 and 2013.

Therefore, this thesis finds strong evidence to support the argument that interest rate and the productivity growth are the key determinants of exchange rate volatility in Nigeria. The implication of this on the economy is that it becomes challenging to have a stable and sustainable economy especially after SAP in 1986. The historical shocks contribute to variations in the policies resulting in macroeconomic instabilities, which are reflected in the volatile interest rate, productivity and exchange rate.

This study therefore suggests that, firstly, policy reversal should be limited even when there is change in the political system. This is to reduce the effect of policy shock on the macroeconomic variable, such as exchange rate and interest rate, which can affect the general economic condition of the country. Secondly, this study suggests that an effective monetary regulation be revisited on the interest rate structure of the economy. The suggestion is associated with the analysis in this study that the deregulated interest rate in Nigeria raises the relative prices and thus affects virtually every part of the economy including wages and productivity.

A controlled interest rate structure is suggested by this study so that the rate of interest could be stable. Given that there is strong linkage between the interest rate and exchange rate markets in Nigeria over the sample period, this study expects that a stable interest rate translates into stable exchange rate in the economy. This study argues that a stable interest rate structure can address most instability in the economy by regulating the relative prices. That is, a stable interest rate structure helps to achieve a stable and sustainable income. This study therefore suggests that the sticky price monetary system should be adopted in Nigeria for a stable economic condition.

CHAPTER SEVEN: GENERAL EQUILIBRIUM ANALYSIS OF THE EFFECT OF EXCHANGE RATE VOLATILITY ON OIL AND AGRICULTURE EXPORT DEMAND IN NIGERIA (1986 – 2013)

7.1 Introduction

This chapter explores the relationship between exchange rate volatility (ERV) and export demand (XD) in Nigeria using quarterly data from 1986 to 2013. The study focuses on the trade effect of ERV because trade, especially export has been reviewed to be one of the dominant factors of economic stability. It is important to investigate the dominant factors of economic stability through trade because an economy that is internationally competitive achieves rapid economic growth (see chapter four for details). This chapter estimates the relationship between ERV and XD in Nigeria using the General equilibrium theory (GET) awareness and a lag effect time series technique.[45] The model points out the effect of ERV in determining bilateral export demand in the agricultural and oil sectors of the economy as derived from the factors that drive exchange rate process in chapter six.[46]

The effect of exchange rate volatility on export demand in Nigeria is important to this study because it is found to affect the price stability goal of developing economy such as Nigeria (see chapter four for details). Therefore, exchange rate volatility is important in this study because it is necessary to eliminate the instability of the Nigerian currency (Naira) through effective policies in different productive sectors of the economy. In addition, the empirical literature on Nigeria confirms that exchange rate volatility is harmful to the growth of the economy (see chapter four for details).

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[45] The GET shows that exchange rate volatility (ERV) impact on trade flows is subject to ERV sources. This led us to investigate the key causes of exchange rate variability in Nigeria (see chapter five). The exchange rate volatility employed in this chapter is the measure of volatility as derived from the factors that drive exchange rate process in Nigeria as found in chapter five.

[46]These are the main productive sectors of the economy.

Particularly, the influence of exchange rate volatility on trade in Nigeria is likely to be worsened due to frequent policy change, especially the interest and exchange rate deregulation policies and the SAP reforms in 1986 (see chapter two for details). Therefore, determining the role of exchange rate volatility on export demand in Nigeria may not be exogenous, but endogenous. That is, modeling exchange rate volatility from the factors that drives exchange rate process in Nigeria. This has been considered in chapter six where volatility in interest rate and productivity growth were found to be the drivers of exchange rate process in Nigeria.

Although, many studies have been carried out on the subject on Nigeria, however, this study notices that there could be aggregation bias because aggregated models were employed in earlier models. It is important to disaggregate the trade model in this study to reduce the generalization that could arise from using aggregate sector model. In addition, using sectoral trade analysis permits sectoral trade policy implication. Sectoral trade policy implication of this study will help to improve sectoral trade flow and stabilize the overall economy.

The sectoral trade model employed in this thesis is motivated by the theoretical model of Barkoulas, Baum & Caglayan (2002) and empirical model of Baum & Caglayan (2010), which investigated the effects of exchange rates volatility on the level and variability of trade flows. However, the main focus of this study is to investigate the effect of exchange rate volatility on changes in export demand in Nigeria. Meanwhile, the model is applicable to Nigeria in many ways.

Firstly, it is a bilateral model. As Nigeria is a small open economy, this study considers that a bilateral model captures country's individual effect in the relationship between ERV and trade. Secondly, the model has theoretical and empirical analysis on export demand (XD) equation. This stands as a guide for both economic and statistical inferences for the analysis of this study as it is a good reference to developing economy. The export demands equation fits Nigeria economy because trade in Nigeria is export led.

Thirdly, the model is used for Nigeria because it exhibits a comprehensive structure of the macroeconomic challenges facing Nigeria (such as price, income and exchange rate) to which policy recommendation is important. However, as relevant and important the model is to Nigeria, this study observes that it may be too large and complicated to be studied effectively. Therefore, the study focuses on the role of exchange rate volatility in determining bilateral export in Nigeria. Also, the model is adjusted by focusing on the production, consumption, prices and trade, which are simultaneously determined in the Nigeria context[47]. Finally, the fundamentals of exchange rate process in Nigeria were employed as investigated in chapter six in drawing policy recommendations. This allows the study to keep track of what is happening to each sector of the economy as it engages in trade. To effectively achieve the above, an Autoregressive Distributed Lag (ARDL) method of analysis is employed (see chapter five for details).

Firstly, the ARDL is relevant and important in this study because it is good for Nigeria policy analysis in two different ways. One, the model helps to investigate the effects of changes in ERV on XD in Nigeria as derived from interest rate and exchange rate policies in Nigeria. The model is applicable to Nigeria in this context because the structures of interest rate and exchange rate in the sample period are influenced by policy changes. So, the lagged property of ARDL helps to model the pattern of shift in the series. Two, the timing of the effect of a change in interest rate and exchange rate in Nigeria are important, considering the Nigeria Structural Adjustment Program of 1986 and its deregulation policies of interest rate and exchange rate. Thus, ARDL is used to determine the

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[47]Availability of data restricted us from applying some of the earlier model on relationship between ERV and trade such as Hooper & Kohlhagen (1978) model. The model requires labour productivity, which is not available for Nigeria.

immediate impact, n-period delayed effect and total effect of the change in the monetary policy in Nigeria on trade.

Secondly, the ARDL can overcome any potential statistical problems that is likely to arise from the use of the Nigerian data in the study as suggested in the literature review chapter. One, the Nigeria data employed may not be stationary. This poses danger of spurious results for the analysis (see chapter four). In addition to being non-stationary, the series may not be cointegrated (see chapter four).[48] Two, given the small number of observation (112) in the model, this study realizes that the ARDL can be used with a small sample (see details in chapter five). To this end, it is important to investigate the relationship between exchange rate volatility and export demand in the oil and agriculture sectors in Nigeria using ARDL techniques for effective policy recommendation.

This chapter is structured as follows. Section two describes the theoretical model of the relationship between exchange rate volatility and export demand with reference to Barkoulas *et al* (2002) model. Firstly, the section specifically explores the export demand equation of the model because the study is interested in export demand of Nigeria to its leading partner as explained earlier. Secondly, the section briefly discusses the theoretical relationship between exchange rate volatility and export demand. Thirdly, the section explores the significant extension to Barkoulas *et al* model. This extension shows that the model employed in this study follows a general equilibrium proposition, which includes the internally generated determinants of ERV as investigated in chapter five. Section three is designed for model specification detailing modelling structure of the mean of export demand. Section four is for empirical analysis with specific attentions to diagnostic testing, presentation and validation of results. The section presents the results from

[48]If the series were to be cointegrated even without being stationary, then there could have been sufficient opportunities to choose from other techniques.

disaggregate oil and agriculture export demand models and discusses the results. Section five concludes the chapter and draws policy analysis.

7.2 Theoretical Significance of the Model

As reviewed in chapter four, empirical studies have not been unanimous in investigating the association between ERV and trade. Studies have reported negative, positive and statistically insignificant relationship between ERV and trade. Propositions two and three hereby provide a reason for the disputable findings.[49] Also, the propositions justify the intuition to the reason for those contradictory empirical evidences. In general, the direction of the overall change in export depends on the sources and sizes of the volatilities.

This thesis considers two sets of modification as extension to Barkoulas *et al* model (see details of the model in chapter four). One, the earlier exchange rate volatility results which represent the true fundamental factors of exchange rate process is employed for volatility proxy. This is considered suitable as it mirrors the fundamental drives of exchange rate volatility in Nigeria using the MGARCH analysis.[50] This extension shows that this model follows a general equilibrium proposition, which includes the internally generated determinants of exchange rate volatility as investigated in chapter six. Two, this study considers it important to include foreign income into the empirical model. This variable is employed to control for external economy's effect on export demand in Nigeria.

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[49]Proposition Two: Volatility in the components of the fundamental forces that drive the ER process has an indeterminate effect on trade. This means that the effect of the variability of the stochastic element on trade flow is ambiguous.

Proposition Three: The effect of the variance of the noise of the signal regarding future policies on trade flows is ambiguous.

[50]The MGARCH analysis has the ability to model internally consistent variations in the model.

7.3 Econometric Specification and Empirical Description of the Model

The study estimates a model which follows Autoregressive Distributed Lags (ARDL) structure. Firstly, the single equation procedure is employed for export of oil and export of agricultural products in Nigeria individually. Secondly, the method estimates the delayed effects of the exchange rate volatility, foreign income and exchange rate in Nigeria. Thirdly, it provides basis for order of integration and cointegration tests for the analysis. Fourthly, this study introduces the importing country's income as discussed in section 7.3.1. Finally, this study presents exchange rate volatility in the model as derived by the fundamental factor of ER process. The study employs oil and agriculture sectors, being the productive sectors that are active in exporting activities from Nigeria to the US.

7.3.1 Modelling the Oil Export Demand

As discussed earlier, it is important to employ a model with lag structure in this study to capture the time lag effect in the Nigeria oil export demand as well as the multiplier effects of exchange rate volatility, foreign income and exchange rate. Thus, the ARDL model for oil export and exchange rate volatility relationship for Nigeria is specified as:

$$\Delta XDO_t = C_O + \sum_{i=1}^{m} \theta_1 \Delta XDO_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta ERV_{t-i} + \sum_{i=0}^{m} \alpha_i \Delta FY_{t-i} + \sum_{i=0}^{m} \delta_i \Delta ER_{t-i} + \omega_t \qquad 7.3.1$$

where XDO is the Nigeria Oil export demand, ERV is the measure of volatility in the exchange rate as driven by factors of ER process, FY is the foreign income and ER is the real exchange rate. Δ is the difference operator of the level series. m is the lag length, which is chosen through maximizing the Akaike Information Criterion (AIC)[51].

The interest of this study in the above long run relationship is on both the significance and sign of the coefficient of ERV, γ_i when $i = 1$. The study estimates coefficients

[51]The study first employed the lag selection criteria, where all the selection criteria established the lag structure to be 1. For a robust check, the study also experiments with several lag lengths starting from six lag lengths and found that one lag is sufficient to capture the dynamics in the series.

associated with XDO, ERV, FY, ER and as expressed in their distributed lag forms $\theta_1, \gamma_i, \alpha_i$ and δ_i respectively.

7.3.2 *Modelling Agriculture Export Demand*

The study also specifies a model to capture the dynamics arising from time lag in the Nigeria agriculture export demand as well as the multiplier effects of exchange rate volatility, foreign income and exchange rate. The ARDL model for Agriculture export demand and exchange rate volatility relationship for Nigeria is also specified as:

$$\Delta XDA_t = C_A + \sum_{i=1}^{n} \emptyset_1 \Delta XDA_{t-i} + \sum_{i=0}^{n} \vartheta_i \Delta ERV_{t-i} + \sum_{i=0}^{n} \rho_i \Delta FY_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta ER_{t-i} + v_t \qquad 7.3.2$$

where XDA is the Nigeria Agricultural export demand, ERV is the measure of volatility in the exchange rate as driven by factors of ER process, FY is the foreign income and ER is the real exchange rate. Δ is the difference operator of the level series. n is the lag length, which is chosen through maximizing the Akaike Information Criterion (AIC).[52] The interest of this study in the above long run relationship is on both the significance and sign of the coefficient of ERV, ϑ_i when $i = 1$. The study estimates coefficients associated withXDA, ERV, FY, ER and as expressed in their distributed lag forms $\emptyset_1, \vartheta_i, \rho_i$ and φ_i respectively.

7.4 Empirical Analysis

Following the empirical model specification above, this study estimates the relationship between ERV and XDO as well as ERV and XDA. This is to validate hypothesis 2 of this thesis that there is no statistically significant relationship between ERV and sectoral (oil and agriculture) export in Nigeria between 1986 and 2013 using the general equilibrium

[52]The study first employed the lag selection criteria, where all the selection criteria established the lag structure to be 1. For a robust check, the study also experiments with several lag lengths starting from six lag lengths and found that one lag is sufficient to capture the dynamics in the series.

approach. However, due to the non-stationary properties of time series data, the study first test for stationarity and order of integration of the series employed using two most popular method of unit root testing.[53] Thus, the preceding sub-section presents the stationarity test result and analysis.

7.4.1 The Unit Root Test Results

This study carries out stationarity test on the series employed in this study to overcome danger of spurious analysis. More importantly, the test is conducted to ascertain the order of integration of the series as this helps to establish the appropriateness of the method employed in the empirical analysis.[54] The univariate unit root tests of ADF, PP and KPSS were conducted to test the Oil Export demand (XDO), Agriculture Export demand (XDA), exchange rate volatility (ERV), exchange rate (ER) and foreign income (FY) series for stationarity as well as determine their order of integration. An appropriate number of lags is employed for the dependent variable as automatically specified by the t-test statistics in the regression, so as to confirm that disturbance in the equation is white noise. This study employs three popular and commonly used stationarity tests of Augmented Dickey Fuller (ADF), Phillips Perron (PP) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) on the series. The KPSS is employed to cross-check the result using a different null hypothesis statement. The results of the tests without time trend and with time trend at level and first difference are reported below in Table 7.1.

[53]Interested reader should see chapter five for more detail on the importance and methods of testing unit root.

[54]For instance, Bound test requires that variables could either be I (0) or I (1) series but not I (2) to avoid invalidation of the computed F-statistic in cointegrating procedure. However, this study does not employ the cointegrating technique later because the series are not cointegrated; hence the ARDL is employed.

Table 7. 1: Unit Root Tests

Type of Tests								
		ADF		PP		KPSS		
Variable	Definition of Variable	Level	First Difference	Level	First Difference	Level	First Difference	Order of Integration
XDO	Oil export demand	-1.4343	-2.9940**	-2.3273	-5.8363***	0.2769	0.0519***	I(1)
XDA	Agriculture export demand	-1.7117	-8.6102***	-1.9499	-8.4443***	0.2565	0.0471***	I(1)
ERV	Exchange rate volatility	-2.8199*	-6.7523***	-8.1027***	-	0.1436	0.0277***	I(1)
FY	Foreign income	-0.5371	-4.5060***	-0.6194	6.8842***	0.1291	0.0419***	I(1)
MER	Exchange rate	-1.4744	-9.0600***	-1.5854	-9.0205***	0.2245	0.0411***	I(1)

Notes: i. The Null Hypothesis for the ADF and PP tests is that the series has a unit root.
ii. The Null Hypothesis for the KPSS test is that the series has no unit root.
iii. *, **, *** signify that the test is statistically significant at 10%, 5% and 1% respectively.
iv. The study takes decision of at least 5% significance level.

