# OIL EXPORT DEPENDENCE AND EXCHANGE RATE BEHAVIOUR IN NIGERIA

By

**Tirimisiyu Folorunsho OLOKO**

ND (Acct.) Ibapoly; B.Sc. (Econ.) Ilorin; M.Sc. (Econ.) Ibadan

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# CERTIFICATION

We certify that this research work was carried out by **Tirimisiyu Folorunsho OLOKO** under our supervision in the Department of Economics, University of Ibadan, Nigeria.


**Dr. Mutiu A. Oyinlola**
Supervisor and Chairman, Thesis Committee
B.Sc. (Econ.) OAU, M.Sc. (Econ.), PhD (Ibadan)
Reader, Department of Economics
University of Ibadan
Nigeria

**Dr. Oluwatosin Adeniyi**
Member, Thesis Committee
B.Sc. (Agric./Econ.), M.Sc. (Econ.), PhD (Ibadan)
Senior Lecturer, Department of Economics
University of Ibadan
Nigeria

**Professor Samuel O. Olofin**
Member, Thesis Committee
B.Sc., M.Sc. (Econ.) Ibadan, M.A. (Econ.), PhD (Princeton)
Professor, Distinguished Service Fellow, Department of Economics
University of Ibadan
Nigeria

## DEDICATION

Which of the favours of my Lord would I deny? In the name of Almighty Allah (SWT): "He who created me, and guides me; He who feeds and waters me; And when I get sick, He heals me; He who makes me die and then revives me; He who, I hope, will forgive my sins on the Day of the Reckoning" Quran 26: 78-82.

"My Lord! Grant me wisdom and include me with the righteous; And give me a reputation of truth among the others; And make me of the inheritors of the Garden of Bliss" Quran 26: 83-85. May the blessings of Almighty Allah be bestowed on the noble soul of prophet Muhammed (SAW), his household, his companions, and those who followed his path till the day of reckoning.

This work is dedicated to my loving and caring parents, Alhaji Oseni Olayiwola Oloko and Mrs. Suwaebat Oloko. You gave birth to me and nurtured me. Your sacrifices to give me good and quality education, and make me live a good and healthy life are quiet enormous. I am so happy you are both alive to witness this success. May Allah continue to shower his blessings on you, and care for you more than you cared for me when I was young.

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**Tirimisiyu Folorunsho OLOKO**

# ABSTRACT

The behaviour of Nigeria's currency exchange rates has been tied to the vagaries of oil export's proceeds. Despite export diversification efforts to reduce the level of Oil Export Dependence (OED), the country's nominal and real exchange rates remain unstable. Nigeria's OED rose from an average of 19.13% in the 1960s to 97.35% in the 1990s, before dropping to 83.89% in 2019. The Nominal Exchange Rate (NER) depreciated from ₦0.71/US$ in the 1960s to ₦306.92/US$ in 2019, while the Real Exchange Rate (RER) of 137 basis points (bpts) in the 1960s appreciated to 97.24bpts in the 1980s, and became 134.52bpts in 2019. Extant literature investigated the effect of OED on Nigeria's NER without considering the managed floating exchange rate (MFER) system and the varied exchange rates stabilising potential of non-oil sectors (NOS), thus overstating the effect. This study was, therefore, designed to investigate the effect of OED on the behaviour of Nigeria's exchange rates from 1960 to 2019.

The Mundell-Fleming-Dornbusch framework provided the basis. The Structural Vector Autoregressive with block exogeneity (SVARX) model was employed to capture both external (oil export) and exogenous (non-oil export) components of OED. The model produced contemporaneous, short-term(h=2), and medium-term(h=4) horizons effects of OED. The study accounted for external reserves, which moderates monetary authorities' commitment to defend NER, thus making RER more responsive under MFER system. The exchange rates stabilising potential of NOS were examined by simulating the effect of export diversification to three main NOS (agriculture, manufacturing, and solid minerals) on OED and exchange rates. The variables included OED (oil export percentage of total merchandise export), NER (domestic price per unit of foreign currency), and RER (foreign price relative to domestic price of a common basket of goods). The data were obtained from the Central Bank of Nigeria Statistical Bulletin. All estimates were validated at $\alpha \leq 0.05$.

The OED shock had insignificant negative contemporaneous effect on NER (-0.07;$\alpha$=0.61) and RER (-0.01;$\alpha$=0.52). In the short to medium-term horizons, OED had insignificant effect on NER (h2=0.01;$\alpha$=0.72, h4=0.03,$\alpha$=0.21), but a significant negative effect on RER (h2=-0.05;$\alpha$=0.00, h4=-0.07,$\alpha$=0.00). This implied that a lower OED had no immediate impact on NER and RER. However, it caused RER to depreciate in the short to medium term. This result was explained by the dominance of oil export in OED, as the reduction in OED over the sampled period was caused by a lower oil export rather than a higher non-oil export. The simulation of export diversification with the dominance of non-oil export in OED showed that higher export of manufactured goods and solid minerals reduced the level of OED, increased external reserves, and stabilized NER better than higher export of agricultural goods. Whereas, a higher export of agricultural goods caused RER appreciation, unlike the other sectors.

Non-oil export was insufficient to generate the reduction in oil export dependence necessary to enhance stable nominal and real exchange rates. Higher commitment to export diversification, particularly in the solid minerals and manufacturing sectors, is required to stabilise exchange rates in Nigeria.



**Keywords:** Oil export dependence in Nigeria, Exchange rate behaviour, Managed floating exchange rate system

**Word count:** 495

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| | |
|---|---|
| ABP: | Anchor Borrowers' Programme |
| AFEM: | Autonomous Foreign Exchange Market |
| BDC: | Bureaux De Change |
| CBN: | Central Bank of Nigeria |
| DAS: | Dutch Action System |
| FEM: | Foreign Exchange Market |
| FX/Forex: | Foreign Exchange |
| IFEM: | Inter-bank Foreign Exchange Market |
| LOED: | Level of Oil Export Dependence |
| MF: | Mundell-Fleming |
| MFD: | Mundell-Fleming-Dornbusch |
| MFER: | Managed Floating Exchange Rate |
| NBS: | National Bureau of Statistics |
| NER: | Nominal Exchange Rate |
| NOS: | Non-oil Sectors |
| OED: | Oil Export Dependence |
| RDAS: | Retail Dutch Action System |
| RER: | Real Exchange Rate |
| SAP: | Structural Adjustment Programme |
| SFEM: | Second-tier Foreign Exchange Market |
| SVARX: | Structural Vector Autoregressive with exogeneity (SVARX) |
| WDAS: | Wholesale Dutch Action System |
| WDI: | World Development Indicators |

# CHAPTER ONE

## INTRODUCTION

### 1.1 Background to the Study

The “Dutch disease” and “resource curse” hypotheses have indicated that excessive reliance on natural resources may have negative consequences on the economic advancement of resource-rich nations. In the case of oil-rich countries, their excessive reliance on crude oil often translates to high oil export dependence, which indicates high concentration of oil export in their total merchandise exports. High oil export dependence would imply that the foreign reserves and total revenue of the oil-dependent country are highly dependent on the manifestations in the global oil market, which has been inherently unstable (Hamilton, 1983). This presupposes that high oil export dependence tends to expose oil-rich countries to the vagaries of oil price shocks, which is a major source of economic uncertainty (Allegret et al., 2014; Nusair, 2016; Badeed and Lean, 2017; Djimeu and Omgba, 2019). This may explain why lower oil dependency has been widely recommended as a panacea for achieving economic stability in major oil-rich countries (see Amin Gutierrez de Pifieres and Ferrantino, 1997; Hosseini and Tang, 2014; Waheed et al., 2020; Alao and Payaslioglu, 2021).

Several economic diversification efforts have been made by governments in different oil-rich countries to reduce their level of oil dependency (Albassam 2015; Alsharif et al., 2017; Hendrix, 2017). From the analysis of the extent of diversification away from oil and natural gas dependence in forty (40) countries, Hendrix (2017), noted that the desire to diversify has been a central goal of successive Saudi economic plans since the release of the First Five-Year Plan in 1970. Similar ambition was found in the official planning documents of Republic of Congo, Libya, Nigeria, and others. As noted by Hendrix also, economic diversification policies in oil- and gas-rich economies were more uniformly successful in diversifying the sectoral composition of their economies while exports – and thus terms of trade and export revenue – remain stubbornly concentrated. This indicates existence of some difficulty in achieving lower oil export dependence by oil-dependent economies.

Generally, achieving lower oil export dependence indicates advancement in the non-oil sector, which would tend to expand the non-oil export and, by implication, the total export and total output of the economy. With higher export mix in favour of the non-oil sector, lower oil export dependence also tends to reduce country's exposure to uncertainties in the oil market. As demonstrated by Nwosa (2018), oil export dependence rate, which measures export concentration in oil, is a complementary rate to export diversification in oil exporting countries; with the sum equal to unity (see also Alsharif et al. 2017). According to Alley (2018), an increase in non-oil export represents an increase in export diversification and by implication; a lower oil export dependence. Meanwhile, Looney (1991) stated that the effect of export diversification on economic factors can be mixed; impacting positively on some factors and adversely on another. While lower oil export dependence has been identified with the potential to reduce the rate of macroeconomic uncertainties in resource-rich nations (see Caselli et al. 2020), limited studies have been conducted to examine how this will affect exchange rate behaviour.

Exchange rate behaviour is characterized as the movements in exchange rate, which may be defined in nominal or real terms, among others (Marsh, 2011). Defined as the domestic price per unit of foreign currency, nominal exchange rate (NER) expresses movements in the value of a country's currency. An upward movements or positive change in NER indicates a fall (depreciation) in the value of domestic country's currency, while a downward movements or negative changes imply increase (appreciation) in the value of domestic country's currency. Real exchange rate (RER), on the other hand, expresses movements in the level of trade competitiveness of a country; as it is defined as the relative prices of foreign goods to domestic goods. A fall in the price of domestic goods relative to the price of foreign goods indicates depreciation of RER, indicating increase in the country's level of trade competitiveness. Whereas, an increase in the price of domestic goods relative to the price of foreign goods indicates RER appreciation, which indicates loss of trade competitiveness.

The behaviour of exchange rate of a country has multi-dimensional economic implications for the residents of the country and foreigners engaging in international transactions with the country or its residents. The welfare of the residents of the country is affected by changes in NER, in the form of appreciation or depreciation. Nominal exchange rate depreciation makes imports more expensive, thus causing increase in general price level and reduction in the welfare of people. For foreigners engaging in international activities such as portfolio investment in the country, NER depreciation will cause loss of investment values on local currency denominated assets, thus discouraging inflow of foreign investments. While exchange rate depreciation also makes export cheaper, it benefits the citizens only where majority are working in the tradeable sector. Unlike the NER however, depreciation of real exchange rate indicates that domestic goods are relatively cheaper than foreign goods. This will be expected to increase income and welfare of citizens and increase trade competitiveness of the country.

The behaviour of exchange rate can be endogenously (by market forces) or exogenously (by the monetary authority) determined, depending on the choice of exchange rate management system by the monetary authority of the country (IMF, 2016). In international economics models, such as the Mundell-Fleming model, two recognized exchange rate management systems are the fixed and flexible systems; under which exchange rate is determined exogenously and endogenously, respectively. However, the International Monetary Fund (IMF) exchange rate classification and some empirical studies on the application of exchange rate policies have shown that exchange rate management system switches between fixed and flexible regimes (Levy-Yeyati and Sturzenegger, 2005; Reinhart and Rogoff, 2004). According to the IMF, exchange rate arrangements that are close to fixed exchange rate regime are classified as soft peg. These include conventional peg, stabilized arrangement, crawling peg, crawl-like arrangement and pegged exchange rate with horizontal bands. Whereas, the exchange rate arrangements that are close to floating regime are classified as other managed or managed floating regime (IMF, 2016).

Using nominal exchange rate data from International Financial Statistics (IFS) and fuel export to total merchandise export data from World Development Indicators (WDI) (see IFS, 2019; WDI, 2019), a review of NER behaviour of net oil exporting countries between 2011 and 2015 revealed that the relationship between level of oil export dependence and exchange rate behaviour can be mixed. Among the OPEC members, which are all high oil export dependent countries, it was noted that Angola and Algeria with relatively higher level of oil export dependence (96.32% and 96.23%, respectively) experienced higher rate of currency depreciation compared to Saudi Arabia and United Arab Emirate with relatively lower level of oil export dependence (85.58% and 49.18%, respectively). This suggests that higher oil export dependence is associated with higher currency depreciation (see sections 2.1.2 and 2.2.3 for details). Conversely, however, Nigeria with relatively lower level oil export dependence (with 87.91% LOED) has its currency (Naira) depreciated from ₦1/US$ in January 1986 to ₦305.7/US$ in March 2018, while Qatar with relatively higher level of oil export dependence (with 88.08% LOED) has been maintaining the current value of Qatari Rial of QAR3.64/US$ since July 1980 (see sections 2.1.2 and 2.2.3 for details). This indicates that currency depreciation may not be associated with high level of oil export dependence. Given that Nigeria currency, Naira, has depreciated (relative to US dollar) faster than the currencies of many other high oil export dependent countries, it may be interesting to investigate potential effect of changes in level of oil export dependence on Nigeria's exchange rates.