Source: Author's computation (2018)

From table 7.1, the results from both ADF, PP and KPSS tests indicate that the series for oil export demand (XDO), agriculture export demand (XDA), exchange rate volatility (ERV), foreign income (FY) and exchange rate (MER) series are non-stationary in level forms. The results are confirmed by the probability values from the ADF, PP and KPSS statistics. Only Philip Perron test indicates that the ERV series is statistically significant for intercept specification at 10% level of significance suggesting that the series are stationary at 10% level. However, since ADF and KPSS suggest that the series are not stationary at all conventional level this study establishes that the series are all not I(0) processes. This means that there is common stochastic movement in each of the series. Then, the study proceeds to first difference, the results of which are presented in table 7.1 as well.

Given the first difference unit root test for ADF and PP, the null hypothesis of a unit root at 1% level of significance is rejected. This means that the tests statistically reject the null hypothesis that all the series (XDO, XDA, ERV, FY and ER) have unit roots at 1% level of significance. Similarly, the KPSS test fails to reject the null hypothesis of stationarity at 1% level of significance for all the series. This implies that the series are stationary at first difference as confirmed by the ADF, PP and KPSS statistics.

The above results conform with some other studies that most macroeconomics variables are expected to possess a unit root (see Baak, 2008). Thus, this study concludes that oil export demand, agriculture export demand, exchange rate volatility, foreign income and exchange rate series are integrated of order one. This result establishes the appropriateness of employing a Johansen cointegration test. The Johansen cointegration representation theorem is then applied which states that, if a group of time series data is integrated of the same order, then, there could be a possible cointegration (long run) relationship among them. The next stage involves the tests and a result of co-integration.

7.4.2 Cointegration Test

The cointegration test results for oil export demand and agriculture export demand are presented in table 7.2.

Table 7. 2: Johansen's Cointegration Test Oil Export Demand Model

Type of Tests									
		Trace				Max-Eigenvalue			
Variable	Definition of Variable	Eigen-value	Trace Statistic	Critical Value (5%)	Prob.	Eigen-value	Max-Eigen Statistic	Critical Value (5%)	Prob.
XDO	Oil export demand	0.1956	58.1949	61.2669	0.0529	0.1956	23.2826	33.7329	0.2055
XDA	Agriculture export demand	0.2009	52.4904	54.0790	0.0540	0.2009	23.9951	28.5881	0.1732
Note: i. Two tests are considered in the Johansen's cointegration test: the Trace test and the Max-Eigenvalue test. ii. The two tests are reported for robust checks.									

Source: Author's computation (2018)

The results from table 7.2 above confirm that both trace and max-eigenvalue statistics indicate no cointegration for both oil export and agriculture export demands. That is, the hypothesis of zero cointegration vectors could not be rejected at 5 percent level of significance. The results suggest that oil export demand, exchange rate volatility, foreign income and exchange rate series do not move together towards a stationary long-run equilibrium state defined by the cointegrating vector. Also, agriculture export demand, exchange rate volatility, foreign income and exchange rate series do not move together towards a stationary long-run equilibrium state defined by the cointegrating vector.

The implication of the results is that there is no stable long-run relationship between oil export demand, exchange rate volatility, foreign income and exchange rate in Nigeria between 1986 and 2013. Also, there is no long-run equilibrium relationship between agriculture export demand, exchange rate volatility, foreign income and exchange rate in Nigeria between 1986 and 2013.

Given the unit root test results and the cointegration test results, this study finds two important reasons to support the choice of methods employed to investigate the relationship between ERV and XD in Nigeria between 1986 and 2013. Firstly, to avoid both spurious and inconsistent regression problems which can occur with regression of non-stationary data, this study employs the ARDL estimation technique for the oil export demand and agriculture export demand in Nigeria between 1986 and 2013 model. Avoiding spurious and inconsistent regression is important because the results from a non-stationary series are not economically intuitive.

Secondly, since the series are not cointegrated (evidence from table 7.2), then, cointegrating analysis like the ARDL bound testing cannot be applied. The ARDL bound testing technique cannot be applied in this study because the study finds no long-run relationship among the series. Therefore, the ADRL is employed as the relevant method of estimation to investigate the relationship between ERV and XD in Nigeria between 1986 and 2013.

7.4.3 Model Selection

To investigate the relationship between ERV and XDO as well as between ERV and XDA, it is important to employ a suitable model. A suitable ARDL model is possible when the right lag length is selected. Table 7.3 presents the results for model selections.

Table 7. 3: Model Selection Criteria for Oil and Agriculture Export Demand Models

Model	Definition of Variable	LogL	AIC*	SIC	HQ	Adj. R^2	Specification
XDO	Oil export demand	-275.6182	5.2407	5.4876	5.3408	0.4012	ARDL(1, 1, 1, 1, 1)
XDA	Agriculture export demand	470.6411	-8.1521	-8.2052	-8.3519	0.4101	ARDL(1, 1, 1, 1, 1)
Note: * signifies that the study chooses the lag length through maximizing the Akaike Information Criterion (AIC).[55]							

[55]The study first employed the lag selection criteria, where all the selection criteria established the lag structure to be 1. For a robust check, the study experiments with several lag lengths starting from six lag lengths and found that one lag is sufficient to capture the dynamics in the series. The model with the minimum AIC for the XDO and XDA models are with lag length one. Therefore, the study employs the models with minimum AIC. The tests were carried out for the two models independently.

Table 7.3 above shows that Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn (HQ) establish the lag structures for oil export and agriculture export demand models to be 1. For a robust analysis, the study also experiments with several lag lengths starting from six lag lengths and finds that one lag is sufficient to capture the dynamics in the series. Thus, the study employs the ARDL(1, 1, 1, 1, 1) for the empirical analysis of oil export demand and agriculture export demand in Nigeria for the period 1986 to 2013.

7.4.4 Diagnostic Tests and Validation of Results

The ADF and PP unit root tests establish that oil export demand, agriculture export demand, exchange rate volatility, foreign income and exchange rate in Nigeria between 1986 and 2013 are I(1) processes. The Trace and Max-Eigenvalue cointegration results confirm that oil export demand, exchange rate volatility, foreign income and exchange rate in Nigeria between 1986 and 2013 do not move in the same direction. For the agriculture export demand model, Trace and Max-Eigenvalue cointegration results also confirm that agriculture export demand, exchange rate volatility, foreign income and exchange rate in Nigeria between 1986 and 2013 do not move in the same direction. The study therefore proceeds to application of the Autoregressive Distribution Lag estimation.

As earlier discussed, the second objective of this research work is to investigate the impacts of ERV on export demand of the oil and agriculture sectors, which are the productive sectors in Nigeria between 1986 and 2013. This objective seeks to validate second hypothesis as stated in chapter one of this thesis that: there is no relationship between exchange rate volatility and export demand in the oil and agriculture sectors in Nigeria between 1986 and 2013. The study then employs the general equilibrium theory as explained earlier.[56] The model is hereby estimated and diagnosed.

[56]That is, export demand is determined by ERV, fundamental forces that drive ER and income. Exchange rate process alone may not be capable of explaining the changes and uncertainties in trade flow.

i. Oil Export Demand (XDO) Model

Given a non-stationary and non-cointegrated series, the ARDL export demand model for Nigeria oil sector has been specified as;[57]

$$\Delta XDO_t = C_O + \sum_{i=1}^{m} \theta_1 \Delta XDO_{t-i} + \sum_{i=0}^{m} \gamma_i \Delta ERV_{t-i} + \sum_{i=0}^{m} \alpha_i \Delta FY_{t-i} + \sum_{i=0}^{m} \delta_i \Delta ER_{t-i} + \omega_t \qquad 7.4.1$$

where XDO is the Oil export demand, C_O is the intercept, ERV is the measure of volatility in the exchange rate as driven by factors of ER process, FY is the foreign income and ER is the real exchange rate. Δ is the difference operator of the level series. m is the lag length, which is chosen through maximizing the Akaike Information Criterion (AIC)[58]. The result is reported in table 7.4

[57]As in equation 7.3.1
[58] See section 7.4.3 for details about model selection.

Table 7. 4: ARDL Result for Oil Export Demand in Nigeria (1986-2013)

Dependent Variable: XDO			
Parameter	Definition of Independent Variables	Coefficients	*t*-Statistic
$\hat{\theta}_1$	Lagged XDO	0.2220*	256.9024
$\hat{\gamma}_0$	ERV	-28.4500*	-1.23E+12
$\hat{\gamma}_1$	Lagged ERV	-0.3760*	-3.10E+11
$\hat{\alpha}_0$	FY	0.0539*	3.8712
$\hat{\alpha}_1$	Lagged FY	0.0512*	4.0579
$\hat{\delta}_0$	ER	-0.0439*	-4.34E+11
$\hat{\delta}_1$	Lagged ER	-0.0655*	-1.92E+13
$\hat{C}_O$	Constant	-1.1065*	-1.55E+12

Notes:

i. * indicates significance of coefficient at least in 5% significance level

ii. Diagnostic statistics are:

$\overline{R^2}$ = 0.9884, DWS = 0.9245, F-Stat = 1337.001 [0.0000], AIC = -7.9195, S.E. of regression = 0.0045, RSS = 0.0021, Log likelihood = 447.5341, AC~F(2, 98) = 0.6991 [0.4995], AC~χ^2(2) = 1.5191 [0.4679], RESET~F(1,99) = 1.1289 [0.2617], RESET~ χ^2(1) = 1.3814 [0.2399], H~F(7, 100) = 1.8840 [0.0800], H~ χ^2(7) = 12.5837 [0.0829].

a. The study presents the probability values in the squared bracket while the t-statistics are presented in parentheses.

b. Except where otherwise stated the results are analyzed at 5% level of significance.

c. AC~F is the F-statistics from the first order serial correlation test while AC~χ^2 is chi-square statistics from the first order serial correlation test.

d. RESET~F is the F statistics from the misspecified functional form test while RESET~ χ^2 is the chi-square statistics from the misspecified functional form test.

e. H~F is the F statistics from the heteroscedasticity test while H~ χ^2 is the chi-square statistics from the heteroscedasticity test.

Table 7.4 above shows that Breusch-Godfrey Serial Correlation LM test is statistically insignificant. So, the study fails to reject the null hypothesis of no serial correlation in oil export demand model. The implication of no serial correlation in oil export demand model is that the classical assumption of strict exogeneity holds for oil export demand model in Nigeria overtime. Similarly, the null hypothesis of homoscedasticity cannot be rejected using the Breusch-Pagan-Godfrey Heteroscedasticity Test. This means that the error variances are serially uncorrelated.

The coefficients of the lagged oil export demand, exchange rate volatility, foreign exchange rate and their lagged series are statistically significant at 5%. Also, the lagged oil export demand, exchange rate volatility, foreign income, exchange rate and their lagged series exhibit theoretical signs.

The stability diagnostic tests show that Ramsey (1969) Regression Specification Error Test fails to reject the hypothesis of correct specification at every conventional level, depicting that the model has correct functional form. This means that the oil export demand model specification is rightly specified. The result of CUSUM and the CUSUM of Squares tests in figure 7.1 and 7.2 respectively demonstrate the stability of the XDO model over the sample period.