## 1.2 The Problem

Over the years, Nigeria's nominal and real exchange rates have been unstable. Nigeria's RER was usually on the appreciating trend (unless depreciation was induced by currency devaluation) while NER has been depreciating rapidly. These problems may not be unrelated to the rising level of oil export dependence (LOED), which has increased rapidly since oil was discovered in the late 1950s. Due to high exposure to oil price volatility occasioned by high LOED and possible output and employment gains due to expansion in the non-oil sectors, Nigerian government has been committed to reducing the country's LOED by increasing productivity and exports of the non-oil sectors. Many studies have been conducted on possible effect of oil export dependence on exchange rate behaviour (see for example, Asterious et al., 2016; Tran et al., 2017), limited studies exist on the nexus in the case of countries operating managed floating exchange rate regime, such as Nigeria. This is the focus of this study.

Nigeria is one of the countries that operates an intermediate exchange rate management system, where exchange rate is determined both endogenously (by market forces) and exogenously (by the monetary authority). The emergence of this status of the Nigeria's exchange rate management can be traced to 1986 when oil glut in the global oil market caused revenue from oil to dwindle, making it practically difficult for the monetary authority to maintain the value of Naira. This, coupled with the observed over-valuation of Naira caused emergence of floating exchange rate market parallel to the official exchange rate market, which is a regulated market. The floating market is for the private sector, while the official market is used for government transactions or official business including debt servicing, payments to international imports for which letters of credit were obtained and disbursements made in respect of public sector letters of credit (Ogiogio, 1996).

Meanwhile, since oil was discovered in the late 1950s in Nigeria, the country's level of oil export dependence (LOED) has increased astronomically. Measured as the percentage value of oil export to total merchandise export, Nigeria's LOED has increased rapidly from the average of 19.02 percent in the 1960s to 85.1 percent in the 1970's and 97.35 percent in the 1990s. It declined slightly to 96.97 percent in 2000s and to 92.11 percent between 2010 and 2019 (CBN, 2020: see sub-sections 2.1.2 and 2.1.3 for details). As a country with high oil export dependency, foreign reserves accumulation by Nigeria are due mainly from the proceeds from oil. These foreign reserves are used by the monetary authority to maintain stability of Naira at the official market and reduce volatility of Naira in the parallel market. Thus, high oil export dependence may worsen the performance of Nigeria's exchange rates as it exposes them to oil price shocks. Since lower oil export dependence is a diversification of the foreign reserves sources, it would appear a better policy as it tends to enhance exchange rates behaviour by reducing their exposure to oil price shocks.

However, to reduce Nigeria's LOED by expanding exports of the non-oil sectors implies that more importations would be required at official exchange rate; to increase input supply to, and boost the productivity of, the non-oil sectors. This will constitute a drag on the foreign reserves. In other words, lower OED may not improve exchange rate behaviour, especially in the short run. This problem is aggravated by the non-repatriation of export proceeds by the exporters in the non-oil sector, some of whom were given foreign exchange (FX) at the official rate to procure imported inputs[1]. Several export diversification policies that have been introduced to reduce Nigeria's level of oil export dependence include Structural Adjustment Programme (SAP) of 1986, establishment of Nigeria Export Processing Zone Authority (NEPZA) in 1992, among others. The Central Bank of Nigeria (CBN) also facilitated the launching of Non-Oil Export Stimulation Facility (NESF). This was first launched in June 2016, and repackaged and re-launched in December 2017, with the sum of ₦500 billion earmarked for the programme (see CBN, 2016b). This amount will also come from the country's reserves generated majorly by oil, threatening the potential of the monetary authority to maintain stability of Naira.

Evidently, Nigeria's NER has depreciated in the parallel/official market from ₦0.63/US$ in 1976, when export diversification policy was first introduced (with the establishment of Nigerian Export Promotion Council (NEPC)) to ₦132.88/USD in 2004 and ₦306.08/US$ in 2018. While NER devaluation/depreciation is supposed to cause corresponding RER depreciation, it only caused it momentarily after which appreciating trend begins. The longest period of RER depreciation was between 1985 and 1992, where RER increased from 54 basis points to 282 points within the period. This epic period was bounded by the period of over-valuation of Nigeria's RER (which was devalued in 1986 as part of the Structural Adjustment Programme (SAP)) and the era of fixed exchange rate policy operated between 1993 and 1998. Nigeria's RER appreciated during the period of fixed exchange rate policy from 236 points to another over-valuation of 63 points in 1998. It also resumed on the appreciation trend till NER was devalued in 1999; falling from 271 points in 2000 to 118 points in 2014. The continuous RER appreciation trend may not be unrelated to high domestic prices, as aggregate demand is higher than domestic supply which

[1] The exporters of the non-oil exports that earn foreign exchange through export diversification policies of government are usually unwilling to supply the FX so realized in the FX market. This is justified by the memo issued by the CBN in January 2021, titled "NON-REPATRIATION OF EXPORT PROCEEDS BY EXPORTERS".

necessitates importation at lower relative prices. This condition may tend to be ameliorated by reduction in LOED, as it indicates higher domestic productivity, export and by implication, lower domestic prices.

In other words, as promotion of non-oil sectors' productivity and export would tend to reduce domestic prices and increase the country's trade competitiveness, achieving RER depreciation by higher dependence on non-oil export may be a possibility. Given that the resources to promote all the non-oil sectors at the same time are limited in supply, determination of the non-oil sector with highest potential to enhance depreciation of Nigeria's RER is necessary. Agricultural sector has always been hyped as being the best in this regard. This is also the position of Central Bank of Nigeria (CBN) as evident in its recently introduced Anchor Borrowers' Programme (ABP), which was set to provide funds and agricultural inputs for farmers. Also, a review of recent trend in production and export of non-oil sector suggests that Nigeria truly has comparative advantage in the agricultural sector. The sectoral GDP and export data from the Central Bank of Nigeria show that, between 2016 and 2018, productivity of the agricultural sector increased from ₦16,607.34 billion to ₦17,544.15 billion, while its export increased from ₦60.709 billion to ₦302.28 billion. The productivity of the manufacturing sector increased from ₦6,302.24 billion to ₦6,420.59 million while its export increased from ₦182.96 billion to ₦645.74 billion. Similarly, the productivity of solid minerals increased from ₦87.609 billion to ₦96.602 billion, while its exports increased from ₦11.163 billion to ₦64.413 billion over the period.

From the foregoing statement of the problem, the following research questions are pertinent. First, what is the effect of lower oil export dependence on Nigeria's nominal and real exchange rates? Second, would export diversification to agricultural sector achieve real and nominal exchange rate stability better than export diversification into other non-oil sectors such as manufacturing and solid minerals?

### 1.3 Objectives of the Study

The general objective of this study is to analyze the relationship between oil export dependence and exchange rate behaviour in Nigeria. The specific objectives are to:

i. examine the effect of oil export dependence on Nigeria's exchange rates.

ii. investigate the exchange rate stabilising potentials of different non-oil sectors in Nigeria.

## 1.4 Justification for the Study

Macroeconomic instability in most oil dependent countries has been attributed to high level of oil export dependency, as oil price is inherently unstable. Several export diversification efforts have been made by the governments of these countries to reduce their level of oil export dependency and achieve high relative economic stability. While majority of the previous studies have investigated the economic implications of export diversification policies on economic growth, limited studies have investigated its potential impact on exchange rate behaviour. Meanwhile, as changes in level of oil export dependence directly influence trade patterns, its impact on exchange rate is not unexpected.

The main contribution of this study is the analysis of the effect of oil export dependence on exchange rate behaviour under managed floating or intermediate exchange rate arrangement. This is necessary to bridge the gap between the theory and practice[2]. Pursuing this makes the study to fill important knowledge gaps in the theoretical, methodological and empirical literature on oil export dependence – exchange rate relationship. Defined as an exchange rate regime in which intervention is used to influence uncertainty in exchange rate movements (Siklos, 2006), evidence from the recent empirical works suggests that the economic effect of the implementation of managed floating regime can be mixed. For example, Santana-Gallego and Perez-Rodriguez (2019) find that intermediate exchange rate regime, between completely fixed and completely flexible, promotes flows of goods between countries. Conversely, Ye et al. (2014) noted that non-floating regime fails to protect firms from exchange rate exposure. Whereas, Reinhart and Rogoff (2004) explained that floating regimes delivers relatively low inflation (possibly at the cost of a lower average per capita economic growth) than less flexible exchange rate regime.

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[2] Specifically, while theory only deals with fixed and floating exchange rate regime, the ‘de jure’ exchange rate system has continuously revealed the practice of intermediate arrangements, with recurring evidence of “fear of floating” and “fear of fixing” (see Calvo and Reinhart, 2002).

A lower level of oil export dependency through increase in non-oil export supply (as in Alley, 2018) implies increase in domestic goods productivity and consequently a fall in the price of domestic goods relative to foreign goods. This would cause increase in trade competitiveness or RER depreciation. The expected effect of changes in oil export dependence on NER is however not as straightforward as may be expected. According to the Mundell-Fleming macroeconomic framework (Fleming, 1962; Mundell, 1962; 1963), this would depend on form of exchange rate regime operated by the country (see also, Barbosa et al., 2018; Lv et al., 2018). Assuming an increase in non-oil export leads to increase in the country's net export, the net effect will be an appreciation of domestic country's NER (at a given real exchange rate) and no effect on aggregate output if floating exchange rate is adopted. Conversely, the monetary authority will prevent currency appreciation and instead accumulate foreign reserves under fixed exchange rate regime. Thus, increase in non-oil export will lead to increase in aggregate output with no effect on NER (at a given real exchange rate) if the country operates a fixed exchange rate regime (Romer 1986).

Meanwhile, the Mundell-Fleming macroeconomic framework as well as other related model such as the monetary approach to balance of payments models by Whitman et al. (1975), Frenkel and Johnson (1976) does not expressly discuss the relationship in the case of managed floating exchange rate regime. On the basis that managed floating regime is a combination of fixed and floating regimes, this study assumes that changes in oil export dependence would have partial effects on exchange rate and economic growth. It, then, emphasises the role of foreign reserves, as this underscores the ability of the monetary authority to implement credible fixed exchange rate policy.

In the course of pursuing its main objective, this study adopts Mundell-Fleming-Dornbusch (MFD) model which assumes variation in domestic prices and foreign prices (to distinguish between real and NER) rather than the popular Mundell-Fleming (MF) model which assumes equality between domestic and foreign prices (thus assuming equality between nominal and real exchange rate). The proposed (MFD) model augments the MF model with the introduction of price adjustment equation, which follows the postulation of the overshooting model of exchange rate by Dornbusch (1973). The study further modifies the

IS equation in the MFD model to allow for the theoretical analysis of the relationship between oil export dependence and exchange rates vis-à-vis output level. Following this model allows for empirical analysis of effect of oil export dependence on the nominal and real exchange rate as well as output, which is possible under managed floating exchange rate regime. This possibility was ignored in earlier studies such as Alley (2018) and Waheed et al. (2020), which rely on absorption model of balance of payment and flow model of exchange rate determination, respectively.

The use of single equation exchange rate model in earlier studies would not also allow for simultaneous examination of the impact of oil export dependence on exchange rate and output as may be suggested by the practice of managed floating exchange rate regime. Aside from the endogeneity bias that the single equation might cause (Twerefou, 2017), it will be unsuitable to analyse the relationship under managed floating arrangement where the simultaneous exchange rate and output effects are possible. This study contributes to the literature on oil export dependence – exchange rate behaviour nexus by adopting system of equation model in Structural Vector Autoregressive model with exogenous variable (SVARX model). This SVAR model variants have the advantage of being able to explain the effect of endogenous and exogenous shocks on the domestic macroeconomic performance (Olubusoye et al., 2015; Olofin et al., 2021). The SVARX model is particularly suitable for this study, as it allows the regulated component of the Nigeria foreign exchange market (official exchange rate) and export diversification component of OED (non-oil export) to be treated exogenously, as these tend to be influenced by exogenous factors (e.g. political factors) in Nigeria. The SVARX model, as a multivariate framework, is also consistent with the MFD theoretical basis adopted in this study.

In addition, earlier study on the case of Nigeria by Alley (2018) did not account for the role of external reserves, thus technically assuming the case of free floating exchange rate regime for Nigeria, which is actually not the case. With this assumption of floating exchange rate system, Alley (2018) finds that export diversification (or lower OED) in Nigeria will cause Naira/USD exchange rate to appreciate. This result appears far from reality as the monetary authority hardly allow NER appreciation under managed floating regime. New empirical analysis based on the assumption of managed floating exchange rate regime for the case of Nigeria is thus necessary to examine the implication of exchange rate system in modelling the relationship between OED and exchange rate behaviour.

More so, earlier study on the determinants of exchange rate behaviour in Nigeria such as Akinlo and Adejumo (2014), Alley (2018) and Longe et al. (2019) focused only on aggregate non-oil export and ignored sectoral decomposition of the exports of the non-oil sector. Hence, these studies cannot explain how diversification to different non-oil sectors will affect the behaviour of Nigeria's currency exchange rates. This study fills this gap by simulating the effect of export diversification to three main non-oil sectors (agriculture, manufacturing and solid minerals), thus generating empirical evidence for the exchange rate stabilising potential of different non-oil sectors in Nigeria.

### 1.5 Scope of the Study

Resource dependence has a very wide scope, as this would involve all natural resources including minerals, precious metals, aluminums and oil. To deal exclusively with oil export dependent countries, this study narrows the scope and investigates oil export dependence rather than resource dependence or oil dependence; they term that may also relates to resources import-dependent countries (see Greene et al., 1998). Oil export dependence is a unique characteristics of exporting countries. This is measured as the percentage of oil export to total merchandise export. This measure was chosen above other measures such as oil revenue to GDP ratio, oil rent to GDP ratio or some diversification indexes such as Hirschman-Herfindahl index and Theil index for two main reasons. First, it is the most recognised measure of oil dependency by the policy makers. Recently, for example, Nigerian government proposed to increase non-oil export to total export from 7.5 percent in 2017 to 15 percent in 2019; implying a decision to lower level of oil export dependence from 92.5 percent in 2017 to 85 percent in 2019. Second, Hendrix (2017) noted that this measure reveals the exposure of oil dependent countries to oil price shock, rather than other measures that tends to understate their exposure to oil price shocks. In addition, this measure of oil export dependence is expected to have higher correlation with exchange rate behaviour than other measures of oil dependency, as they both relate to cross-bother activities (see Romelli et al., 2018).

The exchange rate behaviour in this study is defined as the upward and downward movements in both the nominal and real exchange rates. Nominal exchange rate is defined as the units of Naira per unit of US dollar. Real exchange rate, on the other hand, is the NER adjusted with domestic and foreign price level. Given the definition of NER in this study, RER is the relative price of foreign goods to domestic goods. Falling RER as is the problem in this study indicates that foreign goods are becoming cheaper, and Nigerians and foreigners will prefer to patronize foreign goods. This will indicate low international competitiveness of Nigerian goods. This may result due to higher inflation in domestic economy relative to foreign economy. In the same vein, higher RER implies that foreign goods are relatively more expensive than domestic goods. This may be due to lower inflation in domestic economy relative to foreign economy, and may be induced by domestic economy through devaluation of NER.

The study uses annual data from 1960 to 2019, as monthly data are not available for some of the important variables. The data are obtained from various issues of Central Bank of Nigeria (CBN) statistical bulletin, Nigeria's National Bureau of Statistics (NBS) and World Development Indicator (WDI). The study views exchange rate arrangement in Nigeria from the positive science aspect of "what is". Hence, it investigates the relationship between oil export dependence and exchange rate behaviour under managed floating exchange rate arrangement, as this mostly reflects the exchange rate arrangement in Nigeria. It does not view exchange rate arrangement from the normative science aspect of "what ought to be". Hence, it does not assess efficiency of one exchange rate arrangement over another, or recommend appropriate exchange rate arrangement for Nigeria.

## 1.6 Organization of the Study

This study is organized into five chapters. Following this introductory section, chapter two discusses the background and literature review. This provides a detailed analysis of the dynamics of oil export dependency and exchange rate behaviour in Nigeria and detailed review of theoretical, empirical and methodological literature that are relevant to the study. Chapter three discusses the methodology for the study. In chapter four, the empirical results of the analysis are presented and discussed. Chapter five summarizes the findings of the study, and highlights its limitations and policy recommendations.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Overview

This section presents review of literature on the relationship between changes in level of oil export dependence and exchange rate behaviour. Basically, it consists of conceptual review, theoretical review, methodological review and empirical review of literature. The conceptual review section deals with stylised facts and background to the study. This discusses issues relating to oil export dependence and exchange rate behaviour globally, and in Nigeria, specifically. Theoretical review section discusses relevant natural resources dependence and exchange rate determination theories necessary to understand the expected relationship between LOED and exchange rates. Methodological review presents issues on methods used in the earlier studies and the proposed methodological contribution of this study to the literature. Similarly, empirical review discusses issues relating to the findings relating to relationship between LOED and exchange rates and the proposed empirical contribution of this study to the literature.

## 2.1 Conceptual Review

This section deals with stylised facts and background to the study. Specifically, it comprises four distinct sub-sections. The first sub-section discusses issues relating to exchange rate behaviour in Nigeria. It contains discussions on the trends in exchange rate management in Nigeria, the structure of Nigeria's FX market, analysis of real and NER of Naira, and the analysis of misalignment of Naira/USD exchange rate. The second sub-section deals with the analysis of Nigeria's level of oil export dependence. This sub-section presents trends in the trade structure and evolution of Nigeria's level of oil export dependence, in addition to the analysis of the effect of oil export dependence on the Nigeria macro-economy, such as government revenue, external reserves, trade and economic growth. The third sub-section deals with the core of this thesis, as it matched the first and second sub-sections to determine the relationship between level of oil export dependence and exchange rate behaviour in Nigeria. This sub-section mainly discussed the comparative analysis of the behaviour of Nigeria's exchange rate relative to other oil export dependent countries, the trends in level of oil export dependence and exchange rate behaviour in Nigeria, the relationship between the trade sector (oil and non-oil export sector) and FX market in Nigeria, as well as the recent development in Nigeria for promoting export diversification.

### 2.1.1 Exchange Rate Behaviour in Nigeria

To analyze the relationship between oil export dependence and exchange rate behaviour in Nigeria, we need to understand exchange rate behaviour of the country in the least. This section discusses issues relating to exchange rate behavior in Nigeria. Basically, there are wide definitions for exchange rate behaviour. Generally, in international economics, exchange rate behaviour is usually defined as changes in exchange rate, which implies appreciation and depreciation of exchange rate. However, there are other relevant definitions of exchange rate behaviour commonly used in international finance, these include; exchange rate shocks, exchange rate volatility and exchange rate efficiency. The simplest definition of exchange rate behaviour is to view it as changes in exchange rate, which is the definition adopted in this study. This definition is often considered by policymakers and economists in the analysis of the implications of exchange rate on the economy and balance of payment (Pilbeam, 1998).

With exchange rate defined as units of domestic currency (Naira) per unit of foreign currency (US$), a positive change in exchange rate implies depreciation of Naira while a negative change indicates appreciation of Naira. When domestic currency depreciates, domestic currency is weaker and more of it will be needed to purchase foreign currency. By implication, it is now more expensive to purchase foreign goods while domestic goods are now cheaper for foreigners to purchase. Under a normal trade condition, exchange rate depreciation is expected to cause reduction in imports and cause export to increase. More so, since exchange rate appreciation makes foreign goods cheaper in the domestic economy and domestic goods expensive to foreigners, it is expected to cause higher import and lower export under a normal trade condition.

For proper understanding of the behaviour of exchange rates in Nigeria, the thesis provides discussions on the trends in exchange rate management in Nigeria, the structure of Nigeria's FX market, analysis of real and nominal exchange rates of Naira, and the analysis of misalignment in Naira/USD exchange rate. These issues are considered in turn in the next sub-sections.

#### 2.1.1.1 Trends in Exchange rate management in Nigeria

Exchange rate management can be defined as the form of exchange rate regimes employed by the monetary authority to achieve the objectives of exchange rate. According to the CBN (2016c), the objectives of exchange rate management in Nigeria include: preservation of external reserves; achievement of price stability; economic diversification through promotion of export of non-oil commodities; and maintenance of narrow premium/gap between the parallel/BDC and official exchange rates. To actualize these goals, CBN has implemented fixed, flexible and hybrid exchange rate regimes at different periods, depending on the economic situations and the government's development goals prevailing during the period (see CBN, 2016c). In Nigeria, operations of foreign exchange have been affected by different factors including changing pattern of the country's foreign trade, institutional dynamics, and structural shift in production (CBN, 2016c).

An independent management exchange rate in Nigeria can be said to have begun with the establishment of the Central Bank of Nigeria in 1958 and passing of Exchange Control Act in 1962. Prior to this period however, foreign exchange was mainly grossed by private businesses and the FX balances are kept in the commercial banks abroad, which served as agents to the local exporters. Hence, the management of FX in those periods was undeveloped and naïve. This was motivated by the fact that the Nigerian pound was pegged at par with the British pound sterling during this period. As the CBN operation commenced in 1959 and the export products of Nigeria advanced beyond agriculture (especially with addition of crude oil), there was a rise in the number of Nigeria's trading partners, which prompted the need for proper domestic management of the country's foreign exchange.

***Fixed/Pegged Exchange Rate Regime (1960 – June 1986)***

In the first period of exchange rate policy in Nigeria, which spanned the year 1960-1967, there was a one-to-one relationship between the Nigerian pound (N£) and the British pound sterling (B£). This is equivalent to ₦0.71/USD (see Figure 2.1). This fixed parity was used until the British pound was devalued in 1967. The monetary authorities in Nigeria considered it unnecessary to devalue the Nigerian pound along with the British pound, particularly as devaluation was assessed to have had more adverse effect on the Nigerian economy than good at the period of civil war (see Ogiogio, 1996). Hence, decision was reached by the monetary authorities to quote the Nigerian currency relative to the US dollar.

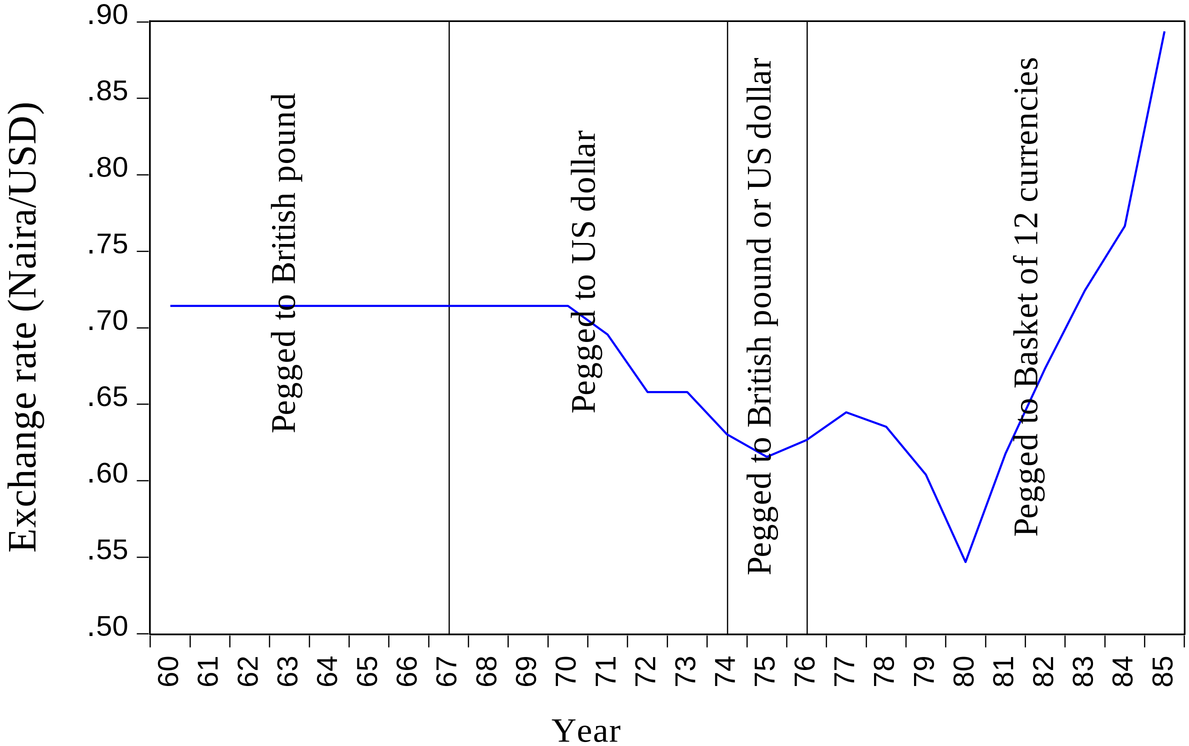


**Figure 2.1: Nigerian exchange rate management between 1960 and 1985**

The period of fixed parity of the Nigerian pound with the US dollar lasted from 1967 to 1974. This is regarded as the second period of Nigeria's exchange rate policy by Ogiogio (1996). This period witnessed significant events in the international environment such as the international financial crisis of the early 1970s, collapse of Britton Wood (adjustable peg) system in 1971, and the Smithsonian Agreement of December 1971[3]. Basically, Nigerian pound was held in fixed parity with American dollar from 1967 to 1971 and with new standard American dollar (under Smithsonian Agreement) between 1971 and 1973. The Smithsonian Agreement eventually collapsed in March 1973. This brought in a system of generalized floating of the major currencies of the international financial system. However, Nigeria did not float its currency (now the Naira) in line with the generalized floating system; rather, it maintained the peg to the US dollar.

This arrangement was maintained till April 1974 when US dollar was again devalued. As observed from Figure 2.1, the value of Nigerian currency remained at ₦0.71/USD between 1967 and 1970, but appreciated from ₦0.71/USD to ₦0.63/USD in 1974. Between April 1974 and late 1976, *an independent exchange rate management policy* was proposed by the monetary authorities in Nigeria, which led to pegging of Naira to the stronger of the British pound sterling or the US dollar. The objective of this policy was to operate an independently managed exchanged system that would stimulate real economic variables and contain the rate of inflation in the economy. Consequently, a policy leading to continuous Naira appreciation was implemented; this was motivated by the oil boom experienced during the period. In other words, huge earnings made by the country from export of crude petroleum enhanced persistent accumulation of external reserves and the policy of maintaining the appreciation of the Naira. The policy of maintaining appreciation of the Naira was considered suitable, since currency over-valuation is consistent with the import substitution industrialization policy of government at the moment. This policy was

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[3] The Smithsonian Agreement was a temporary agreement announced in December 1971. This generated a new dollar standard, whereby the currencies of a number of industrialized nations were pegged to the US dollar. The Agreement was created by the Group of Ten (G-10) nations (Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the United States) to resolve the problem of persistent US dollar devaluation occasioned by the Bretton Woods Agreement. This Agreement lasted just 15 months before it collapsed.

operated through 1976 when the economic fortunes of Nigeria started to wane. As evident in Figure 2.1, Nigerian Naira appreciated slightly from ₦0.63/USD in 1974 to ₦0.62/USD in 1975-76.