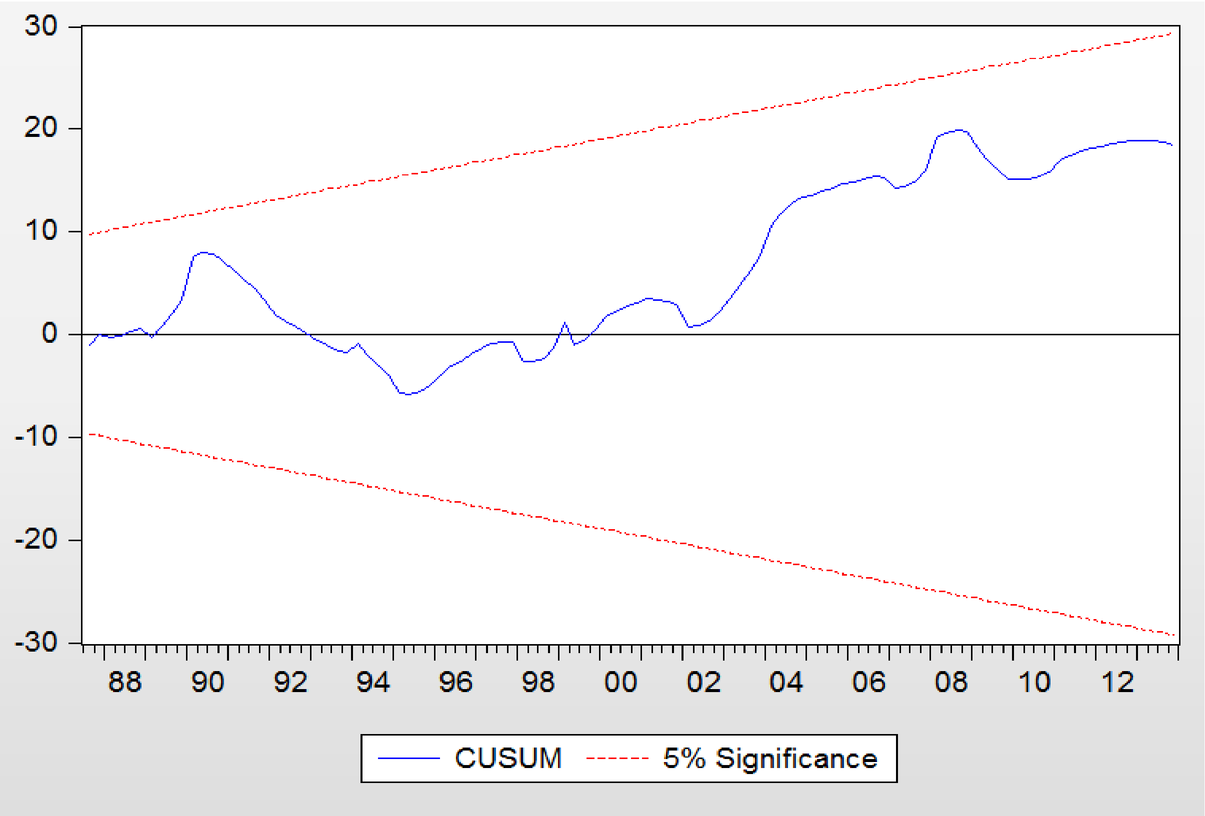

Figure 7.1: The CUSUM Test for Oil Export Model

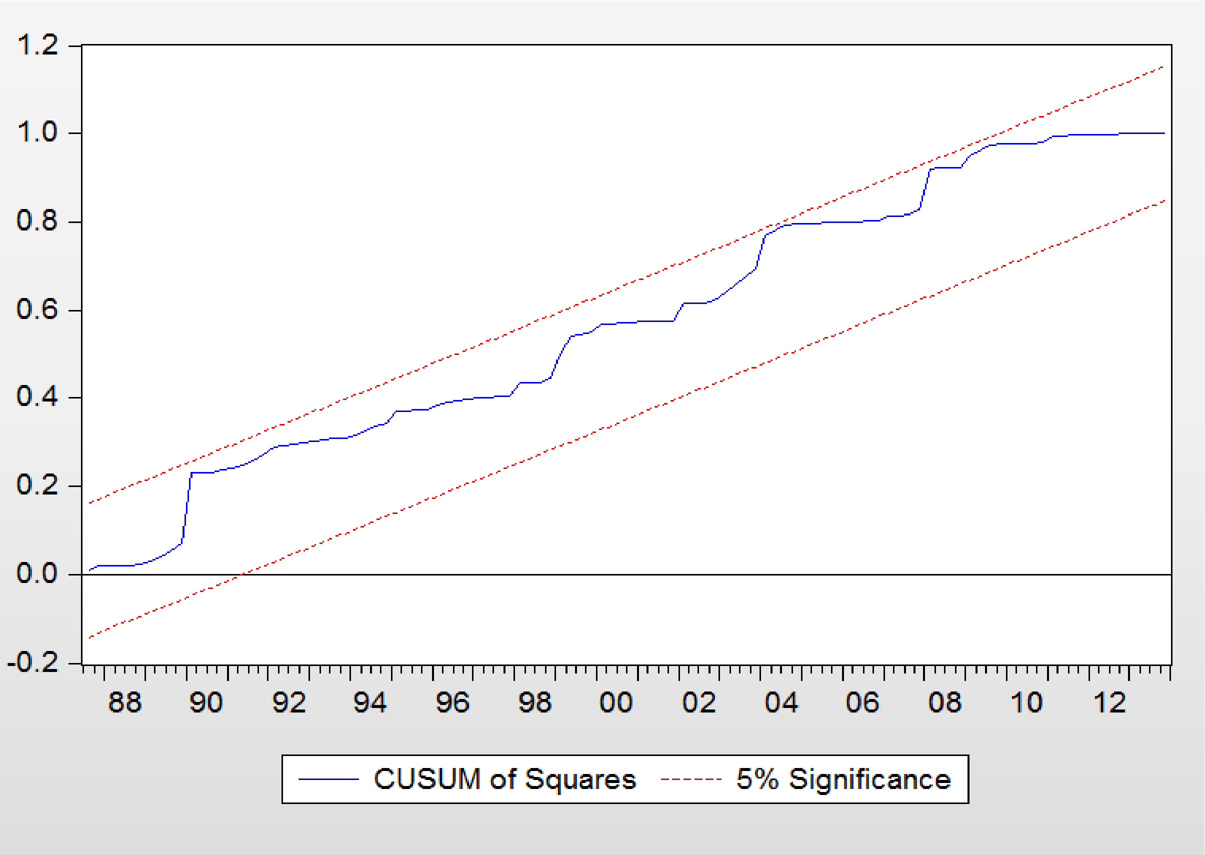

Figure 7.2: The CUSUM of Squares Test for Oil Export Model

Figure 7.1 and 7.2 show further stability diagnostic tests using the CUSUM and the CUSUM of Squares. The results above suggest that the model is stable over the sample period (see figure 7.1 and 7.2). The residuals of the model are generally 2 standard error bands. That is, they are within the two standard error bands. This means that oil export demand model for Nigeria for the period possesses a good fit and passes both the residual and stability diagnostic tests.

The ARDL (1, 1, 1, 1, 1) result in table 7.4 above demonstrates the dynamic estimates of the oil export demand model. The coefficients of differenced exchange rate volatility (-28.45 and -0.38) are highly statistically significant and agree with the theoretical expectation that exchange rate volatility reduces oil export demand. While (-28.45) is the current effect,[59] (-0.38) is the potential lagged or delayed effect.[60] This means that a unit increase in the differenced exchange rate volatility reduces the differenced oil export demand in Nigeria between 1986 and 2013 by about 29 units. These results suggest that any increase in exchange rate volatility in Nigeria, which is determined persistently by interest rate volatility (as investigated in chapter six), immediately reduces trading activities in the oil sector over the sample period.

The coefficients of differenced foreign income (0.0539 and 0.0512) are highly statistically significant and agree with the theoretical expectation that increase in the income of the trading partners increases oil export demand. The meaning is that a unit increase in the differenced foreign income improves differenced oil export demand in Nigeria between 1986 and 2013 by about 0.05 units. The results suggest that a higher income in the US has both an immediate and potential lagged effect of increasing trading activities in the oil sector in Nigeria over the sample period. That is, increase in the income of the trading partner increases the demand to import more. The higher import by the

[59]This is otherwise known as immediate effect.
[60]The lag or delay effect is calculated in the multiplier analysis section.

foreign country generates more income for Nigeria and thus encourages oil production (ceteris paribus). The increasing production of oil subsequently raises the volume of oil, which leads to higher oil export activities in Nigeria. This result confirms the position of Nigerian oil trade with the US. Nigeria has been one of the leading partners of the US, especially on oil export for over four decades.

The coefficients of differenced exchange rate (-0.0439 and -0.0655) are highly statistically significant and agree with the theoretical expectation that increase in exchange rate reduces oil export demand. The meaning is that a unit increase in exchange rate in Nigeria overtime worsen differenced oil export demand by about 0.04 units. The results suggest that a higher exchange rate changes has both an immediate and potential lagged effect of reducing trading activities in the oil sector in Nigeria, however, with a relatively small magnitude. The evidence of an immediate and potential lagged result suggests that the effect of exchange rate volatility is relatively important in determining oil export demand in Nigeria.

For the timing of the effect of exchange rate volatility on oil export demand in Nigeria between 1986 and 2013, the multiplier effect is hereafter examined. The multiplier analysis is important in this study because the identified research hypothesis is to determine the immediate impact and interim multiplier effect of the monetary policy change on oil sector in Nigeria between 1986 and 2013. This study considers four-period delay effect and the interim effect (see chapter five for how multipliers are calculated). The four-period delay effect and the interim effect is to determine the immediate impact and interim multiplier effect of the monetary policy change on oil sector in Nigeria between 1986 and 2013.

Multiplier Analysis – Oil Export Demand (XDO) Model

From the relationship in equation 7.4.1, the four-period delay multipliers (using Nigeria quarterly data from 1986 till 2013) for oil export demand are represented with β's as;

$\hat{\beta}_0$	immediate effect $= \hat{\gamma}_0 = -28.4500$
$\hat{\beta}_1$	$1 -$ period delay effect $= \hat{\gamma}_1 + \hat{\beta}_0\hat{\theta}_1 = -0.3760 - 28.4500 \times 0.2220 = -6.4051$
$\hat{\beta}_2$	$2 -$ period delay effect $= \hat{\beta}_1\hat{\theta}_1 = -6.3994 \times 0.2220 = -1.4232$
$\hat{\beta}_3$	$3 -$ period delay effect $= \hat{\beta}_2\hat{\theta}_1 = -1.4207 \times 0.2220 = -0.3162$
$\hat{\beta}_4$	$4 -$ period delay effect $= \hat{\beta}_3\hat{\theta}_1 = -0.3162 \times 0.2220 = -0.0703$

where $\hat{\gamma}_0$ is the current exchange rate volatility, $\hat{\gamma}_1$ is the lagged exchange rate volatility, and $\hat{\theta}_1$ is the lagged oil export demand. The above calculated delayed multiplier is presented in table 7.5 and figure 7.3 below.

Table 7. 5: Analysis of the Delayed Multiplier Effect of ERV on XDO in Nigeria (1986–2013)

Period	Delayed Multiplier	Effect
Current-Period	-28.4500	Negative
1-Period Delay	-6.4051	Decreasing negative
2-Period Delay	-1.4232	Decreasing negative
3-Period Delay	-0.3162	Decreasing negative
4-Period Delay	-0.0703	Decreasing negative

- Table 7.5 above is present graphically below in figure 7.3

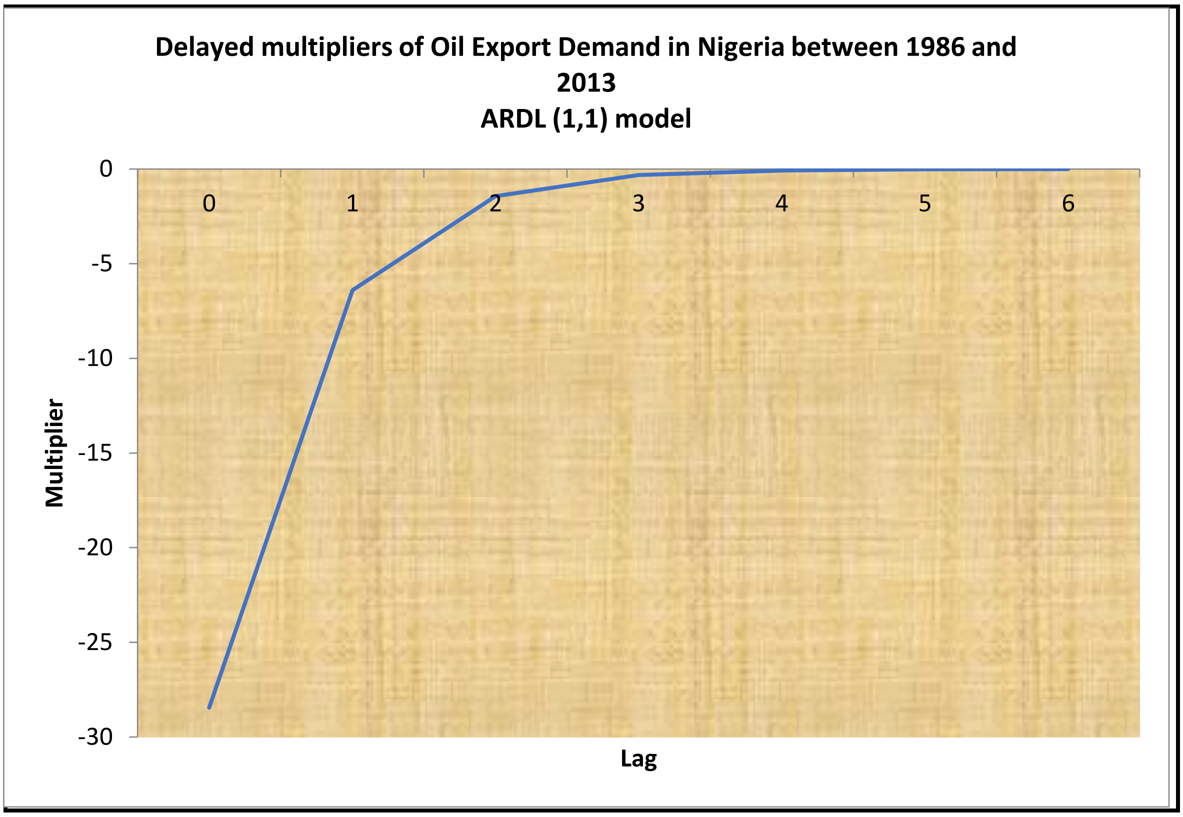

Figure 7. 3: Multiplier Effect of ERV on XDO in Nigeria between 1986 and 2013

Table 7.5 and figure 7.3 above depict that the weights of the effect of exchange rate volatility on oil export demand at long lags go to zero. This confirms that this analysis is valid. Exchange rate volatility leads to fall in oil export demand with the greatest effect being from the current quarter and declines after. That is, the effect of the ERV on XD in the oil sector later declines to zero.

In the above analysis, this study estimates the effect of a unit change in exchange rate volatility in Nigeria as distributed over the current and next 4 period. This study assumes that after 4 periods, changes in ERV no longer affect oil export demand in Nigeria because the study employs a finite distributed lag model.[61] Also, the four-period interim multipliers (using Nigeria quarterly data from 1986 till 2013) for oil export demand are presented as;

[61] The four periods are employed because quarterly data were used.

1-period interim multiplier = $\hat{\beta}_0 + \hat{\beta}_1 = -28.4500 - 6.4051 = -34.8551$

2-period interim multiplier = $\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_2 = -28.4500 - 6.4051 - 1.4232 = -36.2783$

3-period interim multiplier = $\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3 = -28.4500 - 6.4051 - 1.4232 - 0.3162 = -36.5945$

4-period interim multiplier = $\hat{\beta}_0 + \hat{\beta}_1 + \hat{\beta}_2 + \hat{\beta}_3 + \hat{\beta}_4 = -28.4500 - 6.4051 - 1.4232 - 0.3162 - 0.0703 = -36.6648$

The above calculated interim multiplier is presented in table 7.6 below.

Table 7. 6: Analysis of the Interim Effect of ERV on XDO in Nigeria (1986 – 2013)

Period	Interim Multiplier	Effect
1	-34.8551	Negative
2	-36.2783	Increasing at decreasing rate
3	-36.5945	Increasing at decreasing rate
4	-36.6648	Increasing at decreasing rate
Note: Interim multiplier is the effect of ERV on XDO when ERV increases by a unit and remains at the new level in subsequent period up to period four.		

From table 7.6 above, assuming ERV increases by a unit and remains at the new level:

- In the first period, the differenced ERV has a negative effect on the differenced XDO in Nigeria.
- The differenced ERV has negative effect on the differenced XDO in the second subsequent period. However, the negative effect increases but at a decreasing rate compared to the first period effect.
- The third subsequent period witnessed the same negative but increasing at a decreasing rate effect from ERV to XDO over the sample period.
- The last period effect also shows that ERV has a negative effect on XDO. However, it is an increasing but diminishing negative increase effect compared to the third period.

Discussion of Result and Analysis – Oil Export Demand (XDO) Model

The interim multiplier result shows the effect of the differenced ERV on the differenced oil export demand. The result holds if the differenced ERV increases by a unit and remains at the new level in subsequent period up to period four. This study confirms that the multiplier effect of a unit increase in the differenced ERV on the differenced oil export demand is increasing at a decreasing rate (see the delayed effect calculated earlier as demonstrated in figure 7.3).

The negative effect of exchange rate volatility on oil export demand increases from 34.8551 in the first quarter of the policy implementation to 36.2783 in the second quarter, to 36.5945 in the third quarter and finally to 36.6648 in the last quarter. These results suggest that the effect may not be permanent as it later die off. The delayed effects demonstrated in figure 7.3 is similar to this result, where the effect of the policy change dies off in the last quarter. It can be deduced that the magnitude of the effect of exchange rate volatility on export demand in the oil sector in Nigeria between 1986 and 2013 is noticed through its immediate effect (34.8551). On the other hand, the lag effects gradually and negligibly rise to 36.5945 (see fourth quarter effect). A unit increase in the differenced exchange rate volatility reduces differenced oil export demand in the first quarter in Nigeria for the period between 1986 and 2013 by about 35 units.