In the late 1976, when the prosperities of the economy started to diminish, a reversal of exchange rate management policy was introduced. Hence, the Nigeria's currency, Naira, was officially depreciated. For the purpose of realigning the exchange rate, the monetary authorities decided to peg Naira to a basket of currencies to ensure stability and viability of the currency. Hence, a basket consisting of the currencies of seven major trading partners of Nigeria, was adopted. The currencies were the British pound sterling, the US dollar, the French franc, the German mark, the Swiss franc, the Dutch guilder, and the Japanese yen. This import-weighted basket experiment was carried out between 1976 and 1985. The experiment did led to considerable stability in the Naira exchange rate. As may be observed from Figure 2.1, exchange rate appreciated from ₦0.63/USD in 1976 to ₦0.55/USD in 1980 before it began to depreciate from 1981 due to the constraining effect of oil glut on the Nigeria's external reserves.

The economic crisis in Nigeria from January 1981 through 1985 revealed that the exchange rate appreciation policy has become unfeasible. This was happening when both the NER and RER of Naira have been grossly over-valued relative to the US dollar (Ogiogio, 1996). As the economic crisis deepened toward the end of 1985, there are two alternatives in the management of the exchange rate available to the monetary authorities. The first option was to proceed with the policy of fixing the exchange rate against basket of currencies of the Nigeria's trading partners, which is a continuation of exchange rate controls. The second option was to make exchange rate to be market determined (through the forces of demand and supply). The government chose the second option and this led to the introduction and operation of the second-tier foreign exchange market (SFEM) or simply foreign exchange market (FEM), in September of 1986.

***Flexible Exchange Rate Regime (1986 June to date)***

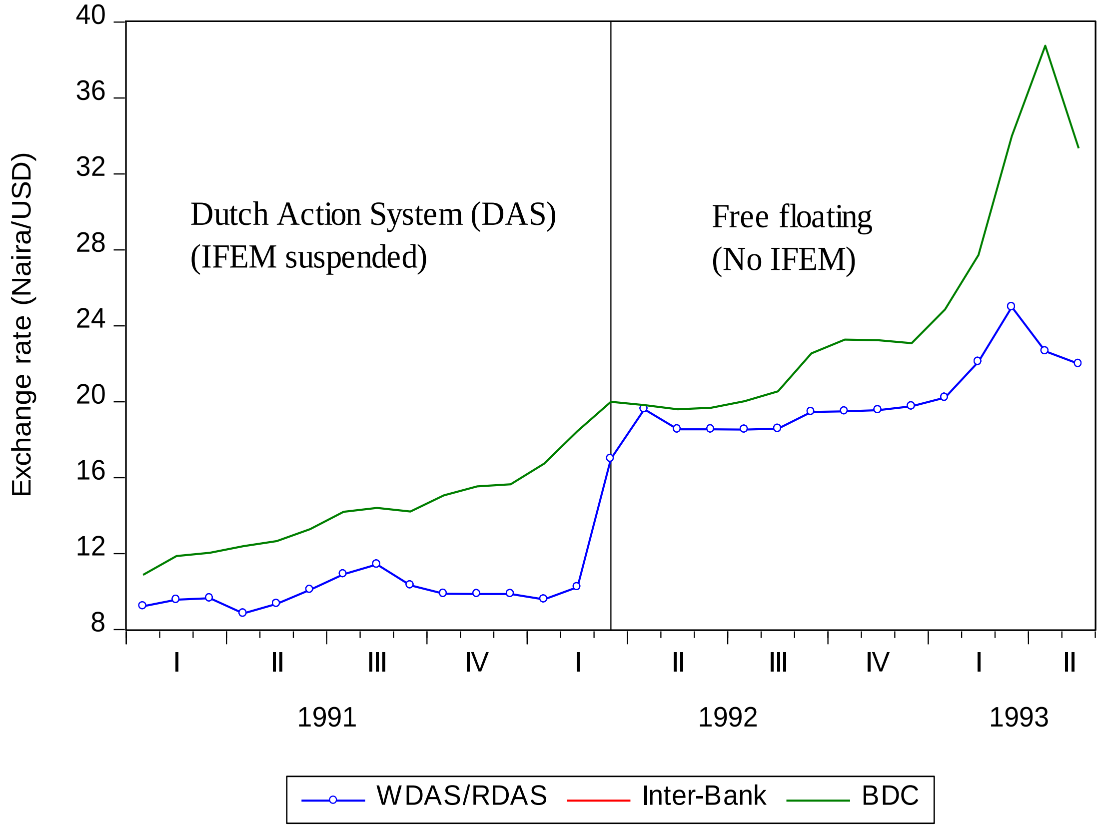
The flexible exchange rate regime in Nigeria was brought in by the exchange rate liberalization policy that was introduced in 1986 under the Structural Adjustment Programme (SAP) framework. Under this regime, the values of exchange rate were determined by the forces of demand and supply (CBN, 2016c). On 26 September 1986, Nigeria's exchange rate was first determined officially through a public auction. This system started with the dual exchange rate system; the first tier FX and the second tier FX market (SFEM). The first-tier market had a fixed exchange rate, which was designated for financing official activities including payments on imports, debt servicing, and expenditures on public sector letters of credit (Ogiogio, 1996). Exchange rate in the second-tier market is market determined, as little or no restriction was placed on the free movement of exchange rate in the FX market. The second-tier market dealt with exchange rate for private sector transactions. At the initiation of this system, first tier exchange rate was ₦1.44/USD, and the second-tier exchange was ₦4.64/USD.

The dual exchange rate system was designed to avoid sharp activities in the FX market that could undermine the smooth running of economic activities (CBN 2016). However, the management of this system became challenging as fluctuations were experienced from bidding session of the second-tier market to another. The Central Bank of Nigeria, then, intervened on two occasions. The first intervention occurred during the sixth session when the initial FX supply was increased from $75 million to $86 million in order to mitigate against the dwindling rate. The second intervention was at the tenth bidding session, initiated to prevent an appreciation of the Naira. Eventually, exchange rate appreciated under the dual system from ₦4.12/USD in September 1986 to ₦3.8/USD in July 1987.

The complexity of managing the dual exchange rate systems made the monetary authorities to merge the first and second tier FX markets into a single FEM in July 1987. In the following year, 1988, FEM was converted to the autonomous foreign exchange market (AFEM) to enhance inflows of non-oil FX into the Deposit Money Banks, and eventually, reduce pressure on the demand for FX. The policy was seen as a way of introducing flexible exchange rate regime capable of reversing the structural distortions in the economy. Meanwhile, Dutch Action System (DAS) had earlier been introduced in April 1987. Dutch auction is characterized by many rates as there are numbers of successful bidders. One important thing that happened under the operation of DAS was the divergent of the market rates from one another, which implied the presence of distortions in the distribution of the foreign exchange.

The AFEM became riddled with speculative activities and was later transformed into the inter-bank foreign exchange market (IFEM) in January 1989. During this period, the funds from the Central Bank and those from autonomous sources were used in the inter-bank market without distinction. The CBN watched advances in the exchange rates of the major international currencies to determine the appropriate level of the Naira exchange rate. The Central Bank determined the exchange rate using one or a combination of some guiding principles: (a) Weighted average of all quotations submitted by banks (the quotation by individual bank weighted by the amount demanded), (b) Simple average of all quotations submitted by all banks, (c) Highest and lowest bank quotes, provided the latter does not depreciate by more than 2% when compared with the rate that emerges in (b) above, and (d) Intelligence report on the exchange rate movements during the previous day in both the inter-bank FX market and some world financial centres. With IFEM, the monetary authorities succeeded in establishing a single and fairly stable exchange rate for the Naira in the official market. Meanwhile, to enlarge the scope of the FX market, bureaux de change (BDC) was introduced in 1989. The major objectives include providing access to FX to small-scale end-users. The weakness of Naira however continued to be an issue of concern to the monetary authorities. As evident, Naira depreciated from ₦7.0389/USD in January 1989 to remain at ₦8.71/USD in December 1990.

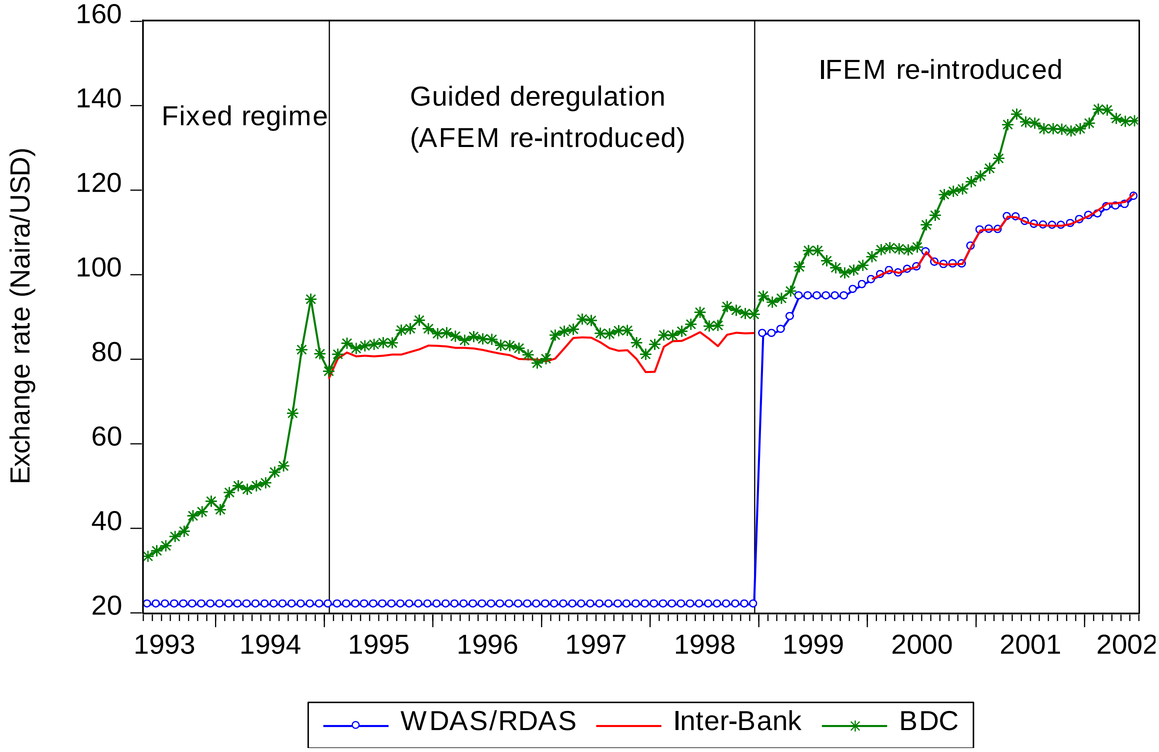
In the continued search for stable and realistic exchange rate, the monetary authorities, on 14 December 1990, abandoned the practice of determining the exchange rate in the inter-bank FX market and re-introduced the Dutch Auction System (DAS) with daily bidding sessions. By March 1991, bidding on a daily basis had been replaced by bidding twice a week. Nonetheless, the unabated exchange rate volatility, and the widening gap between the official and parallel market rates (which was above the internationally acceptable limit of 5.0 per cent), led the CBN to further change the exchange rate mechanism. Hence, on March 5 1992, the FX market was fully deregulated with the floating of the Naira. Though, volatility eased during this period, the demand pressure persisted (CBN, 2016c). As evident from Figure 2.2, exchange rate was fairly stable in the DAS market until March 1992 when it depreciated to ₦17/USD from ₦10.2/USD in February 1992. Also, exchange rate depreciated when free floating was adopted both in the DAS and Bureau de Change (BDC) markets.




Source: Data from CBN Bulletin, 2020Q3

**Figure 2.2: Exchange rate management between 1991M01 and 1993M05**

As a result of volatility in exchange rates, further reforms were introduced in the FX market in 1994. These included the centralization of foreign exchange in the CBN, the formal pegging of the Naira exchange rate, the reaffirmation of the illegality of the parallel market, the restriction of bureaux de change to buy FX as agents of the CBN, and the discontinuation to open accounts and bills for collection as means of payments sectors (Emenike, 2016). Meanwhile, the policy objectives were not realized as the Naira depreciated sharply in the parallel market. As evident from Figure 2.3, while official exchange rate was pegged, there was rapid depreciation in the BDC market. Evidently, though exchange rate was pegged at ₦22 during this period, it depreciated at BDC market from ₦33/USD in May 1993 to ₦94/USD in November, 1994.




Source: Data from CBN Bulletin, 2020Q3

**Figure 2.3: Exchange rate management between 1993M05 and 2002M06**

In 1995, there was the introduction of "guided deregulation" of the FX market, which signifies a change in exchange rate policy from fixed to flexible. The new policy has the objective to address continuous depreciation of Naira and ensure judicious allocation and utilization of foreign reserves. This new policy ushered in Exchange (Monitoring and Miscellaneous Provision) Act, 1995, which allowed free operation of the BDCs (launched in 1989). The AFEM was also re-introduced to stimulate active participation of private sector in the floating exchange market, while the transactions of government were carried out at fixed exchange rate.

The main characteristics of AFEM were the expansion of the market and the abrogation of the inter-bank FX market, while the CBN continued to intervene in the FX market to stabilize the exchange rate. The AFEM was expected to bridge the gap between the official rate and the parallel market rates, and eventually ensure unification of the various exchange rates in a single enlarged FX market. AFEM was to serve as medium for the sale of FX to end-users by the CBN through selected authorized dealers at market determined exchange rate (Emenike, 2016). Under this system, the BDC and AFEM became fairly stable at about ₦85/USD and ₦82/USD, respectively (see Figure 2.3).