The result shows that there is a negative immediate effect of exchange rate volatility on export activities in the oil sector to the magnitude of 35 units. The meaning of this result as related to Nigeria is that the introduction of accelerated depreciation of Nigerian Naira weakens oil sector over the considered period. The higher cost of exchange led to increase in the cost of production in the sector (as expressed in chapter two). The increase in production costs subsequently reduced exporting activities in the sector. As reviewed in chapter two, the percentage share of both mining and manufacturing sectors to GDP fell under the reform. Also, the policy change gave rise to a large measure of disinvestment and a high incidence of plant closures, especially in industries that had relied solely on imported raw materials such as oil sector.

As discussed in chapter four, volume of exports reduces due to an increase in the variance of the general microstructure shock in the exchange rate process, which is driven by the forces that influence behaviour of exchange rate. For example, preposition one in chapter four states that: *When the variance of microstructure shocks in the ER process rises there is a decrease in the volume export.* Thus, the persistent driving factor of ER process (as confirmed in chapter six) influences oil export demand overtime. These are primarily associated with monetary policy in Nigeria. In other words, export activities in the oil sector reduced in Nigeria during 1986 and 2013 due to deregulation policies implemented on both exchange rate and interest rate (as examined in chapter six).

The market-determined or deregulated policy that was introduced in 1986 has an immediate decreasing effect on export activities in the oil sector in Nigeria. The results confirm that the SAP policy did not favour oil sector as planned in the policy's objectives (see more details in chapter two). Therefore, the instability and incessant depreciation of the foreign exchange value of the Naira is intuitive to have negative effect on oil export in Nigeria for number of reasons.

Firstly, the negative result could be attributed to the interest rate deregulation policy which subsequently affects exchange rate process over the sample period. The shock in interest rate has been investigated in chapter six to raise exchange rate changes and persistence in Nigeria due to the flexibility of the policy implemented (as discussed in chapter two during the policy changes). The study finds that relative interest rate rose in Nigeria due to deregulation policy instituted in 1986. Higher interest rate led to increase in the relative prices and consequently the value of money fell. The loss of money value reduces demand for domestic currency, which results to depreciation of the home currency. In this case, increase in relative interest rate leads to increase in exchange rate after SAP (see details in chapter six).

Therefore, this study concludes that the spillover effect of interest rate volatility on exchange rate volatility transmits into the oil sector by increasing cost of production in the sector. A rising cost of production subsequently led to reduction in the productivity level in the sector over the sample period. Therefore, the result confirms that the interest rate deregulation policy has adverse effects on oil export through exchange rate linkages in Nigeria over the sampled period.

Secondly, the Naira became unstable with the implementation of the exchange rate policy leading to a more weakened oil sector (details in chapter two). Consequently, the trading activities in the oil sector reduced. The reduction in the trading activities in the sector suggests that agents of trade in the Nigerian oil sector are risk averse. That is, an increase in risk due to ERV results in shifting the risk-averse people from risky to less risky activities and thus reduces their trade participation (details in chapter four). The trade participation reduces because agents of trade in Nigeria have no perfect information about the behaviour of future ER in a flexible or deregulated ER regime since exchange rates are subject to shocks that are determined by the forces of demand and supply.

This study establishes in chapter six of this thesis that exchange rate volatility in Nigeria is found to depend on shocks and volatilities from interest rate and output growth. The above results therefore support the theoretical model of Barkoulas *et al.* (2002), which states that the direction and magnitude of risk-averse agents' optimal trading activities depend upon the sources of the volatility in exchange rate process (see details in chapter four).

Thirdly, due to deregulation of the Nigerian Naira, high proportion of foreign exchange earnings was used to service debts, which considerably reduces importation of capital goods for the oil sector in Nigeria (see details in chapter two). In other words, the flow of capital goods used for production in the oil sector reduced due to higher cost of production and consequently reduced exporting activities in the sector between 1986 and 2013. Thus, a volatile exchange rate hampers trade activity in the oil sector.

The above results are supported by the previous theoretical studies evaluated in chapter four that ERV hinder trade flow based on the view that ERV signifies volatility and as such imposes cost on commodity traders. This study finds that ERV directly depresses oil export demand through volatility and adjustment costs in Nigeria over the period. Therefore, the study confirms that the immediate effect of interest rate and exchange rate deregulation policies in Nigeria is highly unfavorable in the oil sector. Although, the negative effects of the policies gradually die off as indicated by the periodic lag multiplier, but the result confirms that the deregulation policies has adverse effects on oil export in Nigeria over the sample period.

The analysis of the effect of ERV on XDO as detailed in this section composed of policy changes in exchange rate and interest rate in 1986. Thus, the analysis supports the general equilibrium theory that the ERV should be measured endogenously to reflect the effect of the factors that drive the exchange rate process in the economy (see details in chapter four). In addition, the general equilibrium theory analysis has shed more light on the relationship between exchange rate volatility and oil export demand by taking into account the response of variations in ER from interest rate and exchange rate policy changes in Nigeria from 1986 till 2013. This study therefore concludes that policy changes triggered the factors of exchange rate process, which consequently depresses trade activities in the oil sector in Nigeria between 1986 and 2013.

In conclusion, this study affirms that an increase in risk due to ERV results in shifting the risk-averse people from risky to less risky activities and thus reduces their trade participation in the oil sector. In addition, export demand in the oil sector in Nigeria between 1986 and 2013 is affected negatively by ERV through a persistent volatile interest rate as occasioned by policy changes. This therefore validates the hypothesis 2a of this thesis that there is a statistically significant negative relationship between ERV that is occasioned by policy changes and export demand in the oil sector in Nigeria between 1986 and 2013.

ii. Agriculture Export Demand (XDA) Model

Given a nonstationary and non-cointegrated series, the ARDL export demand model for agriculture sector in Nigeria between 1986 and 2013 has been specified as:

$$\Delta XDA_t = C_A + \sum_{i=1}^{n} \emptyset_1 \Delta XDA_{t-i} + \sum_{i=0}^{n} \vartheta_i \Delta ERV_{t-i} + \sum_{i=0}^{n} \rho_i \Delta FY_{t-i} + \sum_{i=0}^{n} \varphi_i \Delta ER_{t-i} + v_t \qquad 7.4.2$$

where XDA is the Agricultural export demand,C_A is the intercept, ERV is the measure of volatility in the exchange rate as driven by interest rate volatility, FY is the foreign income and ER is the real exchange rate. Δ is the difference operator of the level series. n is the lag length, which is chosen through maximizing the Akaike Information Criterion (AIC). See section 7.4.3 for details about model selection. The result is reported in table 7.7.

Table 7. 7: ARDL Result for Agriculture Export Demand in Nigeria (1986-2013)

Dependent Variable: XDA			
Parameter		Coefficients	*t*-Statistic
$\hat{\emptyset}_1$	Lagged XDA	0.3108*	68.3249
$\hat{\vartheta}_0$	ERV	-0.0644*	-2.0997
$\hat{\vartheta}_1$	Lagged ERV	-0.0514*	-3.8211
$\hat{\rho}_0$	FY	-0.0622*	-4.8537
$\hat{\rho}_1$	Lagged FY	0.0566*	4.6578
$\hat{\varphi}_0$	ER	0.0122*	16.2060
$\hat{\varphi}_1$	Lagged ER	-0.0049*	-4.3779
$\hat{C}_A$	Constant	0.1889*	5.4252

Notes:
i. * indicates significance of coefficient at least in 5% significance level
ii. Diagnostic statistics are:

$\overline{R^2}$ = 0.9078, DWS = 1.7004, F-Stat = 155.6780 [0.0000], AIC = -7.3673, S.E. of regression = 0.0059, RSS = 0.0036, Log likelihood = 416.8869, AC~F(1, 102) = 2.7640 [0.0995], AC~χ^2(1) = 2.9285 [0.0870], RESET~F(1,100) = 0.2222 [0.6384], RESET~ χ^2(1) = 0.2420 [0.6228], H~F(7, 101) = 1.1180 [0.3578], H~ χ^2(7) = 7.8383 [0.3471].

a. The probability values are presented in the squared bracket while the t-statistics are presented in parentheses.
b. Except where otherwise stated the results are analyzed at 5% level of significance.
c. AC~F is the F-statistics from the first order serial correlation test while AC~χ^2 is chi-square statistics from the first order serial correlation test.
d. RESET~F is the F statistics from the misspecified functional form test while RESET~ χ^2 is the chi-square statistics from the misspecified functional form test.
e. H~F is the F statistics from the heteroscedasticity test while H~ χ^2 is the chi-square statistics from the heteroscedasticity test.

Table 7.7 above shows that Breusch-Godfrey Serial Correlation LM test is statistically insignificant. So, the null hypothesis of no serial correlation in agriculture export demand model cannot be rejected. This means that the classical assumption of strict exogeneity holds for agriculture export demand model in Nigeria between 1986 and 2013. Similarly, the study cannot reject the null hypothesis of homoscedasticity using the Breusch-Pagan-Godfrey Heteroscedasticity Test. This means that the error variances are serially uncorrelated.

The lagged agriculture export demand, exchange rate volatility, foreign income, exchange rate and their lagged series are statistically significant at 5%. Also, the lagged agriculture export demand, exchange rate volatility, foreign income, exchange rate and their lagged series exhibit theoretical signs.

The stability diagnostic tests that the Ramsey (1969) Regression Specification Error Test fails to reject the hypothesis of correct specification, depicting that the functional form of the model is correct. This means that the agriculture export demand model specification is rightly specified and there are no neglected nonlinearities in the model. Further to the stability diagnostic test, figure 7.4 and 7.5 below present the CUSUM and CUSUM of Squares result respectively. The diagrams demonstrate the stability of the XDA model over the sample period.

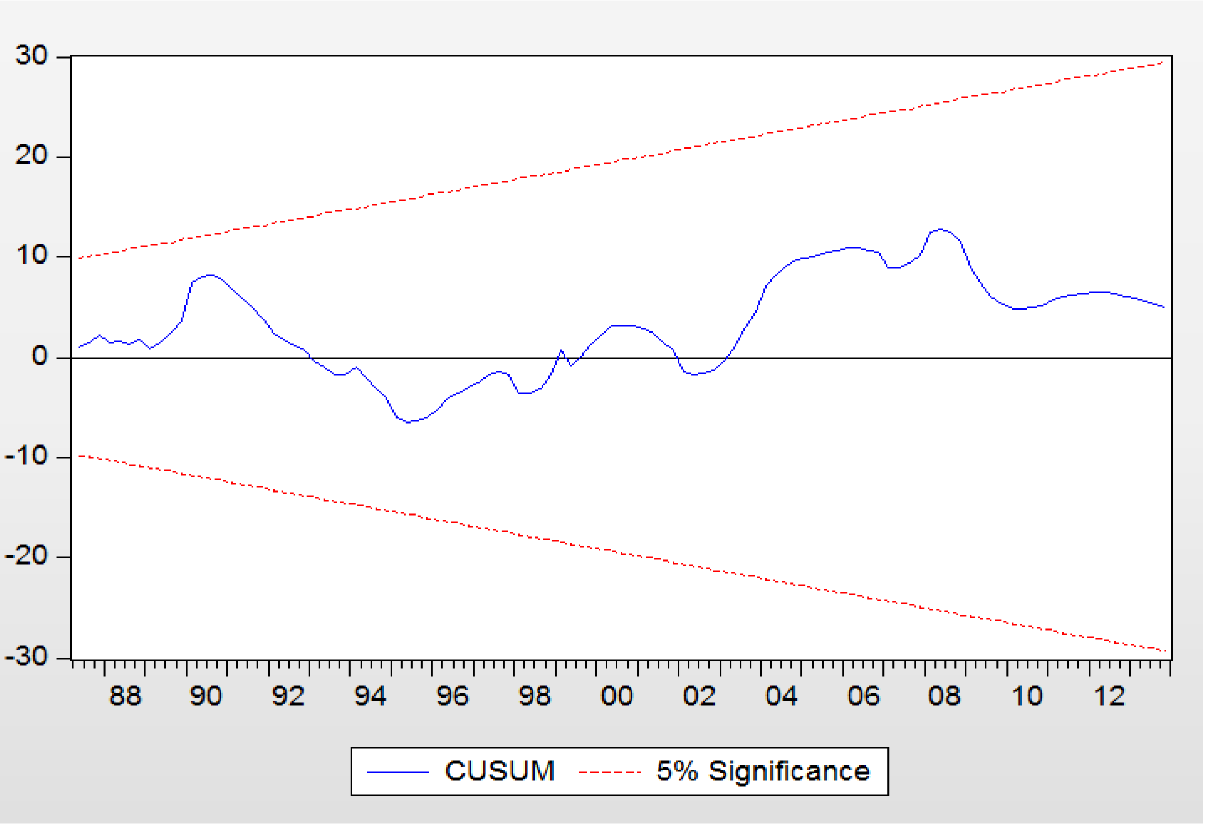

Figure 7.4: The CUSUM for Agriculture Export Model

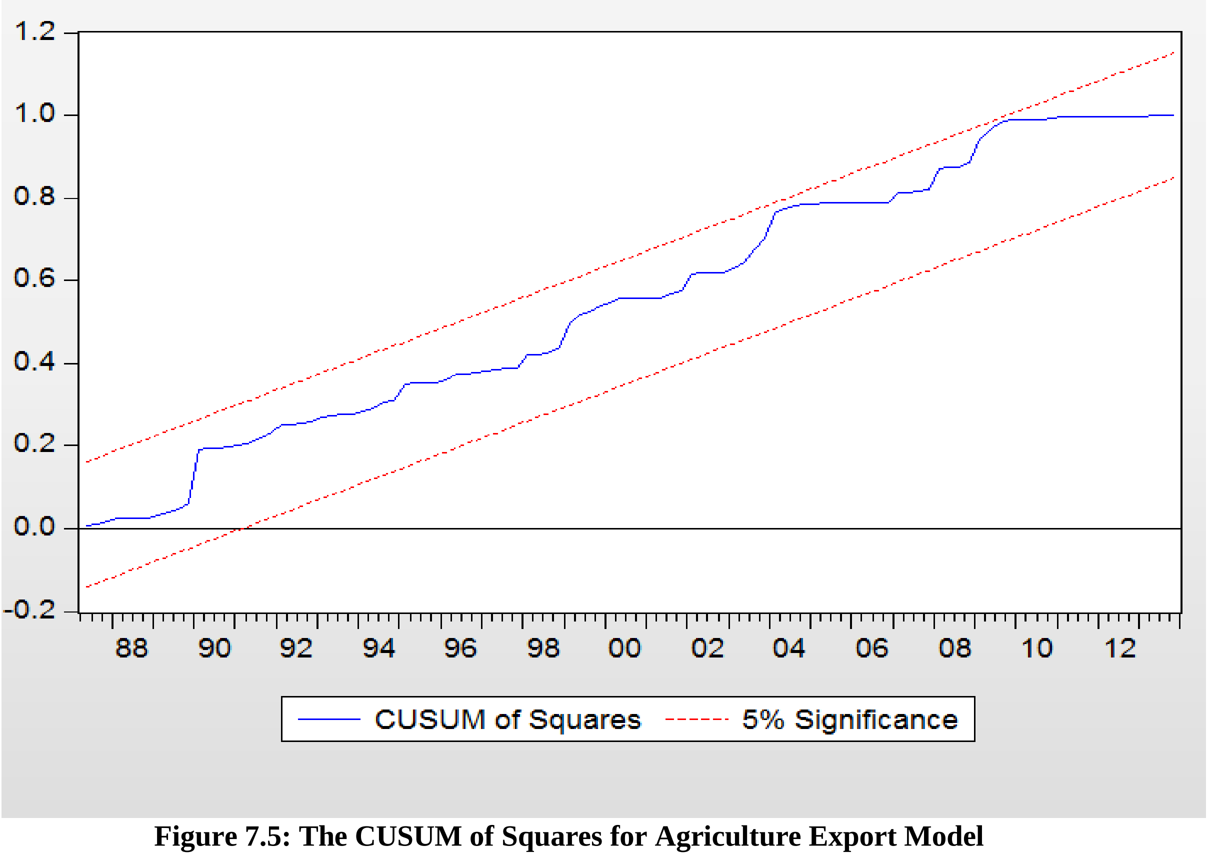

Figure 7.5: The CUSUM of Squares for Agriculture Export Model

Figure 7.4 and 7.5 present the CUSUM and the CUSUM of Squares for more stability diagnostic tests. The results above suggest that the model is stable over the sample period. The residuals of the model are generally 2 standard error bands. That is, they are within the two standard error bands. The implication is that there is no autoregressive conditional heteroscedasticity (ARCH) in the residuals. Hence, the study confirms that agriculture export demand model for Nigeria between 1986 and 2013 possesses a good fit and passes both the residual and stability diagnostic tests.