The foreign exchange market was further allowed to be more free in 1999 with the re-introduction of the inter-bank foreign exchange market (IFEM), with a view to reduce the prevalent rent-seeking behavior in the market, and restore exchange rate stability (CBN, 2016c). As the premium between the official and parallel market exchange rates continued to expand due to the ever-growing demand for FX in the country, the CBN reintroduced the retail Dutch Auction System (rDAS) in 2002. The rDAS was, however, replaced with the wholesale Dutch Auction System (wDAS) in February 20, 2006 with a view to strengthen the gains of rDAS and achieve a more liberalized FX market. Other possible reasons are increased external reserve, better banking sector soundness, and entrenched fiscal discipline.

Adoption of wDAS entailed revision of the Foreign Exchange Manual, Sale of Foreign Exchange to Bureaux-de-Change operators in an effort to increase access of FX to small end-users, bridge the supply gap and develop the local Bureaux-de-Change (BDCs). The introduction of wDAS led to unification of exchange rates between the Official and Inter-bank Markets and resolution of the multiple currency problems. It also facilitates greater market determination of exchange rates for the Naira vis-a-vis other currencies. As evident from Figure 2.4, wDAS caused reduction in demand pressure on the market and brought about relative stability of the exchange rate. Notable development under wDAS includes exchange rate appreciation in the parallel market for the first time in 20 years.

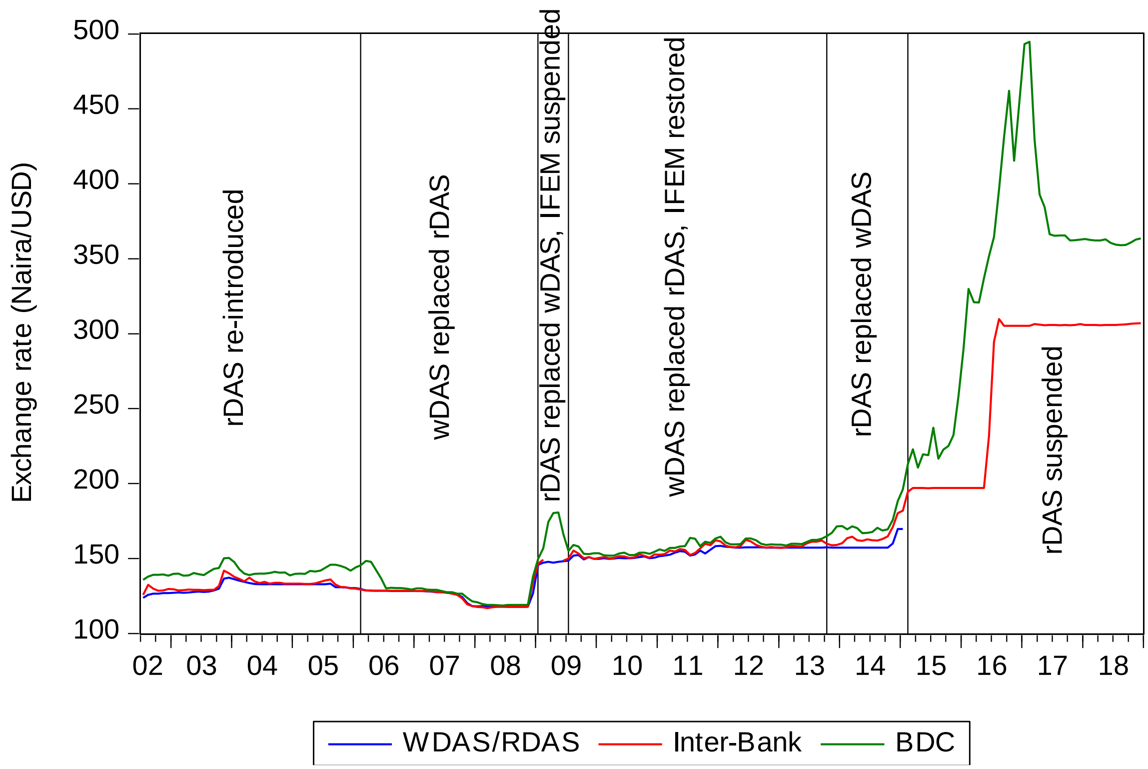



**Figure 2.4: Exchange rate management between 2002M07 and 2018M12**

*Source*: Data from CBN Bulletin, 2020Q3

This great development in the Nigeria FX market resulted in large inflow of FX to the market from oil firms and international investors. However, there was also a large outflow of FX from Nigeria in October 2008, which was largely explained by the global financial crisis. This prompted high pressure on the Nigeria FX market and caused a sharp fall in the exchange rate. In effect, the CBN re-introduced the rDAS in January 2009 to ease the demand pressure. Despite this policy, the rising demand pressure persisted and all segments of the market continued to experience a fall in exchange rate. Consequently, the monetary authority re-introduced wDAS in July 2009. Due to its inability to alleviate the demand pressures, however, it was again replaced by rDAS in October 2013, which was also suspended in February 17, 2015 after some reforms in the FX market. Thus, the official window of the market was closed by the CBN, thereby diverting all demand for FX to the interbank market.

Further policy introduced on June 23, 2015 in the face of shortage of foreign reserves due to continuous falling oil price include the inclusion of 41 goods and services on the list of items not valid for FX in the Nigerian FX market[4]. Figure 2.4 revealed that the effects of these measures are short-lived, as the stability could not be maintained beyond 2015. Specifically, the premium became even wider after rDAS was suspended, which eventually makes Naira to depreciates largely and consistently from ₦197 in May 2016 to ₦231.76 in June, ₦294.57 in July, ₦309.73 in August, before it started to oscillate around ₦305-₦306 from September 2016 till December, 2018. The history of exchange rate management in Nigerian from independence till 2018 is summarized in Table 2.1.

[4] See External Memo TED/FEM/FPC/GEN/01/010 on “Inclusion of some imported goods and services on the list of items not valid for foreign exchange in the Nigerian foreign exchange market”, issued by the Trade and Exchange Department of the Central Bank of Nigeria on June 23, 2015.

**Table 2.1: History of exchange rate management in Nigeria (1960 - 2018)**

| Date | Exchange rate regime | Active exchange rate markets | Policy adjustment |
|---|---|---|---|
| 1960 – 1967 | Fixed regime | Official market | Pegged to British Pound |
| 1967 – 1974 | Fixed regime | Official market | Pegged to USD |
| 1974 – 1976 | Fixed regime | Official market | Pegged to stronger of British Pound or USD |
| 1976 – 1986 | Fixed regime | Official market | Pegged to Basket of 12 currencies of trading partners |
| September, 1986 | Flexible regime | First-tier and Second-tier market introduced | Official transaction was traded on First-tier market |
| April, 1987 | Flexible regime | First-tier, Second-tier and Dutch Action System (DAS) | DAS was introduced |
| July, 1987 | Flexible regime | Bank trading in Foreign exchange market (FEM) and Dutch Action System (DAS) | First-tier and Second-tier market collapsed to FEM |
| April, 1988 | Flexible regime | Autonomous Foreign exchange market (AFEM), DAS | AFEM replaced FEM |
| January, 1989 | Flexible regime | Interbank Foreign Exchange Market (IFEM), Bureau De Change (BDC) | AFEM and DAS was merged to IFEM and was BDC introduced. |
| December, 1990 | Flexible regime | Dutch Action System (DAS) and Bureau De Change (BDC) | DAS was re-introduced and IFEM suspended |
| March 5, 1992 | Free floating | Parallel markets, Bureau De Change (BDC) | FX market was deregulated and DAS suspended. |
| 1994 | Fixed regime | Official market (with pegged rate) | Restriction of BDC operation, illegality of parallel market |
| 1995 | Flexible regime (Guided deregulation) | Autonomous Foreign exchange market (AFEM), Bureau De Change (BDC), Official market | AFEM was re-introduced and BDC operations expanded. |
| 1999 | More flexible regime | Bureau De Change (BDC), Official market and Interbank Foreign Exchange Market (IFEM). | IFEM re-introduced. |
| July 22, 2002 | Flexible regime | BDC, IFEM, Retail Dutch Auction System (RDAS) | DAS re-introduced |
| February, 2006 | Flexible regime | BDC, IFEM, Wholesale Dutch Auction System (WDAS) | WDAS replaced RDAS |
| January, 2009 | Flexible regime | BDC, IFEM, Retail Dutch Auction System (RDAS) | RDAS replaced WDAS |
| February 13, 2009 | Flexible regime | BDC, Retail Dutch Auction System (RDAS) | IFEM suspended |
| June, 2009 | Flexible regime | BDC, IFEM, Retail Dutch Auction System (RDAS) | IFEM re-stored |

| | | | |
|---|---|---|---|
| July, 2009 | Flexible regime | BDC, IFEM, Wholesale Dutch Auction System (WDAS) | WDAS replaced RDAS |
| October 2, 2013 | Flexible regime | BDC, IFEM, Retail Dutch Auction System (RDAS) | RDAS replaced WDAS |
| February 18, 2015 | Flexible regime | BDC and IFEM | RDAS was closed and IFEM became the reference official rate. |

Source: Compiled by the author

According to the officially declared (de jure) exchange rate system, Nigeria has moved from fixed exchange rate regime between 1960 and 1986, to flexible regime in September 1986 (under the Structural Adjustment Programme, SAP), to free floating in March 1992, and again to flexible regime in 1999 through 2018. Meanwhile, according to the IMF classification (IMF, 2016), Nigeria's de facto (observed) exchange rate arrangement changed from other managed to stabilized arrangement in March 9, 2015[5].

***Recent Development in Nigeria Foreign Exchange Market***

In April 2017, the Central Bank of Nigeria (CBN) released a circular establishing an Investors and Exporters (I&E) Foreign Exchange Window to be operated under Nigerian Autonomous Foreign Exchange Rate Fixing (NAFEX). This is a separate from the current official inter-bank foreign market. This new window was introduced to improve the liquidity of the FX market. It is a different window from the SME window recently introduced by the CBN. The rate at I &E NAFEX window is determined based on the forces of demand and supply, and will not be set by the CBN. The CBN may, however, intervene in order to regulate the rate, thereby "managing" the market determined rates (PWC, 2018).

Generally, all invisible transactions including capital repatriation by foreign investors, loan repayment, payments for agreements registered with the National Office for Technology Acquisition and Promotion, personal home remittance and other miscellaneous transactions set out in memorandum 15 of the Foreign Exchange Manual. International airlines ticket

[5] That is shortly after the Central Bank of Nigeria (CBN) expressed its decision to avert the emergence of a multiple exchange rate regime and preserve the country's foreign exchange reserves by closing the Retail Dutch Auction System (RDAS) and Wholesale Dutch Auction System (WDAS) foreign exchange windows in February 18, 2015, leaving only the interbank foreign exchange market (see CBN, 2015).

sales remittances are however excluded. Participants in this Window include exporters, portfolio investors and authorised dealers. This initiative is expected to ease the demand for foreign currency in the parallel market and reduce the downward pressure on Naira exchange rate (PWC, 2018). As evident in Figure 2.5, Naira/USD exchange rate has appreciated relatively in the BDC and I&E windows since I&E window was introduced. This is apparent as exchange rate fell from ₦398 per US dollar and ₦378.11 per US dollar in the BDC and I&E markets respectively, in April 2017, to ₦360 per US dollar and ₦363 per US dollar in December, 2019[6]. Meanwhile, the interbank rate has been stable at about ₦306 per US dollar over the period.

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[6] Note that emergence of COVID-19 pandemic, which caused rapid fall in the global demand for oil and fall in crude oil price by extension, affected the ability of the CBN to maintain this relative stability in 2020. Specifically, CBN devalued Nigeria's exchange rate in March, 2020 and July, 2020, which makes Naira/USD exchange rate to depreciate in the interbank market from ₦306.95/USD in February, 2020 to ₦361/USD in March, 2020, and from ₦361/USD in March through June, 2020 to ₦381/USD in July, 2020. The depreciation pressure was also felt in the BDC and I&E windows, as Naira/USD exchange rate depreciated to ₦464 in the BDC window and ₦386 in I&E window as at September, 2020.