The ARDL (1, 1, 1, 1, 1) result above demonstrates the dynamic estimates of the Agriculture export demand (XDA) model. The coefficients of differenced exchange rate volatility (-0.0644 and -0.0514) are highly statistically significant and agree with the theoretical expectation that exchange rate volatility reduces agriculture export demand in Nigeria between 1986 and 2013. While (-0.0644) is the current effect, (-0.0514) is the potential lagged effect. The result confirms that a unit increase in the differenced variability of exchange rate reduces differenced agriculture export demand in Nigeria between 1986 and 2013 by 0.064 units. The above analyses suggest that the immediate effect of exchange rate volatility in Nigeria, which is determined persistently by interest rate volatility immediately reduces trading activities in the agriculture sector in Nigeria.

The coefficients of differenced foreign income (-0.0622 and 0.0566) are highly statistically significant, however, the immediate effect does not agree with the theoretical expectation. The result shows that increase in the income of the trading partners reduces agricultural export demand. That is, a unit increase in the differenced foreign income depresses differenced agriculture export demand in Nigeria between 1986 and 2013 by about 0.06 units. The results suggest that a higher income in the US worsen trade activities in the agricultural sector in Nigeria over the sample period. However, the potential lagged effect remains positive to support the theories.

The above results may be attributed to the effect of scrapping Commodity Boards (CBs) as one of the policy goals under SAP (see chapter two for details). Scrapping the CBs encouraged exportation of poor-quality cash products like cocoa, palm and groundnuts products that were not long rejected abroad. The results suggest that the Nigeria agriculture products survive in the US when income is low. However, with higher income, a better-quality agriculture product is patronised leading to the rejection suffered by the Nigerian products. The result therefore confirms that the 1986 reform on agriculture sector negatively influenced the effect of foreign income on agriculture export activities in Nigeria over the period.

The coefficients of differenced exchange rate (0.0122 and -0.0049) are highly statistically significant, however, the immediate effect of exchange rate changes on agriculture export does not agree with the theoretical expectation. The results show that the effect of a unit increase in exchange rate in Nigeria overtime increased differenced agriculture export demand by about 0.01 units. The above results suggest that a higher exchange rate changes increases trading activities in the agriculture sector in Nigeria. The analysis could be supported by the analysis of the foreign income as higher exchange rate connotes lower overall income in the US. Thus, lower income means higher demand for agriculture export. Although, this effect is intuitive for Nigeria, however, it has a relatively small magnitude. The results suggest that the effect of exchange rate volatility is relatively important in determining agriculture export in Nigeria.

It is important in this study to examine the timing of the effect of exchange rate volatility on agriculture export demand in Nigeria between 1986 and 2013. The timing of the effect is necessary in this study because the identified research hypothesis is to determine the immediate impact and interim multiplier effect of the monetary policy change on agriculture sector in Nigeria between 1986 and 2013. This study therefore considers four-period delay effect and the interim effect (see chapter five for how multipliers are calculated). The four-period delay effect and the interim effects are used to determine the immediate impact and interim multiplier effect of the monetary policy change on oil sector in Nigeria between 1986 and 2013.

Multiplier Analysis - Agriculture Export Demand (XDA) Model

The four-period delay multipliers (using Nigeria quarterly data from 1986 till 2013) for agriculture export demand are represented below with ∂'s using the relationship in equation 7.4.2;

$\hat{\partial}_0$	immediate effect $= \hat{\vartheta}_0 = -0.0644$
$\hat{\partial}_1$	$1 -$ period delay effect $= \hat{\vartheta}_1 + \hat{\partial}_0\hat{\emptyset}_1 = -0.0514 - 0.0644 \times 0.3108 = -0.0360$
$\hat{\partial}_2$	$2 -$ period delay effect $= \hat{\partial}_1\hat{\emptyset}_1 = -0.0205 \times 0.3108 = -0.0112$
$\hat{\partial}_3$	$3 -$ period delay effect $= \hat{\partial}_2\hat{\emptyset}_1 = -0.0064 \times 0.3108 = -0.0035$
$\hat{\partial}_4$	$4 -$ period delay effect $= \hat{\partial}_3\hat{\emptyset}_1 = -0.0020 \times 0.3108 = -0.0012$

where $\hat{\vartheta}_0$ is the current exchange rate volatility, $\hat{\vartheta}_1$ is the lagged exchange rate volatility, and $\hat{\emptyset}_1$ is the lagged agriculture export demand. The above calculated delayed multiplier is presented in table 7.8 and figure 7.6 below.

Table 7. 8: Analysis of the Delayed Multiplier Effect of ERV on XDA in Nigeria (1986–2013)

Period	Delayed Multiplier	Effect
Current-Period	-0.0644	Negative
1-Period Delay	-0.0360	Decreasing negative
2-Period Delay	-0.0112	Decreasing negative
3-Period Delay	-0.0035	Decreasing negative
4-Period Delay	-0.0012	Decreasing negative

- Table 7.8 above is present graphically below in figure 7.6

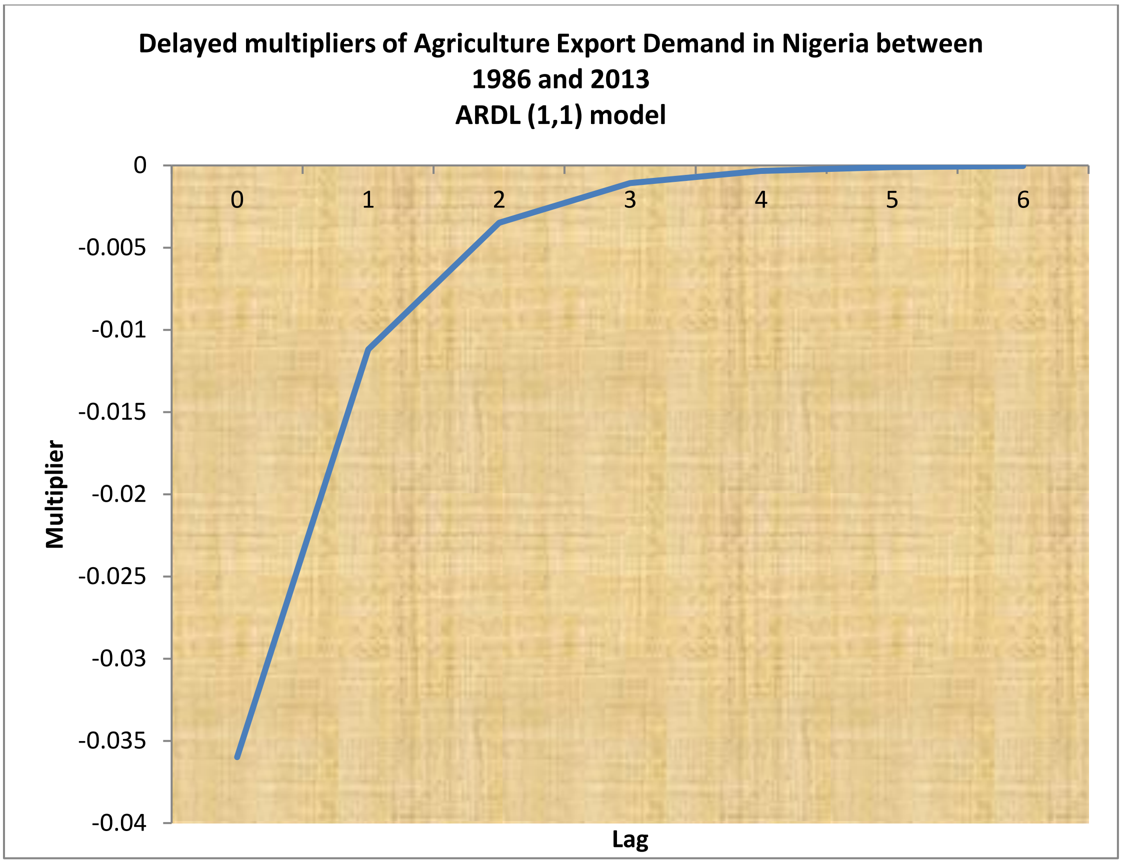

Figure 7. 6: Multiplier Effect of ERV on XDA in Nigeria between 1986 and 2013

Table 7.8 and figure 7.6 above show that the weights of the effect of exchange rate volatility on agriculture export demand at long lags go to zero. The results confirm that this analysis is valid. Exchange rate volatility leads to fall in agriculture export demand with the greatest effect being from the current quarter and declines after. That is, the effect of the ERV on XD in the agriculture sector later declines to zero.

In the above analysis, this study estimates the effect of a unit change in exchange rate volatility in Nigeria as distributed over the current and next 4 period. This study assumes that after 4 periods, changes in ERV no longer affect agriculture export demand in Nigeria. The assumption regarding the 4 periods is made because the study employs a finite distributed lag model. The four periods are employed because quarterly data were used. Also, the four-period interim multipliers (using Nigeria quarterly data from 1986 till 2013) for agriculture export demand are presented as;

1-period interim multiplier = $\hat{\partial}_0 + \hat{\partial}_1 = -0.0644 - 0.0360 = -0.1004$

2-period interim multiplier = $\hat{\partial}_0 + \hat{\partial}_1 + \hat{\partial}_2 = -0.0644 - 0.0360 - 0.0112 = -0.1116$

3-period interim multiplier = $\hat{\partial}_0 + \hat{\partial}_1 + \hat{\partial}_2 + \hat{\partial}_3 = -0.0644 - 0.0360 - 0.0112 - 0.0035 = -0.1151$

4-period interim multiplier = $\hat{\partial}_0 + \hat{\partial}_1 + \hat{\partial}_2 + \hat{\partial}_3 + \hat{\partial}_4 = -0.0644 - 0.0360 - 0.0112 - 0.0035 - 0.0012 = -0.1163$

The above calculated interim multiplier is presented in table 7.9 below.

Table 7. 9: Analysis of the Interim Effect of ERV on XDA in Nigeria (1986 – 2013)

Period	Interim Multiplier	Effect
1	-0.1004	Negative
2	-0.1116	Increasing at decreasing rate
3	-0.1151	Increasing at decreasing rate
4	-0.1163	Increasing at decreasing rate
Note: Interim multiplier is the effect of ERV on XDA when ERV increases by a unit and remains at the new level in subsequent period up to period four.		

From table 7.9 above, assuming ERV increases by a unit and remains at the new level:

- The differenced ERV has a negative effect on the differenced XDA in the first period in Nigeria.
- The differenced ERV has negative effect on the differenced XDA in the second subsequent period. However, the negative effect increases but at a decreasing rate compared to the first period effect.
- The third subsequent period witnessed the same negative but increasing at a decreasing rate effect from ERV to XDA over the sample period.
- The last period effect also shows that ERV has a negative effect on XDA. However, it is an increasing but diminishing negative increase effect compared to the third period.

Discussion of Result and Analysis - Agriculture Export Demand (XDA) Model

The interim multiplier results show what happens to the differenced agriculture export demand if the differenced exchange rate volatility increases by a unit and remains at the new level in subsequent period up to period four. This study hereby confirms that the multiplier effect of a unit increase in the differenced ERV on the differenced agriculture export demand is increasing at a decreasing rate. The results suggest that the effect may not be permanent as it later dies off (see the delayed effect in table 7.8 and figure 7.6).

The negative effect of exchange rate volatility on agriculture export demand rises from 0.1004 in the first quarter of the policy implementation to 0.1116 in the second quarter, to 0.1151 in the third quarter and finally to 0.1163 in the last quarter. The meaning of this is that the effect may not be permanent as it later die off. These results are similar to the delayed effects calculated earlier as demonstrated in figure 7.6 where the effect of the policy change dies off in the last quarter. The magnitude of the effect of exchange rate volatility on export demand in the agriculture sector in Nigeria between 1986 and 2013 is noticed through its immediate effect (0.1116). On the other hand, the lag effects gradually and negligibly rise to 0.1163. A unit increase in the differenced exchange rate volatility reduces differenced agriculture export demand in the first quarter in Nigeria for the period between 1986 and 2013 by about 10 units.

The above results imply that the deregulated exchange rate and interest rate policies (as discussed in chapter two) increases exchange rate volatility (as investigated in chapter six). Consequently, there is an immediate negative effect on export activities in the agriculture sector to the magnitude of 10 units. In other words, export activities in the agriculture sector reduced in Nigeria during 1986 and 2013 due to deregulation policies implemented on both exchange rate and interest rate. The negative effect of ERV on XDA continues till the fourth quarter as considered under this analysis, however, the rate of change was negligible (compared to the beginning of the policy) in the agriculture sector.

The implication of the result is that SAP reform has an immediate negative effect on the agriculture sector (see details in chapter two). The immediate negative effect of exchange rate volatility on agricultural sector may be attributed to two major reasons as orchestrated by the deregulation policies. Firstly, the price incentives created through floating exchange regime of SAP by relying on introduction of Second Tier Foreign Exchange Market (SFEM) affected productivity in the sector. The Second-Tier Foreign Exchange Market (SFEM) presented price inducements to farmers; however, it also generated increases in the input costs (such as fertilizers, tools, insecticides and equipment). Meanwhile, to make SAP reform a valuable program for farmers, the incentives in prices should produce a broad margin against the input costs (which was ignored under SAP). Therefore, the higher cost of inputs could be attributed to the increase in the cost of production in the agriculture sector. This further reduced the exporting activities in the sector.

Secondly, the Nigerian currency was deregulated to enhance the level of agriculture exports, discourage imports of consumer and producer goods and as a result reduce the nominal value of imports while increasing the value of exports. However, the expected reduction in importation, owing to devaluation of the Naira, failed to materialize. The inability of importation to respond to devaluation of Naira could be attributed to the importing nature of the economy, which is insatiable. As discussed in chapter two, the macroeconomic policies encourage consumption rather than production. The economy was consuming what she was not producing through import. Thus, the sector lost its market to foreign substitutes and that reduced trade activities in the agricultural sector.

Thirdly, the effect of interest rate deregulation may also be attributed to depressed trade activities in the agriculture sector through exchange rate. As discussed in chapters two and six, the deregulated interest rate resulted into higher and unstable exchange rate movement. The higher and unstable exchange rate movement resulted into higher relative prices, which raised cost of production in the productive sectors of the economy especially the agriculture sector. The higher interest rate and the requirements of credit facility as instituted by the interest rate policy could not be met by the majority of the farmers. The smaller proportion of the farmers that could afford the price and the requirements of credit facility faced higher production costs. The higher cost of production increased the price of the products giving rise to either costly or substandard products relative to its foreign counterparts.

In addition, Commodity Boards (CBs) were scraped as part of the SAP reform. The scraped CBs encouraged exportation of poor-quality cash products like cocoa, palm and groundnuts products that were not long rejected abroad. As a result, agricultural products became less competitive both internally and internationally. The less competitive agricultural products led to a weaker agriculture sector as against the objective of the SAP reform. The reform was to increase savings through higher interest rate thereby increase investment in the agriculture sector. However, savings remained low and higher interest rate discouraged investment in the sector (see details in chapter two). Thus, the exchange rate and interest rate deregulation policies hamper trade activities in the agriculture sector as found in this study. Thus, this study concludes that the exchange rate and interest rate deregulated policies depress trade activities in the agricultural sector over the considered period.

The general equilibrium theory (GET) that is applied to this study is confirmed relevant because the findings of this research work reveal that exchange rate volatility reduces trade activities in the agriculture sector over the sample period as a result of policy changes in exchange rate and interest rate. As investigated in chapter six, the two markets are well connected with strong linkages. The analysis supports the general equilibrium theory that the ERV should be measured endogenously to reflect the effect of the factors that drive the exchange rate process in the economy (see details in chapter three and four).

Also, the application of this theory shed more light to the relationship between exchange rate volatility and agriculture export demand by taking into account the response of variations in ER from interest rate and exchange rate policy changes in Nigeria from 1986 till 2013. The depreciation in the Nigerian Naira due to the deregulation policies led to price inducement to farmers which could not measure up the higher input cost generated. As a result, there is pressure on the production cost in the agriculture sector and consequently reduced the exporting activities in the sector. Equally, the deregulated interest rate raised cost of production, which made agricultural products less competitive in the market.

This study therefore confirms that policy changes in both exchange rate and interest rate drive exchange rate process, which consequently depresses trade activities in the agriculture sector in Nigeria over the sample period. Moreover, Barkoulas, *et al.* (2002) theoretical model is justified in this study that the relationship between ERV and trade is determined by the underlying source of ERV. The proposition highlights the endogeneity of ERV in trade determination as carried out in this study.

The above findings are in line with Alegwe, Aye & Asogwa (2017) study on Nigeria, which concluded that exchange rate volatility is harmful to agricultural products export. Alegwe, *et* al recommended stable exchange rate policy as well as promotion of the production of export crops to expand the national export basket. More so, adding value to Nigeria's primary agricultural products is expedient and imperative because it does not only command higher prices but also enhances patronage at the international market. The variability of exchange rate shocks could be harmful, given the presence of asymmetric effect. While adhering to a flexible exchange rate policy, managing fundamentals to reduce excessive volatility over time should be given priority. Although Alegwe *et al* found that exchange rate volatility is harmful to agricultural products export, however, the finding could not justify the effect of policy changes in the determining export activities in the agriculture sector in Nigeria overtime.

7.5 Summary, Conclusions and Policy Implications

This study investigates the relationship between exchange rate volatility and export demand in oil and agricultural sectors in Nigeria between 1986 and 2013 using general equilibrium approach (that is, endogenous exchange rate volatility). The analysis is based on a lag structure econometric estimation technique using bilateral dataset of exports, income and exchange rates for Nigeria and its leading partner – US between 1986 and 2013.

The findings of this study show that exchange rate volatility depresses trade activities in the oil and agriculture sectors in Nigeria between 1986 and 2013. As earlier discussed, the endogenised exchange rate volatility employed in this study reveals that exchange rate and interest rate deregulation policies reduce trade activities in the sectors over the sample period. The study finds that the fundamental factor of exchange rate volatility has an indirect impact on export demand. Thus, the study confirms that export demand in Nigeria is not a partial model analysis but rather includes internally generated factors that drive exchange rate volatility.

The policy analysis of this finding indicates that the immediate effect of the differenced exchange rate volatility on the differenced export demand in the oil sector is high but with a reduced delayed effect from the exchange rate and interest rate deregulation policies in 1986. On the other hand, much of the effect of exchange rate and interest rate policy in the agriculture sector is delayed till the second quarter. The above analysis confirms that exchange rate is possibly not a delayed policy-concern in the oil sector in Nigeria.

The study finds that the importance of exchange rate volatility is indisputably related to increase in interest rate in Nigeria, which hedged against exchange rate risks (such as forward contract). This finding is established in the exchange rate volatility model in chapter six. Thus, exchange rate volatility as influenced by the deregulation policies reduces trade activities in the oil and agriculture sectors in Nigeria between 1986 and 2013.

In general, this thesis has two major policy implications. Firstly, regardless of how exchange rate and trade are determined, the policy makers have to pay more attention to the structure and management of exchange rate in Nigeria. This study notes that there is substantial effect of currency variations on export demand changes. The implication of this is that there is need to monitor Nigerian Naira relative to Nigeria trading partners' currencies as well as that of their competitors. This is equally important for the delayed effect of exchange rate volatility on agriculture export attractiveness.

Secondly, exchange rate variation cannot explain the full degree of trade imbalances in Nigeria. Thus, exchange rate arrangement is only a part of the needed resolution to trade improvement. This study suggests that a strict and regulated interest rate policy be pursued in Nigeria alongside other policy actions. This is to enhance a stable interest rate, which is capable of generating stable exchange rate movement as well as stable and sustainable economic environment. This is important because the study finds close connection and strong linkages between interest rate and exchange rate markets in Nigeria as confirmed in chapter six. Since an indirect impact is found to emanate from interest rate to trade, this study therefore concludes that Nigeria interest rate policy should be reviewed and become stable.

CHAPTER EIGHT: SUMMARY AND POLICY RECOMMENDATION

8.1 Introduction

This chapter presents an overview of this thesis. The thesis made an all-inclusive empirical investigation and analysis on the role of fundamental factors of exchange rate volatility on export demand in Nigeria between 1986 and 2013 using the general equilibrium analysis. Inspite of several empirical studies on the causes of exchange rate volatility and its subsequent effects on trade, studies on the Nigerian economy have numerous gaps that this study found and provided solution.

For instance, the effect of oil price shock that is usually ignored from exchange rate volatility models on Nigeria is considered in this study. Secondly, past models of exchange rate volatility determination, which had ignored the effects of historical shocks in Nigeria despite the obvious political regime shocks on the exchange rate overtime, are hereby adjusted in this study. Thirdly, on the methodological appropriateness, there has been little or no effort to capture the joint effect of shocks to specific macroeconomics variables on exchange rate volatility in Nigeria, which this thesis addresses. Fourthly, studies on Nigeria had virtually employed aggregated trade model; ignoring the effect of aggregation bias. This study remedied the problem by using sectoral trade analysis. Finally, it is observed that inspite of theoretical awareness that exchange rate volatility cannot exogenously determine trade; general equilibrium analysis of the relationship on Nigeria is rare or hardly exists.

To fill the above gaps in the empirical literature on Nigeria, this thesis set up two major hypotheses. The first hypothesis is to investigate the fundamental factors that drive exchange rate volatility in Nigeria between 1986 and 2013. Secondly, the thesis investigates the effect of exchange rate volatility on export demand in Nigeria between 1986 and 2013 using the general equilibrium analysis. Thus, unlike earlier studies on Nigeria that assumed linear relationship of exchange rate volatility and export demand, this research work is the first to investigate the dynamic effect of factors of exchange rate volatility on sectoral export demand.

It is important in this study to first understand the effect of bilateral exchange rate volatility on bilateral export activities in Nigeria. This helps to set up a sustainable exchange rate policy and optimum trade policy. The idea is important in this thesis because Nigerian economy largely depends on exports (especially oil export) for its aggregate income and economic growth. Secondly, given that exporting activities may not be determined solely by exchange rate volatility (as proposed by the general equilibrium hypothesis), this thesis first considers the fundamental factors of exchange rate volatility. This analysis allows the use of internally generated volatility from the factors that drive ERV in Nigeria in the trade model.

Like many other developing countries where exchange rate determination is not solely monetary or non-monetary, Nigeria's exchange rate is mostly influenced by both monetary and non-monetary factors. Aside the economic factors, historical events such as political regime shifts always convey shock to exchange rate volatility determination in Nigeria. It then becomes important in this thesis to first understand the fundamental drives of exchange rate volatility before establishing the subsequent "general equilibrium effect" on export demand in Nigeria. The analyses of this study therefore confirm the monetary and non-monetary factors that cause exchange rate volatility in Nigeria as summarize below.

Firstly, this thesis establishes that interest rate permanently drives exchange rate volatility in Nigeria, whereas, productivity growth temporarily drives exchange rate volatility in Nigeria overtime. However, the study finds that oil price only has a random walk effect on exchange rate volatility in Nigeria over the considered period. Secondly, shocks to the exchange rate due to historical events produce positive response of interest rate to the shock in exchange rate volatility during Abacha regime and Obasanjo regime (due to policy changes). On the other hand, a positive response from the productivity growth during the Yar'Adua/Goodluck regime was short lived. This is attributed to the effect of 2008 global financial crises. Whereas, a delayed persistent positive response is again established to influence the volatile exchange rate.

Regarding the consequent effect of exchange rate volatility on sectoral export demand, the internally generated volatility is found to depress export activities in the oil and agriculture sectors in Nigeria between 1986 and 2013. From these findings, higher exchange rate volatility reduces export attractiveness and competitiveness in Nigeria over the sample period. These results are robust using diverse estimation approaches. The results confirm that exchange rate and interest rate deregulation policies reduce exports demand in the productive sectors in Nigeria between 1986 and 2013. The findings of the thesis are generally in accordance with the recent studies that support a negative relationship between exchange rate volatility and export demand. The higher the volatility of exchange rate, the more adversely affected the exports activities.

This chapter summarizes the previous chapters of the thesis. Secondly, the chapter outlines the policy recommendation of the thesis on international economics and trade, which could be of interest to the policy makers. Finally, the chapter points out the limitation in the study and provides suggestions for further research.

8.2 Summary of the Chapters

Chapter one of this thesis sets out the motivations for conducting this research work in the context of Nigeria. The chapter focused on the reasons and importance of investigating the impact of exchange rate volatility on export demand in Nigeria using a general equilibrium framework. The assessment in the chapter reveals that both external and domestic sectors in Nigeria had persistent economic problem associated with exchange rate volatility. The study finds that there has been lingering economic depression (negative economic growth in agriculture and industry sectors) in Nigeria which is triggered by the unstable exchange rate and negative growth of external reserves overtime. Moreover, unstable exchange rate is found to be one of the main sources of economic instability in the world, especially in developing countries because economic agents tend to reduce trading activities when the exchange rate is not predictable.

In chapter one, the study considers the problem of economic instability in Nigeria through exchange rate volatility from trade perspective since external and domestic sectors are involved in trading activities. Thus, the main objective of this thesis is to investigate the relationship between exchange rate volatility and export demand in Nigeria overtime. The study found that the relationship between exchange rate volatility and export demand is better examined through a general equilibrium framework (using endogenized exchange rate volatility). The framework is considered in this study because exchange rate volatility on its own (exogenous) may not effectively influence export demand in Nigeria. Thus, this research work first designs a question regarding the fundamental macroeconomic factors that drive exchange rate volatility in Nigeria considering the several political regimes shift and oil price fluctuation. Thereafter, the study asked whether there is any relationship between exchange rate volatility and sectoral exports demand in Nigeria overtime.

The chapter further considered the two main hypotheses used to achieve the main objective of this thesis as well as answer the above two research questions. Firstly, in order to derive an endogenous exchange rate volatility in Nigeria, the study investigates whether one-time shock and persistence in interest rate, productivity growth and crude oil price drive exchange rate volatility in Nigeria between 1986 and 2013. This hypothesis is tested in the first model using the GARCH BEKK analysis through which the endogenous exchange rate volatility (to be used in the second model) is derived.

Secondly, the study investigates whether export demand in Nigeria responds to changes in exchange rate volatility that is due to policy changes between 1986 and 2013. The hypothesis is tested in the second model using the ARDL technique, which helps to examine the economic analysis of the relationship between exchange rate volatility (derived from first model) and export demand in Nigeria overtime.

This chapter later assessed the justifications for this research work. Firstly, the chapter pointed out that this thesis is the first study to unify the theoretical and empirical literature on the determinants of ERV in Nigeria. The unification is done by including oil price shock and volatility as a factor that drive ERV, which most of the previous studies on Nigeria ignored. Secondly, the study used a multivariate framework analysis in the exchange rate volatility model. The framework makes it possible to combine monetary and non-monetary in the explanation of ERV by examining the relationships in the model in terms of volatility shock. In addition, the framework helps to examine the spillover effects and responses of the various shocks. Thirdly, the chapter shows that this is the first study on Nigeria that analyses ERV under different historical events, compares the results under different regime shifts and investigates volatility spillovers between exchange rate volatilities and monetary and non-monetary factors. Fourthly, the chapter noted that this thesis overcome aggregating bias in the previous studies by taking disaggregating process a step further. The study examined sector-specific export demand as against the aggregated trade data employed in the previous studies. Lastly, the study examined the immediate and delayed effects of the exchange rate and interest rate policies on export demand in Nigeria.

In chapter two, the study noted that it is important to have a comprehensive understanding of the economic background and policy performance of an economy when conducting empirical analysis such as discussed in chapter one. Thus, chapter two of this thesis assessed the Nigeria economic policies and performance since 1960. The chapter provided the background knowledge of the Nigerian situation over the period using the exchange rate policy, interest rate policy and trade policy especially since the deregulation (the Structural Adjustment Programme (SAP)) reforms in 1986.

The assessment shows that over 90 percent of the Nigeria’s overall export earnings were derived from the primary sector prior to the 1970s and that the economy was performing well. Nigeria was recorded to be the twelfth largest oil producer in the world and eighth largest oil exporter prior to oil discovery in large quantity in 1973. The engine of growth changed from agriculture to oil after crude oil discovery. However, in early years of 1980s there was a world economic slow-down, which led to an oil glut, which contributed to the steep decline in Nigeria’s oil production for most of the 1980s. This subsequently led to a great domestic problem given the economy’s dependence on oil revenues and the already weakened agriculture sector by the mid-1980.

To address the above economic distortions as well as guarantee globally competitive and stable economy, Nigeria introduced developmental policies, plans, programmes and projects (including trade and exchange rate reforms). This study examined reforms that fall within the sample period under three sub-periods, Pre-SAP (before 1986), SAP Period (1986-1998) and Post-SAP (1999-2013). These are distinguished majorly by different structural events.