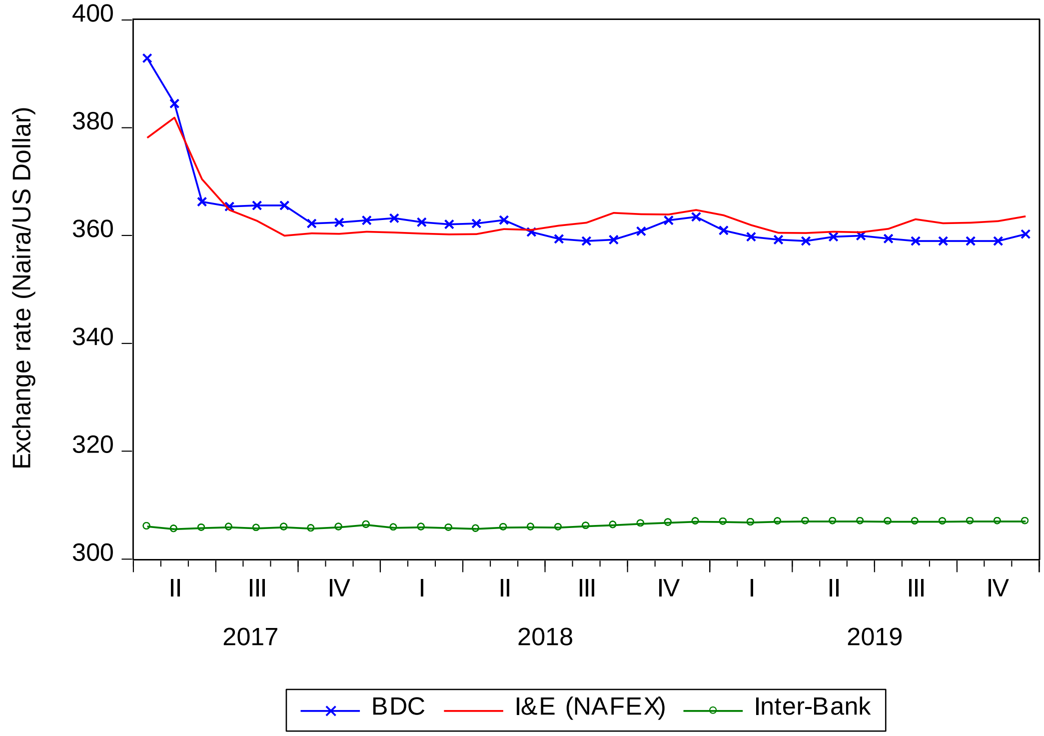


**Figure 2.5: Recent exchange rate management policy**

*Source*: Data from CBN Bulletin, 2020Q3

#### 2.1.1.2 Structure of Foreign Exchange Market in Nigeria

The *de jure* exchange rate regime operated in Nigeria is managed floating regime; hence, the FX market has a combination of fixed and flexible regime characteristics. Basically, the Nigerian FX market has sustained the use to three major sub-markets since IFEM was re-introduced in 1999. These are: the official market, the Inter-bank Foreign Exchange Market (IFEM) and the Bureau De Change (BDC) market. In the official market, rates are for official transactions of government. With the reintroduction of Dutch Auction System (DAS) on July 19, 2002, the determination of official rate has been subjected to auctioning/bidding system. In the Inter-bank and Bureau de change market, rates are determined by forces demand and supply by private sector, however CBN reserves the right to intervene in the market to ensure the rate is within a particular range with the official rate. The difference between official and parallel market (BDC or IFEM) rate is termed exchange rate premium. Following CBN (2016), further issues on the characteristics of these markets are discussed in the following sub-sections.

***Official Foreign Exchange Market***

The CBN is the largest single supplier of FX in Nigeria by virtue being in the custodian of the external reserves of the country. Aside from dealing with government official transactions, the official FX window is used by the CBN to intervene in the FX market. The intervention is carried out by selling FX to authorized dealers using Dutch action system; implying that CBN will sell at highest bid. In this market, the spot transaction is carried out twice in a week (every Monday and Wednesday) and the foreign currency is received in T + 2 days (that is, the transaction day plus two days).

To bid successfully, authorized dealers (banks) are expected to credit their account with the CBN with the Naira equivalent of the foreign currency they intend to buy in not less than 48 hours before the time for auction. Their bids are collated and later submitted to the CBN dealing room by 11am on the bidding day. Notably, such bids are expected to include the name of customer, RC number, Form 'M' number, address, purpose, amount (USD), rate Naira/US$ (or other currencies of interest), mode of payment, Bank name and code. A bid is considered unsuccessful when the bid rate falls below the cut off for the action.

Authorized banks are allowed to source FX either in their own or customers' account under the wDAS, but are only allowed to source FX in their customers' account under the rDAS. Figure 2.6 presents the highest and lowest bid rates in the official market between March 24, 2010 and February 18, 2015, when rDAS window was suspended. Wider margin between lowest and highest bid after September 2013 signifies the effect of changing from wDAS to rDAS which took place in October 2, 2013.

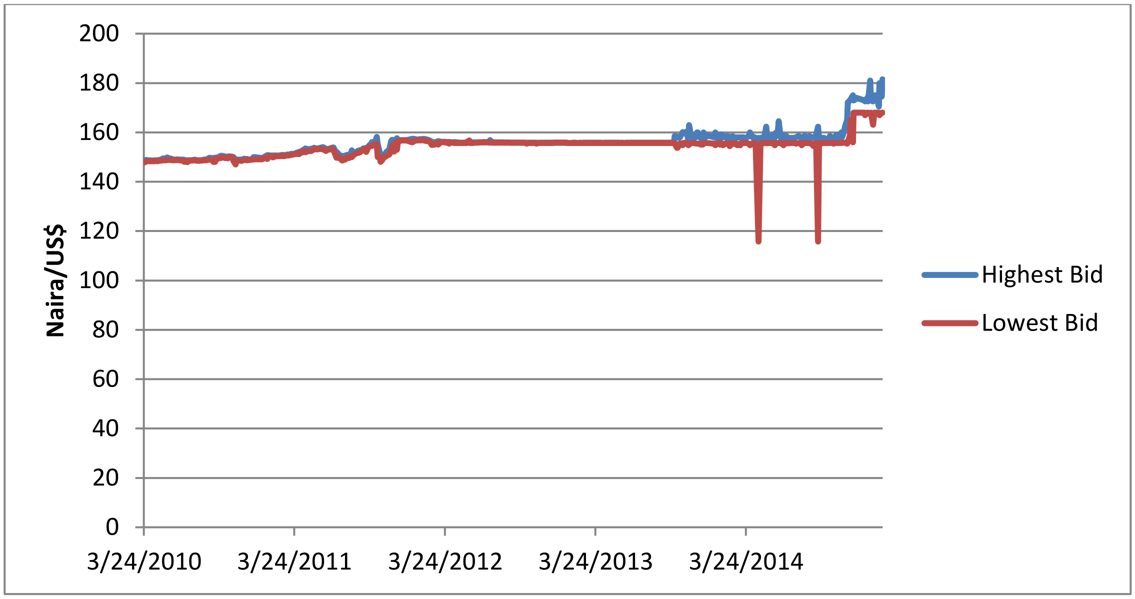


**Figure 2.6: The highest and lowest bid rates in the official market (2010 - 2015)**

*Source*: CBN website (Retrieved: May 9, 2019)

***Inter – Bank Foreign Exchange Market***

The inter-bank foreign exchange market (IFEM) was first introduced in Nigeria in January 1989 to ease demand pressures in the official FX market. It was, however, abolished in 1995 and re-introduced in October 1999. The IFEM permitted the banks to trade among themselves, while the CBN intervene intermittently to ensure Naira is kept at a desired rate. The interbank market comprised of the authorized banks and large institutions interacting and exchanging foreign currencies under the market system of the interaction of demand and supply. The system was designed to run on funds generated by the private sector (autonomous sources). However, CBN intervenes, usually at the prevailing interbank rate, to keep Naira within a determined premium with the official rate. The usual players in this market include the banks, the Nigerian National Petroleum Corporation (NNPC), the private oil companies, and the treasuries of big firms, among others. Notably, IFEM segment has become the reference official rate since rDAS was suspended in February 2015.

Figure 2.7 shows the premium between interbank rate and official exchange rate between 2000 and 2015 in Naira term and in percentage. As evident, the premium was within the 2% bound stipulated by the soft peg arrangement (particularly under stabilized and conventional peg). The bound was best met between 2000 and 2002 before DAS was re-introduced, and between 2005 and 2008 when WDAS was adopted. The bound was however badly met after replacing rDAS with wDAS in 2013. As evident from Figure 2.7, the premium increased from ₦2.9 (or 1.9%) in January 2014 to ₦12.1 (7.1%) in January, 2015.

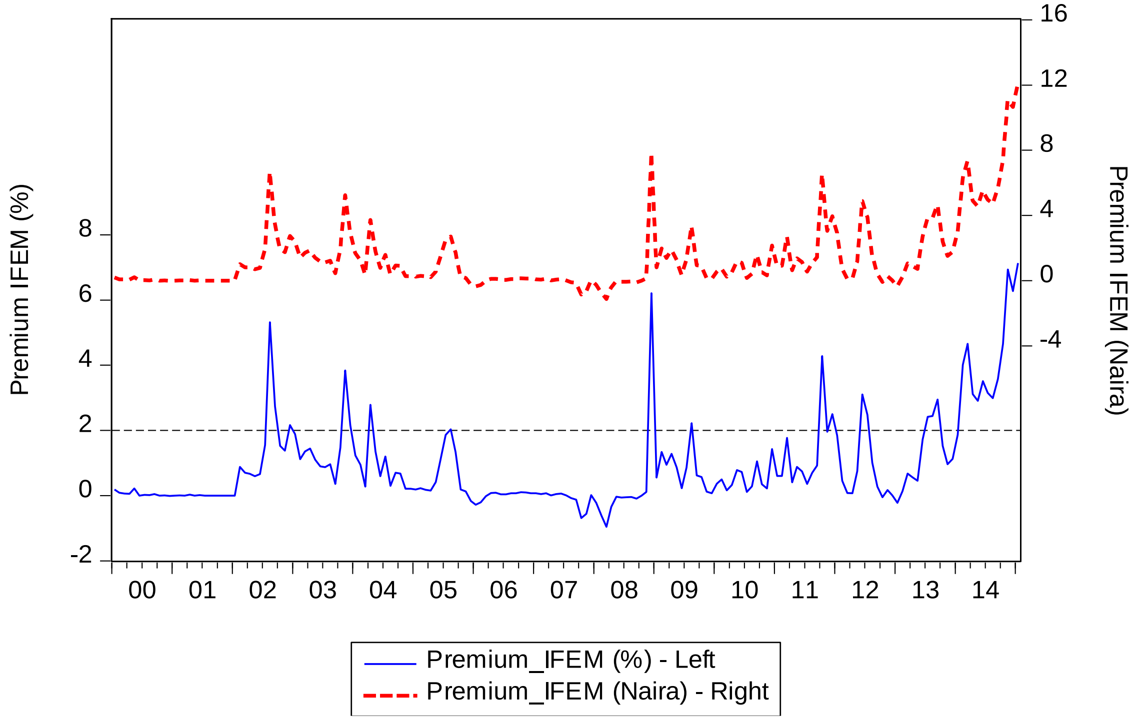


**Figure 2.7: Premium between Interbank rate and Official rate (2010 - 2015)**

*Source*: Computed from CBN bulletin (2020Q3)

***Bureaux-De-Change (BDC) Market***

The BDCs were introduced in Nigeria in 1989 in order to expand the FX market and improve small end-users access to foreign exchange. The operation of BDC in Nigeria was first boosted by the Exchange (Monitoring and Miscellaneous Provision) Act of 1995, when “guided deregulation” was introduced. The BDC provides FX to end-users for Personal travel allowance (PTA), Business Travel Allowance (BTA), payments of monthly mortgage, medical bills, school fees, among others, subject to the available limit. The BDCs act as dealers in the spot market and buy/sell foreign currencies with small margin (premium) as returns. They also purchase and sell Travellers' Cheque (TCs) and foreign bank notes from members of the public, banks and the CBN. Exchange rate determination in the BDC market is subject to market speculation; the impulse or perception by the traders that a particular currency is either undervalued or overvalued, which usually leads to sudden change in supply of, or demand for, such currencies.

As noted from Figure 2.8, on the average, the premium of BDC is wide beyond the 2% recognized under the stabilized and conventional peg arrangement. It was however within the range 2005 and 2008 when WDAS was adopted. The huge premium in the BDC market was observed before DAS was re-introduced in 2002 (₦25/21.8%), during the Global Financial Crisis (GFC) in 2008-09 (₦33/22.2%) and after wDAS was replaced with rDAS in October 2013 (₦26/15.6%).

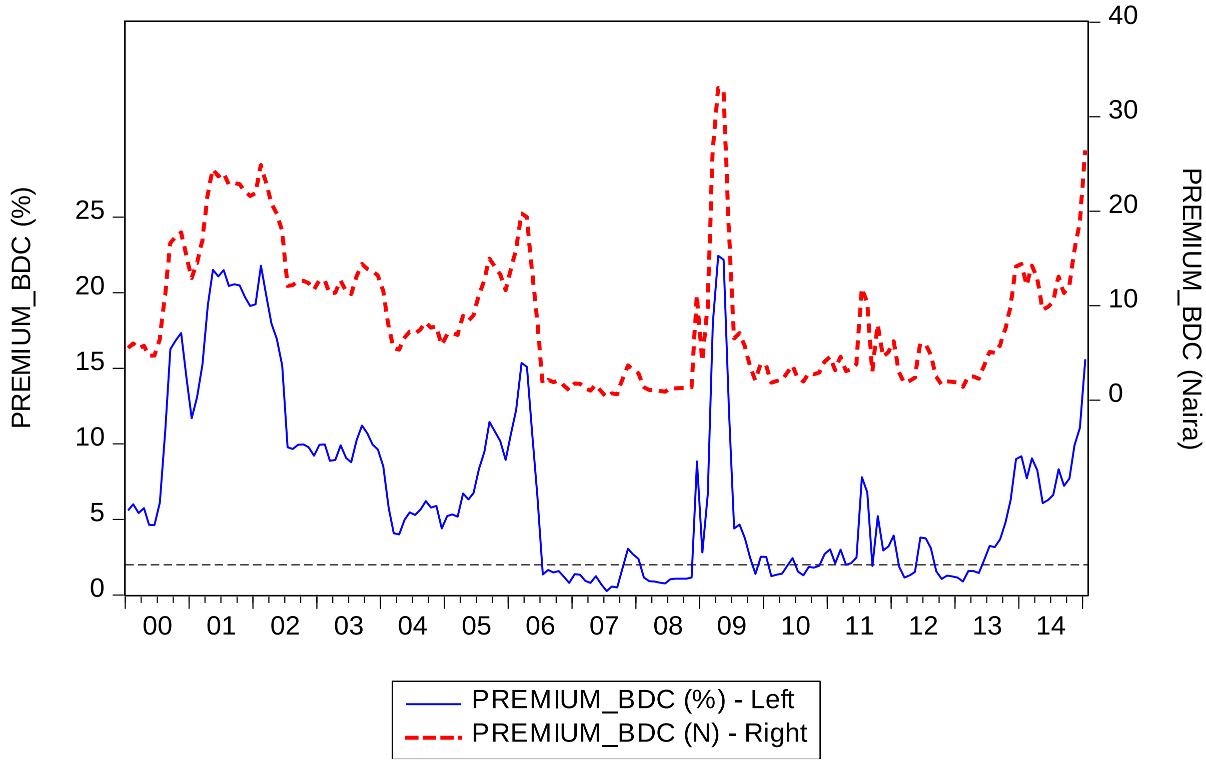


**Figure 2.8: Premium between Interbank rate and Official rate (2010 - 2015)**

*Source*: Computed from CBN bulletin (2018)

#### 2.1.1.3 Real and nominal Naira exchange rate

The distinction between real and nominal exchange rates has been identified in the theoretical and empirical literature on exchange rate behavior. The NER tells how much foreign currency can be exchanged for a unit of domestic currency, while the RER is the price of foreign goods in units of domestic goods (Romer, 2006). In terms of computation, the distinction between the two rests on how changes in the price level in the domestic and foreign countries are handled. While effect of changes in domestic and foreign price levels on exchange rate is ignored when computing NER, it is conspicuously considered when computing RER.