Exchange rate, trade and financial policies in Nigeria were highly regulated before 1986. The Structural Adjustment Programme (SAP) was introduced in 1986 with a major plank of deregulating the policies to boost the international competitiveness of Nigeria’s exports. There was massive local currency devaluation at the inception of SAP. The foreign exchange market deregulation was instituted during SAP; the Central Bank of Nigeria (CBN) introduced three-tier markets into the foreign exchange. Since the reform in 1986 till date, the ER has been moving from regulated, guide deregulation, and deregulation with devaluation throughout on the average.

Chapter two also annexed the relationship that exists between exchange rate policies, interest rate deregulation and trade policies in Nigeria between 1986 and 2013 with special attention to the effect of SAP reform. The devalued exchange rate of the naira in 1986 and at the different shades of the Foreign Exchange Market (SFEM, AFEM or IFEM), was meant to discourage excessive importation and thus improve production capacity thereby increase exportation. Consequently, this reduces the pressure on the balance of payments.

Despite the good-looking objectives of the evaluated reforms, Nigerian export has not responded impressively from the following observations. Firstly, Nigeria is an import dependent economy. Thus, the devalued exchange rate could not achieve its objectives in the face of trade liberalization policies. Secondly, the deregulated interest rate improves investment, however, not the productive investment that could expand exports of the economy. For instance, funds became inaccessible to the productive sectors such as agriculture. This is due to the cost and condition of contracting loans. Thirdly, the political regime structure in Nigeria does not permit effectiveness of the policies. This is owing to the policy reversal nature of the political leaders. Several policies and projects are jettisoned at the inception of new administration. This contributed to the Nigeria's incessant volatile exchange rate and the unstable economy. Meanwhile, the standard theoretical literature held that unstable exchange rate is harmful to export demand of a country.

It is obvious that exports demand in the Nigerian productive sectors are yet to improve and that raised two important questions which this thesis sought to answer. Firstly, it becomes imperative to identify the place of monetary and non-monetary liberalization in ensuring a stable exchange rate system in Nigeria. Secondly, there is need to investigate the effect of the endogenized volatile Nigerian currency on trade after the structural Adjustment Programme in 1986. The study found that the macroeconomic policies had failed in ensuring enviable exports in Nigeria, thus, the literature on fundamental drives of exchange rate volatility and its subsequent effect on export demand were reviewed, especially in developing economy in chapter three.

Chapter three surveyed the relevant theoretical and empirical literature on the determination of exchange rate volatility. Firstly, the chapter provided detailed theoretical foundations and the practical formulations of determination of exchange rate volatility (second moment of exchange rate) with the conventional (monetary) ERV models – flexible price and sticky price models. The development in the application of these models suggests that non-monetary factors are indeed statistically significant in the determination of exchange rate volatility. For example, recent development found that oil price is also statistically significant in the determination of exchange rate volatility, especially in an oil trading economy. Given the structure of Nigeria's trade in which oil happens to be the major product of exchange, this study held the proposition. To accommodate this development in the model, this thesis developed a simple exchange rate volatility model in its empirical sections.

Secondly, some relevant empirical studies were evaluated in the chapter. From the empirical evaluation, this thesis found that the factors that drive exchange rate volatility are numerous and should be investigated as applicable to individual economy based on its macroeconomic condition. One of the findings is that most of the empirical studies do not incorporate the covariances of the potential determinants of exchange rate volatility in their investigations. However, this is important because there is co-movement of monetary and non-monetary factors in many of the studies.

Couple with this is the policy change effects that are ignored in studies on the developing economies. Meanwhile, this may probably be irrelevant in studies on developed economies due to the stable structure of policies. Also, most of the past methods of analysis employed on exchange rate volatility modelling are not designed to model the conditional volatility of the random variable. Specifically, no study on Nigeria employed this type of design to model exchange rate volatility. Meanwhile, the method is important in generating an endogenous volatility to allow a general equilibrium analysis. Thirdly, the chapter evaluated the different econometric methods employed by the past empirical studies to model exchnage rate volatility, especially in multivariate time series. Thus, the chapter further reviewed the multivariate GARCH - BEKK, which is later employed in chapter six.

Chapter four surveyed the relevant theoretical and empirical literature on how endogenised exchange rate volatility affects exports. Firstly, the thesis examined the different theoretical models on the relationship between exchange rate volatility and trade in the literature viz; the partial equilibrium model and the general equilibrium model. This study found that the partial equilibrium analyses, which centered on risk and option, were applied to the earlier studies. Using this approach, a firm's source of risk is exchange rate volatility while other factors remain constant. Given this approach, the major theoretical proposition is that volatility of profit increases alongside exchange rate volatility. So, a risk-averse firm is prone to declining export volume because the firm reduces its risk exposure.

However, other propositions that support positive hypothesis in this approach suggested that higher exchange rate volatility raises trade volume. The idea behind the propositions is that there is higher profit opportunity when exchange rate becomes more unstable. From this hypothesis, export is perceived to be an 'option', which can be extracted in favorable conditions. Therefore, given a more volatile exchange rate, there is higher probability of increasing profit on international trade. The volume of trade increases relative to higher chances of making more profit on trade.

On the other hand, the general equilibrium approach is also reviewed. This approach considered the interaction of relevant variables in providing a comprehensive picture on the link between unstable exchange rate and trade. To this approach, exchange rate volatility affects trade through factors that drive exchange rate volatility. This proposition suggested that the effect of volatile exchange rate on trade may not be justified by theory alone as it is ambiguous. Summarily, the theoretical review of the relationship between exchange rate volatility and trade remain inconclusive. Although, the general equilibrium approach explains the ambiguity in this relationship, there is still no tangible consensus on its direction and nature.

Secondly, given the inconclusive theoretical significance of the effect of exchange rate volatility on trade, several empirical studies were carried out. The empirical studies are also ambiguous as much as theoretical hypotheses. Due to the ambiguity in the theoretical and empirical analysis of the relationship, this thesis notes that past studies are careful in choosing exchange rate volatility’s proxy, fundamental exchange rate, trade flow proxy, trade model as well as the techniques of estimation. This thesis also identified some methodological issues that cast doubts on the results and conclusions of previous studies. For instance, endogenising exchange rate volatility’s proxy and the issue of aggregation bias are found to be of great concern in the literature.

Thirdly, the chapter assessed the specification of trade models such as the long run export demand and the gravity models. In a long run export demand model, exports are quantified as a function of relative prices of export, exchange rate, foreign income and exchange rate volatility. In this model, supply of exports is infinitely inelastic. This means that exporters have slight or no market-power. Thus, equilibrium quantity for exports is demand determined and features the different measures of exchange rate volatility employed by various empirical studies. The issue of gravity model is of secondary importance in this study.

Chapter five of this thesis outlined the methodology used in this research work. The thesis employed a multivariate generalized autoregressive conditional heteroscedasticity (MGARCH) for the first empirical model (exchange rate volatility model) estimation. The chapter provided the justification for using the MGARCH of Baba, Engle, Kraft and Kroner (MGARCH-BEKK) with special attention to its volatility impulse response functions (VIRFs) analysis. Due to the inability of the BEKK parameters to provide intuitive analysis as a dynamic model, this thesis employed the volatility impulse response functions analysis for a comprehensive analysis of the factors that drive exchange rate

This study first presents a brief overview of the MGARCH – BEKK and the volatility impulse response functions (VIRFs) analysis. Afterwards, the exchange rate volatility model for Nigeria in a MGARCH BEKK system of equation was specified. The four-variable model comprises of the interest rate, productivity growth, oil price and exchange rate as proposed in the theories and supported by the empirical studies considered.

To mention a few of its advantages, the MGARCH BEKK helped in modeling conditional variances and covariances and also captured the joint effect of shocks to the specified macroeconomics variables on exchange rate volatility. More importantly, the MGARCH BEKK helped in investigating volatility transmissions between interest rate and exchange rate under different historical shocks using the VIRFs. This study found this important because interest and exchange rate market in Nigeria is expected to be linked in the policy analysis and have close connection to different historical events. Thus, the chapter discussed the four-variable MGARCH BEKK model as would be applied in the empirical exchange rate volatility model in chapter five. The model is used to validate hypothesis 1 of this thesis that shock and volatility spillover effect of interest rate differential, productivity growth differential and oil price increases exchange rate volatility in Nigeria between 1986Q3 and 2013Q4.

Secondly, the Autoregressive Distributed Lag (ARDL) techniques were applied in the second empirical model in this study. The ARDL is employed in this thesis because its lag structure helps to eliminate potential serial correlation arising from the non-stationary data employed. Also, it helps in economic policy analysis given the deregulation policy effect of exchange rate volatility on trade over the sample period. That is, the use of the analysis helps to pin down the immediate or delayed effect of the interest rate and exchange rate deregulation policies since the inception of Structural Adjustment Program (SAP) in 1986 in Nigeria using its multiplier analysis property. Finally, the constructions of the variables and data sources are reported in the chapter.

Chapter six examined the fundamental factors that drive exchange rate volatility in Nigeria between 1986 and 2013. The model combines the monetary and non-monetary factors using the MGARCH BEKK techniques. This empirical chapter presented the Multivariate GARCH – BEKK estimation techniques and described how exchange rate, interest rate, productivity growth and oil price variables are fitted into the BEKK MGARCH model. Using the VIRFs, the study analysed the historical shocks effect of interest rate volatility, productivity growth volatility and oil price volatility on exchange rate volatility in Nigeria between 1986 and 2013.

This thesis found that historical shocks are important in exchange rate volatility determination in Nigeria due to policy reversal from political regime changes, incessant oil price surges and global financial crisis. The study established that interest rate volatility and productivity growth volatility react to these shocks and consequently drive exchange rate volatility over the period. Although the responses are not immediate, however, the shocks later increase volatilities in interest rate and productivity growth with subsequent influence on exchange rate in Nigeria between 1986 and 2013. The unstable political system led to variations in the policies resulting in macroeconomic instabilities, which are reflected in the volatile interest rate and exchange rate.

The analysis showed a strong evidence that interest rate volatility consistently drives exchange rate volatility in Nigeria over the considered period. Whereas, productivity growth temporarily drives exchange rate volatility in Nigeria over the period. However, the study found no volatility effect on exchange rate volatility from oil price. This means that there is no persistent relationship or linkage from oil price to exchange rate volatility in Nigeria between 1986 and 2013. This confirms that oil price volatility has only random effect on exchange rate volatility in Nigeria over the sample period. These results are in line with the expectation of this study in number of ways.

Firstly, the deregulation reform of 1986 led to increase in the interest rate and exchange rate due to market forces effect. The forces of demand and supply dictate the price in the foreign exchange market after SAP in Nigeria. Similarly, the forces of demand and supply dictate price in the financial market after SAP in 1986. The two markets are linked together through relative prices and thus move together with persistency (this validates hypothesis 1). Although, there is unstable political system in which political administrations reverse policies, especially the monetary policy, the path of the policies remains the same. Thus, the study concludes that interest rate has both one-time effect and persistent effect on exchange rate volatility in Nigeria between 1986 and 2013.

Theoretically, the result supported the flexible monetary determination of ER model (as discussed in chapter three) that a rise in the local relative to foreign interest rate reduces domestic money demand and causes local currency to depreciate (that is, increase in the rate of exchange). Thus, the result confirmed that there is permanent persistent relationship between interest rate and exchange rate volatility in Nigeria over the sample period.

Secondly, the improved economic growth (as measured by productivity growth) after SAP is accompanied by increase in exchange rate volatility over the sample period. This means that shock in the productivity growth and oil price are positively related to exchange rate persistence in Nigeria over the period. Increase in the aggregate income level after SAP increases pressure on wages on the whole economy compared to its foreign partner. This increases the relative prices of non-tradable goods and consequently reduces the value of money. A fall in the value of domestic currency reduces demand for domestic currency which led to increase in the rate of exchange over the period 1986 to 2013. The result further showed that productivity growth and exchange rate are temporarily connected as its effect is not permanent on exchange rate volatility over the period.

Theoretically, this result supports the Balassa-Samuelson hypothesis that higher income (productivity growth and oil price) increases wages and consequently raises exchange rate volatility. However, this finding deviate from some previous studies on Nigeria on the effect of productivity growth on exchange rate volatility. Recently, Adamu, *et al* (2017) found that productivity has no statistically significant relationship with exchange rate volatility in Nigeria. The differences in these analyses on the productivity growth result could be attributed to the fact that; one, this thesis recognizes the impact of shocks from the SAP policy and other historical events over the considered period. As a result, the sample employed in this study begins from the policy period (that is, 1986) whereas Adamu, *et al* covered 1989 to 2015. The selection of the period suggests that shocks to exchange rate are important in determining the factors that drive ERV in Nigeria since 1986 till 2013.

Two, this study employs a dynamic analysis that permits introduction of shocks in the model, which accommodate some asymmetrical events in the economy such as periods of political regime shift and surges in oil price. Also, the analysis of this study provides volatility spillover as well as degree of association among the system analysed. The model helps to identify the timing and degree of the effect of interest rate and productivity growth on exchange rate volatility in Nigeria unlike previous studies on Nigeria.

Thirdly, this study found that oil price has a past one-time shock effect on the current exchange rate volatility, however, there is no volatility spillover from lagged oil price to current exchange rate volatility in Nigeria between 1986 and 2013. The inability of the persistence of oil price shock to influence exchange rate volatility can be attributed to the incessant spikes and frequent collapses in the world oil price over the period 1986 to

2013. Thus, this study concludes that oil price only has one-time shock effect and no persistent relationship with exchange rate volatility in Nigeria between 1986 and 2013. The findings are in accordance with Alexius (2001) on oil trading economy that the effect of oil price on exchange rate volatility is only a random effect.

Overall, the result showed that policy reversal raise volatility in interest rate which subsequently and persistently increases volatilities in exchange rate, oil price and productivity growth overtime. While sudden oil price surge raises volatility in productivity growth, which subsequently increases volatilities in interest rate and exchange rate overtime. The implication of the results on the economy is that it becomes challenging to have a stable and sustainable economy. The findings are true for the Nigerian economy because over the years, the unstable political system led to variations in the policies and reforms. The findings therefore reveal that variations in the policies and reforms consequently led to macroeconomic instabilities which are reflected in the volatile interest rate, exchange rate and productivity.

Chapter seven focused on the general equilibrium analysis of the relationship between exchange rate volatility and export demand in Nigeria from 1986 to 2013. In contrast to previous studies on the topic, especially in Nigeria, the internally generated volatility results from chapter six was extracted and employed for the volatility proxy. This is the endogenous volatility of exchange rate, which represents the true fundamental factors of exchange rate process. Unlike the previous studies that presented linear relationship between exchange rate volatility and exports demand, this thesis examined a dynamic general equilibrium relationship. The study does this through the policy effect of interest rate on the relationship between volatility of exchange rate and export demand in Nigeria. It is worth noting that there has not been any study on Nigeria that considered such general equilibrium analysis to the knowledge of the author. Also, this thesis employs oil export demand and agriculture export demand models, which was ignored by previous studies on Nigeria. The study employs these models in this chapter to overcome aggregating bias as noted in the literature review chapter.