Real exchange rate is computed as the NER multiply by the foreign price level to domestic price level ratio. Or, in other words, as the product of NER and foreign price level divided by domestic prices level ($\varepsilon = \frac{eP^*}{P}$) ; where $\varepsilon$ denotes RER, $e$ is the NER – defined as the units of domestic currency per unit of foreign currency, $P^*$ is the foreign price level and $P$ is the domestic price level[7]. As may be observed from its computation, a change in RER can be prompted by a change in the NER of the domestic country, change in the domestic price level or a change in the foreign price level. An increase in RER or RER depreciation implies that domestic goods have become less expensive relative to foreign goods. Hence, more of domestic goods would be demanded in the domestic and foreign countries, implying higher trade competitiveness of the domestic country. On the other hand, NER depreciation makes imports to be more expensive and exports to be cheaper. This would tend to promote exports and discourage imports. The reverse holds when NER appreciates. Notably, a depreciation or appreciation of the NER does not necessarily imply that the country has become more or less competitive on international markets. Real exchange rate is considered in such case (Pilbeam, 2006).

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[7] Real exchange rate index of Naira is computed from the data obtained from World Development Indicators (WDI). These include the official exchange rate (LCU per US dollar) and Consumer Price Index (CP) of Nigeria, and the CPI of the United States. The CPI and of Nigeria and the United States have common base period, which is 2010 (that is, 2010=100).

Table 2.2 presents how nominal and real exchange rate indices are calculated. In the first period, the RER index of Naira is set to 100 and the NER is ₦200/$. A basket of Nigeria goods that is priced at ₦100 would cost a US resident US$0.5 (100/₦200), and a basket of US goods priced at US$100 would cost a Nigeria resident ₦20,000 (100*₦200). Under this condition, there is purchasing power parity (PPP); the price of basket of Nigerian goods is equivalent to the price of basket of US goods in the international market. Hence, Nigeria and US residents would be indifferent between buying of basket of Nigeria goods and buying of basket of the US goods.

Meanwhile, between period 1 and period 2, there is no change in the NER, which remains at ₦200/$; but the US price index increases while Nigeria index remains the same. This means that a basket of Nigeria goods priced at ₦100 would remain at US$0.5 to the US residents, while a basket of US goods priced at US$100 would now cost a Nigeria resident ₦24,000 (120*₦200). This suggests that US residents and Nigerian resident would prefer to basket of Nigeria goods, implying that Nigeria has gained in trade competitiveness. Actually, suppose PPP holds, the US resident is supposed to now need US$0.6 (120/₦200) to procure basket of Nigeria goods he usually buys with US$0.5, the fact that Nigeria's NER remained at ₦200/$ implies that it has failed to pick up the change in competitiveness (Pilbeam, 2006). This may lead to under-valuation or over-valuation of currency.

Between period 2 and 3, Nigeria's NER per US dollar depreciates, indicated by an increase in nominal exchange index from 100 basis points to 120 basis points. The US price index remained constant but Nigeria price index also increased by 20% from 100 basis points to 120 basis points. In this case, RER depreciation that may be occasioned by NER depreciation has been consumed by increase in domestic price level. Between period 3 and period 4, NER appreciates from ₦240/$ to ₦180/US$, causing nominal index to decrease from 120 basis points to 90 basis points. The US price index increases by 10 basis points, from 120 basis points in period 3 to 130 basis points in period 4, and Nigeria price index reduce slightly from 120 basis points to 117 basis points. In this case, RER does not appreciate as much as the NER. This is mostly due to increase in foreign prices and reduction in domestic prices, which reduce the force of NER appreciation.

**Table 2.2: Construction of nominal and real exchange rate indices**

| Period | Nominal exchange rate | Nominal exchange index | US price index | Nigeria price index | Real exchange index of ₦ |
|---|---|---|---|---|---|
| 1 | ₦200/$ | 100 | 100 | 100 | 100 |
| 2 | ₦200/$ | 100 | 120 | 100 | 120 |
| 3 | ₦240/$ | 120 | 120 | 120 | 120 |
| 4 | ₦180/$ | 90 | 130 | 117 | 100 |
| 5 | ₦150/$ | 75 | 150 | 125 | 90 |

Note: Nominal exchange rate index is constructed by dividing the exchange rate by ₦200, which is its value in the chosen basis period (period 1). The real exchange rate index is constructed by multiplying the nominal exchange rate index by the US price index and dividing the result by the Nigeria price index.

Lastly, between periods 4 and 5, there was NER appreciation, which reduces the nominal index from 90 basis points to 75 basis points. Despite increase in foreign prices (from 130 index points to 150 index points), which tends to stir real exchange rate appreciation, there was increase in domestic price index and the net effect is RER appreciation from 100 basis points to 90 basis points.

Figure 2.9 shows the graphical presentation of Nigeria NER and RER index for period 1960 to 2019. The trend in the exchange rates can be partitioned into five (5) regimes. The first regime, quadrant A, is the pre-Structural Adjustment Programme (SAP) era. During this period, Nigeria NER valued more than the US dollar and the NER was below ₦1/US$. However, RER was fairly stable up till 1968, before it started appreciating; the trend it follows as it declined from 144 basis points in 1968 to 53.6 basis points in 1985. Real exchange rate appreciation experienced during this period is attributed to rapid increase in the US price level, which increased consistently from 13.56 points in 1960 to 49.33 points in 1985. With real appreciation Naira, Nigeria becomes less competitive, as her prices were expensive to her trading partners, and there were also higher imports, which was established due since oil boom of the early 1970s. Nigerian government was encouraged to embrace SAP to ameliorate these economic conditions.

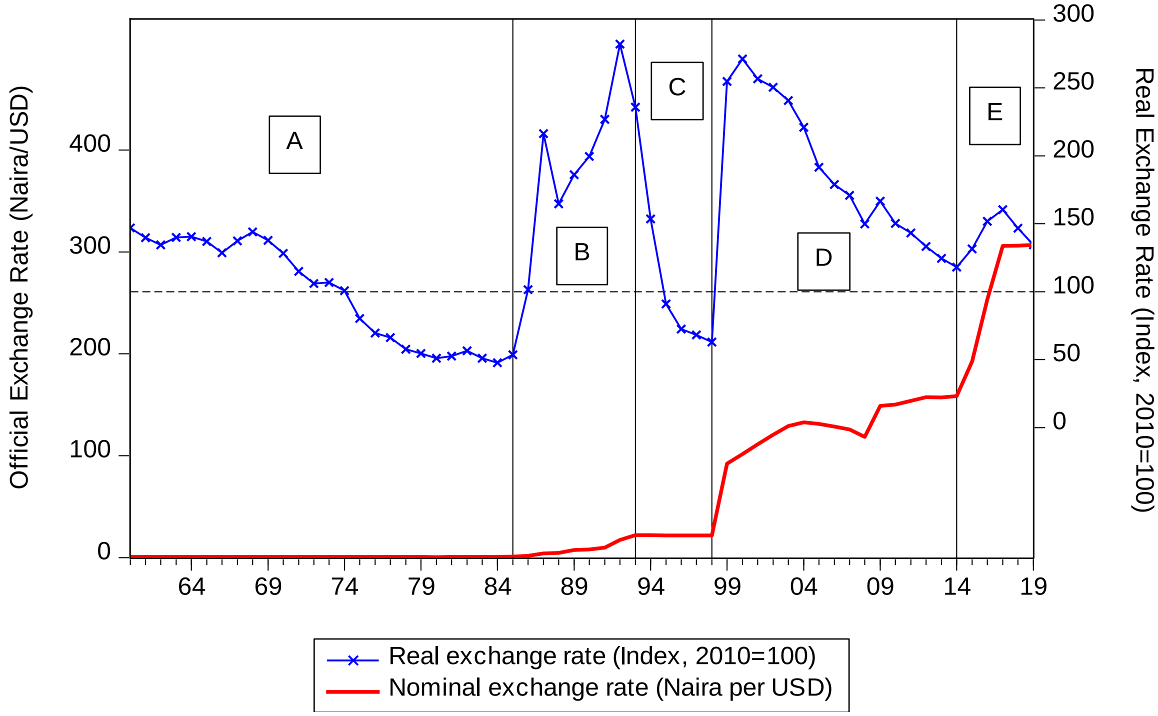


**Figure 2.9: Real and nominal exchange rate of Naira/USD in official market**

*Source*: World Development Indicators (WDI) database

In the early post-SAP period, between 1986 and 1993, which was described as the second regime, quadrant B, nominal exchange rate was devalued gradually, as it increased from ₦1.75 per US dollar in 1986 to ₦22.06 per US dollar in 1993. There was RER depreciation in this period, which suggests that the change in NER was not consumed by lower foreign prices or higher domestic prices. The RER deprecation indicates that Nigeria gained in trade competitiveness in the early post-SAP period, and had opportunity to sell as many Nigeria goods to the world as possible. The third period, quadrant C, indicates the period of fixed exchange rate practice in Nigeria. Nigeria NER was pegged at ₦21.89 per US dollar in this 5-year period; 1994 to 1998. During this period, Nigeria lost almost all the RER depreciation gained in the early pre-SAP era, as the RER index of Naira declined from 153.6 index points in 1994 to 63.02 index points in 1998.

The fourth period, quadrant D, signifies the beginning of the fourth republic civilian administration in Nigeria. In the first year of this administration in 1999, Nigeria NER was devalued at the official market from ₦21.886 per US dollar in 1998 to ₦92.34 per US dollar in 1999. This appears to prompt instantaneous RER depreciation, as RER increased from 63.02 index points in 1998 to ₦254.82 per US dollar in 1999 and ₦271.3 per US dollar in 2000. After the year 2000, RER of Naira started appreciating; falling from its value in year 2000 value to 118.06 basis point in 2014. This suggests loss of trade competitiveness. The loss of this trade competitiveness can be attributed to the rapid increase in domestic price level in Nigeria, which shows increase in domestic price level from 29.6 index points in 1999 to 145.8 index points in 2014.

In the fifth period, between 2014 and 2019 (quadrant E), NER was, again, devalued from ₦158.55 per US dollar in 2014 to ₦305.79 per US dollar in 2017. As was observed in under quadrant D, this causes instantaneous RER depreciation, which returned on the appreciating trajectory after 2017. This suggests that the use of changes in NER as mean of stimulating RER depreciation has only short-term effect. By implication, changes in the fundamental structure of the economy such as reduction in level of oil export dependence may be a valuable method to achieve sustainable RER depreciation. This would tend to increase domestic productivity and export of non-oil, thus reducing general price level, with the cheaper price attracting higher export demand.

#### 2.1.1.4 Naira and Exchange Rate Misalignment

Exchange rate misalignment occurs in a situation where the exchange rate of a country deviates from the equilibrium exchange rate of that country. Exchange rate misalignment can lead to overvaluation or undervaluation of domestic currency. A currency is over-valued when its value is higher than the equilibrium value, and it is undervalued when its value is lower than the equilibrium value. Following Qayyum et al. (2005), equilibrium value of Naira is computed using the Purchasing Power Parity (PPP) approach. Specifically, PPP is computed as domestic exchange rate index multiplied by foreign price level. In this study, the PPP equilibrium exchange rate is computed on nominal and RER index of US dollar. This is presented in addition to misalignment (computed as percentage deviations from domestic real and nominal rates) in Figures 2.10, 2.11, 2.12 and 2.13.

Figure 2.10 and Figure 2.11 show the graphical presentations of NER misalignment in the IFEM and BDC markets, respectively. A common conclusion from the two markets is that Naira was overvalued before 2009, and it has been increasingly undervalued since 2010. Apparently, the rate of Naira undervaluation in the IFEM and BDC markets has increased from 0.12 percent in January 2010 to 16.34 percent in December, 2018.