This study confirmed that the relationship between exchange rate volatility and export demand is conditional on the degree of shock to interest rate of the economy: the more unstable the interest rate, the more the exports are adversely affected by exchange rate volatility. The results suggest that ERV has a nonlinear effect on export demand in Nigeria overtime.

The findings showed that exchange rate volatility depresses trade activities in the oil and agriculture sectors in Nigeria between 1986 and 2013. Thus, the results validated hypotheses 2 of this thesis that export demand in Nigeria responds negatively to changes in exchange rate volatility that is due to policy changes in Nigeria between 1986 and 2013. More importantly, the endogenised exchange rate volatility employed in this study reveals that exchange rate and interest rate deregulation policies reduce trade activities in the sectors over the sample period.

The study found that the fundamental factor of exchange rate volatility has an indirect impact on export demand. Therefore, the study confirms that export demand in Nigeria is not a partial model analysis but rather should include internally generated factors that drive exchange rate volatility. This is confirmed by the relationship between interest rate and exchange rate process (being well connected with strong linkages) in chapter six with its indirect influence on export demand in both the oil and agriculture sectors in this chapter. The results suggest that exchange rate and interest rate deregulation policies reduce exports demand in the productive sectors in Nigeria between 1986 and 2013.

The policy analysis of this finding indicated that the immediate effect of the differenced exchange rate volatility on the differenced export demand in the oil sector is high. Although, this is with a reduced delayed effect from the exchange rate and interest rate deregulation policies in 1986. On the other hand, much of the effect of exchange rate and interest rate policy in the agriculture sector is delayed till the later quarter. This analysis confirms that exchange rate is possibly not a delayed policy-concern in the oil sector in Nigeria.

This study majorly attributes this result to the system of managing policies in Nigeria overtime. For example, exchange rate policies move from pegged to managed float to flexible exchange rate within short periods. Meanwhile, the importance of exchange rate volatility is indisputably related to increase in interest rate in Nigeria, which hedged against exchange rate risks (such as forward contract). This finding is established in the exchange rate volatility model in chapter six. Thus, exchange rate volatility as influenced by the deregulation policies in the exchange rate and interest rate market reduces trade activities in the oil and agriculture sectors in Nigeria between 1986 and 2013.

8.3 Policy Implications and Recommendation of the Thesis

Going by the analysis of the exchange rate volatility model as well as trade model for Nigeria between 1986 and 2013, this thesis finds a number of recommendations that are important for policy makers and the growth of the economy at large.

Firstly, this study suggests that an effective monetary regulation be revisited on the exchange rate of the economy. This suggestion is important for Nigeria because the analyses of this study confirm that the deregulated exchange rate in Nigeria virtually affects every part of the economy including productivity. This thesis therefore recommends that the sticky price monetary system be adopted in Nigeria for a stable economic condition. Secondly, this thesis recommends that policy reversal should be limited even when there is change in the political system. Limiting policy reversal is recommended to reduce the effect of policy shock on the macroeconomic variable such as exchange rate and interest rate, which usually affect the general economic condition of the country. This thesis therefore advocates reduction in the way political leaders reverse policies because a stable macroeconomic policy is necessary in Nigeria for stable economic growth.

Thirdly, this thesis recommends that local industries in the oil and agriculture sectors in Nigeria be given incentives to progress and grow before introducing trade liberalization policies. This is because trade liberalization policy encourages foreign product consumption thereby paralyzing the local industries. As found in this thesis, shocks to interest rate increase, shocks to exchange rate increase and export is adversely affected when the economy consumes more foreign products relative to local products. Therefore, this thesis suggests that the local markets should be efficient and highly competitive before introducing the economy to foreign competitions.

Fourthly, this thesis suggests that regardless of how exchange rate and trade are determined, the policy makers should pay more attention to the structure and management of exchange rate in Nigeria. This study makes the suggestion because the analyses confirm that there is substantial effect of currency variations on export demand changes. The implication of this is that there is need to monitor Naira relative to Nigeria trading partners' currencies as well as that of their competitors. This is equally important for the delayed effect of exchange rate volatility on agriculture export attractiveness.

Fifthly, the findings in this thesis confirm that exchange rate variation on its own cannot explain the full degree of trade imbalances in Nigeria. The first empirical model established that volatility in exchange rate is mostly driven by shocks in the interest rate. This means that exchange rate arrangement is only a part of the needed resolution to trade improvement in Nigeria and interest rate arrangement should also be considered alongside. Thus, this thesis suggests that a strict and regulated interest rate structure be adopted so that the rate of interest could be stable.

Given that there is strong linkage between the interest rate and exchange rate markets in Nigeria over the sample period, this study expects that a stable interest rate transmits into stable exchange rate in the economy. To this study, a stable interest rate structure can address most instability in the economy by regulating the relative prices. Addressing most instabilities in the economy and regulating relative prices help to achieve a stable and sustainable income as well. This appears to be the solution to the constantly distorted foreign exchange markets. Since this study found an indirect impact emanating from interest rate to export demand in the oil and agriculture sectors, this study therefore recommends that Nigeria interest rate policy should be reviewed and become regulated to achieve its stability.

8.4 Limitation of the Study and Suggestions for Further Researches

This research work is a comprehensive analysis of the relationship between exchange rate volatility and export demand in Nigeria between 1986 and 2013. The study examined the primary factors that drive exchange rate volatility in Nigeria in the face of policy changes and its subsequent effects on the sectoral export demand in Nigeria. Despite its all-inclusiveness, this research work is not without some restrictions. There are three notable linmitations present in this thesis to which further research should possibly improve on.

Firstly, the sample period for the empirical analyses is a bit short due to data availability. Thus, the analysis of the results is restricted to the specified duration. Further research on this topic is therefore suggested to be carried out with an extended data span or when additional data are available on Nigeria. Secondly, it is a well known fact in the exchange rate volatility studies that estimates from higher frequency data provides more information. This study is limited to the use of quarterly data as daily, weekly or monthly data are not available for Nigeria on some of the series employed in this study. Thus, further studies are suggested to be carried out when higher frequency data are available.

Thirdly, the breakpoint unit root test in this study is limited to a breakpoint in the series. The choice of additive outlier breakpoint unit root test is considered useful in this study because it permits the data series and detrended stationary series to follow unit root process with a break. Detrending the series is important in this study as most of the series employed suggests trend than breaks. Therefore, it becomes easier to test both the series with trend and no-trend break in the same system. Further studies are encouraged to employ a two-break test where the data series suggest more breaks than trend.

Lastly, the analysis of this study is limited in its policy response as it only depends on flexible policies. It is obvious that the evidence of a pegged policy response is not pronounced in this study considering the sample period. The study observes that such correlation is better investigated because exchange rate disorders may not help to remove prevailing trade barriers in the economy. In other words, the study does not deal with the issue of fixed exchange rate or flexible exchange rate system. This is because Nigeria practiced dual/managed float exchange rate system throughout the period covered by this study. So, this thesis is limited to flexible exchange rate regime. In general, this study is limited to the causes and trade effect of exchange rate volatility in Nigeria between 1986 and 2013 using the general equilibrium analysis. Further researches on the topic on Nigeria are therefore suggested to investigate exchange rate misalignments in different sectors of the economy considering the different structure of exchange rate in Nigeria.

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APPENDIX

Table Apx 1: Structure of economy in Nigeria, %, 1970-2012						
Year	**Agriculture**	**Industry**	**Construction**	**Trade**	**Transport**	**Service**
1970	47	17.2	6.1	14.6	4.5	10.5
1980	28.1	38.3	5.7	13.6	5.9	8.3
1990	31.5	43.6	1.6	13.6	2.2	7.4
2000	26	51.5	0.67	11.7	2.9	7.3
2010	30.3	44.9	1.2	14	2.3	7.2
2012	33.1	39.3	1.3	15.9	2.5	8

Table Apx 2: The Trend of Savings, Investment and Economic Growth in Nigeria

Year	Savings (#m)	Investment (#m)	GDP (#m)
1981-1985	4014.42	5662.5	120322.7
1986-1990	22563.04	10397.42	264594.7
1991-1995	82220.48	36138.82	1413058
1996-2000	628090.28	142964.3	4837299
2001-2004	539431.3	188943.1	9212421

Table Apx3: Manufacturing Comparison of Nigeria and the neighbors

Table 2a: Nigeria Manufacturing and the neighbors, bln. dollars, 1970-2012						Table 2b: Nigeria Manufacturing per capita and the neighbors, dollars, 1970-2012					
Year	Nigeria	Cameroon	Chad	Benin	Niger	Year	Cameroon	Benin	Chad	Nigeria	Niger
1970	0.69	0.17	0.057	0.026	0.027	1970	25.6	8.9	15.6	12.3	6.1
1980	7.7	1.3	0.13	0.1	0.094	1980	145.3	27.6	29.9	105	16.1
1990	1.8	2.2	0.17	0.14	0.17	1990	184.9	27.2	29.2	19.1	21.3
2000	1.7	1.8	0.12	0.19	0.11	2000	112.3	27.8	14.6	13.5	9.6
2010	4.3	3.5	0.52	0.51	0.27	2010	171.8	53.2	44.5	26.8	17.1
2012	4.9	3.8	0.61	0.57	0.41	2012	174.5	56.4	49	28.8	23.9

Table Apx 4: Summary of Measurements of ERV Proxy

Author	ERV Measure	Derivation
Hooper & Kohlhagen (1978) and Akhtar & Spence-Hilton (1984)	SD of the exchange rate level	$V_t = \sqrt{\frac{\sum_{t-1}^{n}(e_i-\bar{e})^2}{n-2}}$, where e is the log of ER
Thursby and Thursby (1987)	ER absolute percentage change	$V_t = \frac{\lvert(e_t-e_{t-1})\rvert}{e_{t-1}}$, where e is the spot ER
Ethier, (1973) and Hooper & Kohlhagen (1987)	The mean absolute change in the expected forward and realized ER	$V_t = \frac{\sum_{t=1}^{n}\lvert f_{t-1}-e_t\rvert}{n}$, where f is the forward rate
Thursby & Thursby (1987)	The variance of spot ER around an expected estimated trend.	$lne_t = \phi_0 + \phi_1 t + \phi_2 t^2 + \varepsilon_t$
Bini-Smaghi (1991), Kenen and Rodrik (1986), Dell'ariccia (1999) and Rose (2000)	SD of rate of growth or change of ER	$V_t = \sqrt{\frac{\sum_{t-1}^{n}(\Delta e_i-\Delta\bar{e})^2}{n-2}}$, where e is the log of ER
Cushman (1983), Koray and Lastrape (1989), Kenen and Rodrik (1986) and Chowdhury (1993)	MASD of the ER	$V_t = \left[\left(\frac{1}{m}\right)\sum_{i=1}^{m}(e_{t+i-1} - e_{t+i-2})^2\right]^{\frac{1}{2}}$, where e is the log of ER and m is moving average order

Perée and Steinherr (1989)	Medium-run ER volatility	$V_t = \frac{max e^t_{t-k} - \min e^t_{t-k}}{\min e^t_{t-k}} + \left[1 + \frac{\lvert e_t - e^p_t \rvert}{e^p}\right]$, where e^t_{t-k} is the ER value over the given time interval of k till time t while e^p_t is the equilibrium ER
Arize (1995); Doyle (2001); Holly (1995); Doroodian (1999); De Vita and Abbot (2004a); and Lubinga and Kiisa (2013)	ARCH and GARCH	$X_t = \alpha_0 + \alpha_1 x_{t-1} + \mathcal{U}_t$, The white noise error with constant variance is $\mathcal{U}_t$. The conditional variance h^2_t could vary with time such that $$V(\mathcal{U}_t \vert I_{t-1}) = h^2_t = \beta_0 + \beta_1 \mathcal{U}^2_{t-1} + \phi_1 h^2_{t-1}$$
Dell'ariccia (1999)	Sum of squares of forward errors	$V_t = \sum_{t=1}^{n} (f_t - e_t)^2$
Baum *et al (*2004) and Klaassen, (2004)	AR(2) forecast based on previous daily volatilities	$V_{t-1}[s_t] = \mu + \sum_{p=1}^{2} \alpha_p \left(\sqrt{\sum_{d=1}^{D_{t-p}} \{100(s_d - s_d)\}} \right)$

Chit *et al*. (2008)	GARCH 1. SD of the first difference of the real ER log. 2. The MASD of the quarterly bilateral real ER log 3. The estimated conditional ERV	1. $V_{it} = \sqrt{\frac{\sum_{t=1}^{m}\left(\Delta e_{ijt} - \Delta \bar{e}_{ijt}\right)^2}{m-1}}$, where e_{ijt} is first difference of quarterly ER log and m is the number of quarters. 2. $V_{ijt} = \left[\left(\frac{1}{m}\right)\sum_{i=1}^{m}\left(e_{ijt+i-1} - e_{ijt+i-2}\right)^2\right]^{\frac{1}{2}}$, where e_{ijt} is the bilateral ER log and m is the moving average order. 3. $\boldsymbol{e}_{it} = \alpha_0 + \alpha_1 \boldsymbol{e}_{it-1} + \mu_{it}$, where $\mu_{it} \sim \boldsymbol{N}(\boldsymbol{0}, \boldsymbol{h_{it}})$. The conditional variance is: $\boldsymbol{h_{it}} = \beta_0 + \beta_1 \mu_{it-1}^2 + \beta_2 \boldsymbol{h_{it-1}}$. β_0 means a period lag of squared residual from the ER equation, μ_{it-1}^2 is the ARCH term, $\boldsymbol{h_{it-1}}$ is the GARCH term
Baum and Caglayan (2010)	MGARCH-BEKK	$H_t = C'C + A'\epsilon_{t-1}\,\epsilon_{t-1}'A + B'H_{t-1}B$
David, (2004); Kenen and Rodrick, (1986); and Mehare & Edriss (2013)	Exchange rate standard deviation	$EV = \left[\frac{1}{3}\sum_{t=-1}^{+1}(REER_t - REER_{t-1})^2\right]^{1/2}$

Akinlo and Adejumo (2014)	A state space representation (a form of signal to noise extraction)	$E_t = \sigma\varepsilon_t e^{\frac{1}{2ht}} \ldots\ldots\ldots.. iid\ (0,1)$ where $h_{t+1} = \pi h_t + \mu_t \ldots\ldots\ldots. NID\ \left(0, \sigma_\mu^2\right)\lvert\pi\rvert \leq 1$ E_t is REER, , σ_μ^2 is a scale factor, π is a parameter, μ_t is disturbance term and $\sigma\varepsilon_t$is an iid (0, 1) random i.e disturbances symmetrically distributed about zero
Odili (2015)	ER risk faced by exporters/importers	Measure of ER risk that exporter/importer faces as a result of ER fluctuations.
Hock-Tsen and Hock-Ann (2016)	TGARCH	$lne_t = \mu + \gamma lne_{t-1} + \mu_t$ $\sigma_t^2 = \omega + \alpha\mu_{t-1}^2 + \delta D_{t-1}\mu_{t-1}^2 + \beta\sigma_{t-1}^2$