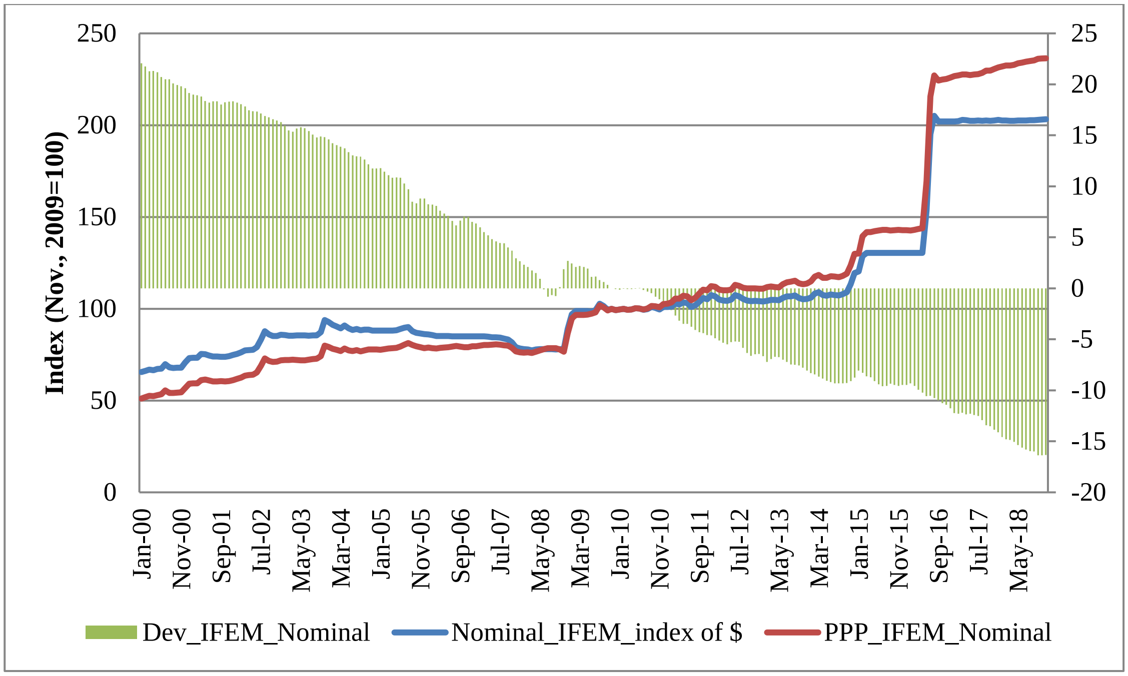


**Figure 2.10: IFEM Nominal exchange rate misalignment**

*Source*: CBN and FRED database, Deviations computed by the author

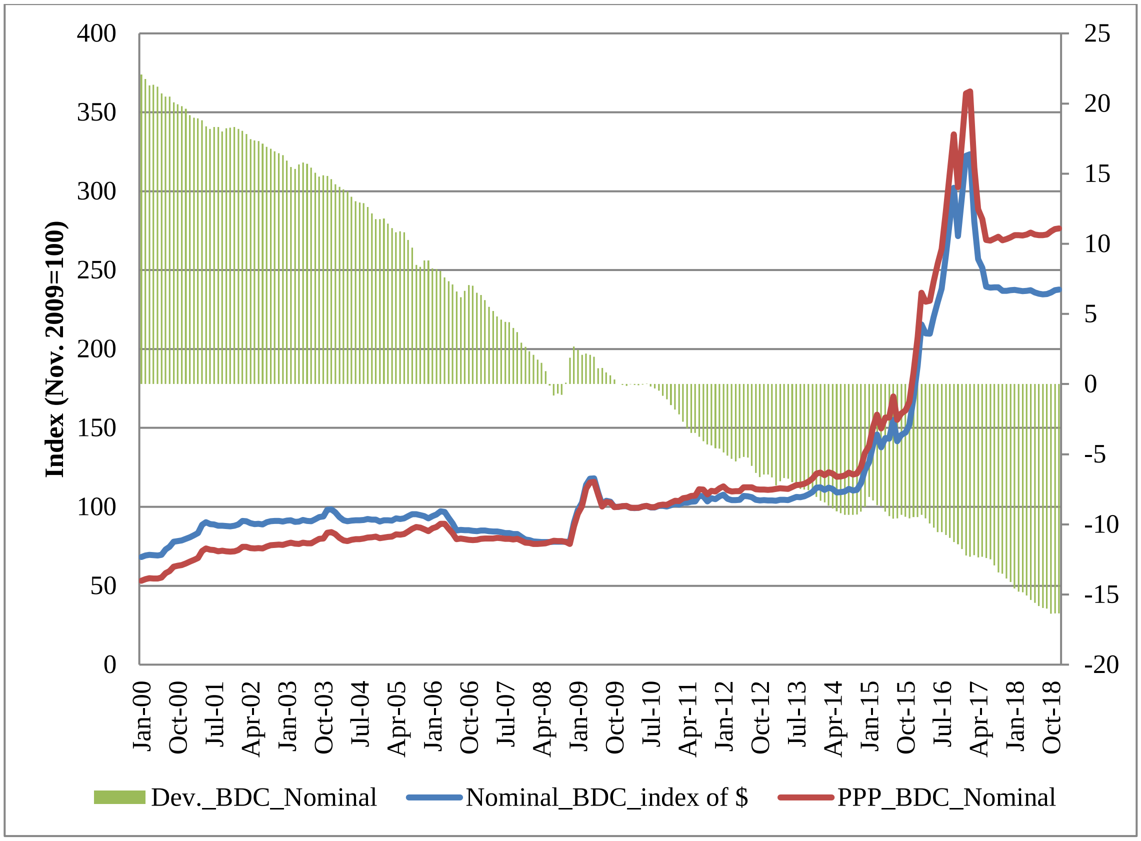


**Figure 2.11: BDC Nominal exchange rate misalignment**

*Source*: CBN and FRED database, Deviations computed by the author

Figures 2.12 and 2.13 show the RER misalignment in the IFEM and BDC markets, respectively. Like in the case of nominal real exchange rate, a common conclusion from the IFEM and BDC markets is that the value of Naira has been declining consistently since year 2000. Meanwhile, Naira was overvalued before 2009, and it has been increasingly undervalued since 2010. Apparently, the rate of Naira undervaluation in the IFEM and BDC markets has increased from 0.12 percent in January 2010 to 16.34 percent in December, 2018.

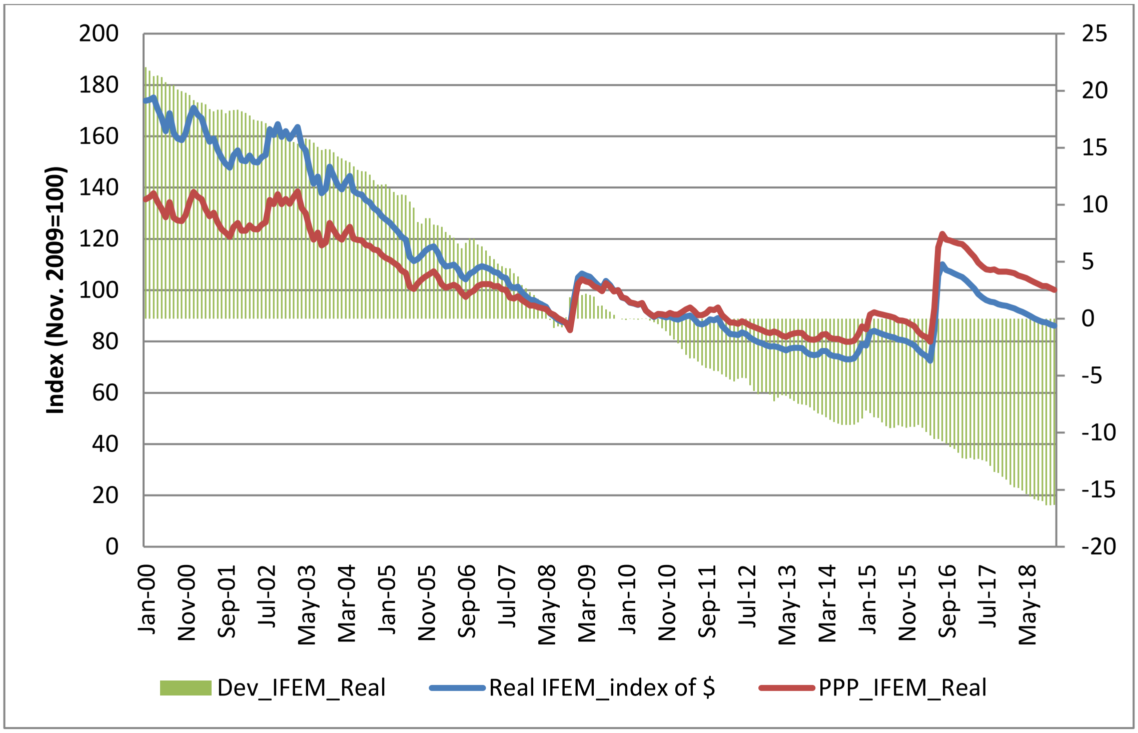


**Figure 2.12: IFEM real exchange rate misalignment**

*Source*: CBN and FRED database, Deviations computed by the author

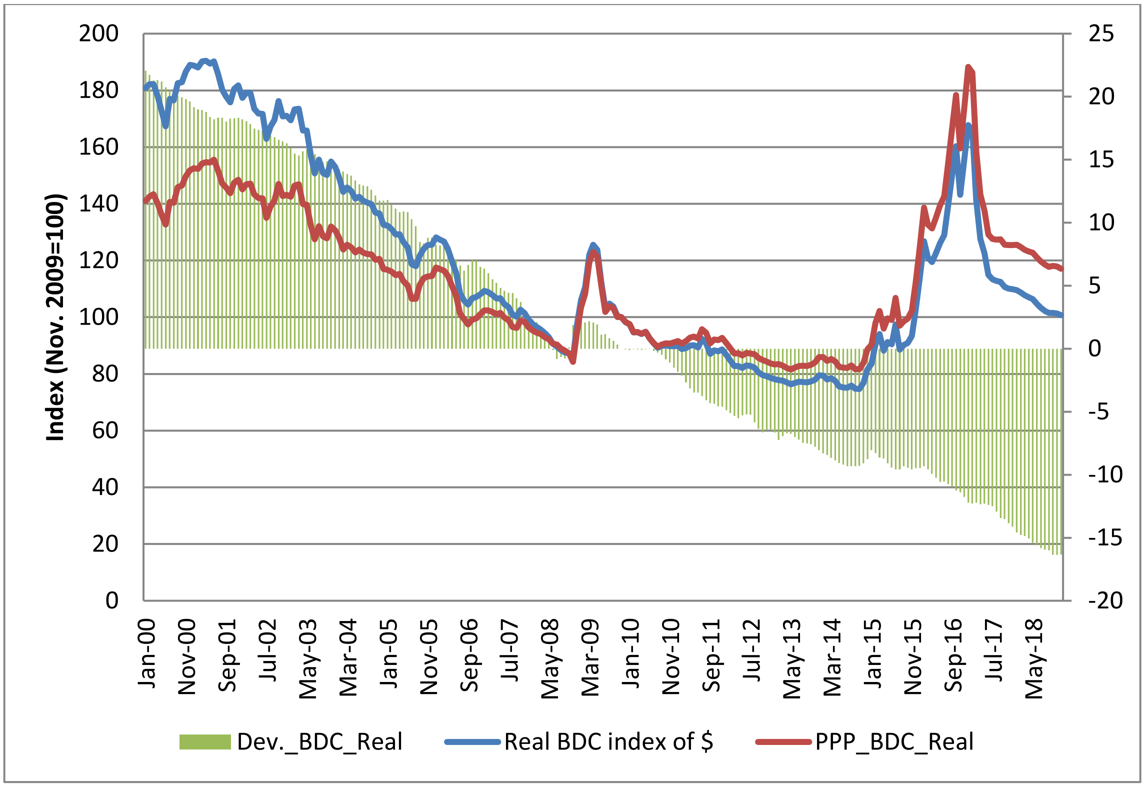


**Figure 2.13: BDC real exchange rate misalignment**

*Source*: CBN and FRED database, Deviations computed by the author

### 2.1.2 Nigeria and Oil Export Dependence

Oil export dependence has been defined differently by different authors based on the objectives of their studies. In the theoretical analysis by Bhattacharya and Balke (2010) and Akli and Kim (2014), oil export dependence was defined as a function of effective oil export price, oil export importance, oil dependency, and primary energy intensity. According to Bhattacharya and Balke (2010) and Akli and Kim (2014), oil export dependence is measured as the percentage of the value of oil export revenue to the Gross Domestic Product (GDP) of the country.

Meanwhile, in a recent study by Hendrix (2017), a measure of oil export dependence as a percentage of oil revenue to GDP was criticized on the ground that it identified diversification in oil-producing countries in terms of the contribution of oil sector to GDP and ignores its contribution to total export. According to Hendrix (2017), a measure of oil export dependence as a percentage of oil revenue to GDP creates an illusion that oil exporting countries are increasingly getting diversified while the composition of oil export in total merchandise exports is still high. Hendrix (2017) analyzed that, with a high composition of oil export in total merchandise exports the economy of many oil exporting countries remained exposed to the vagaries of oil price volatility and terms of trade shocks.

As this study focuses on exchange rate behaviour, which is expected to be highly responsive to a term of trade shocks and oil price volatility, it supports the argument of Hendrix (2017). It, thereby, defines level of oil export dependence in terms of the percentage of oil export in the total merchandise export. In the following sub-sections, background issues on the level of oil export dependence of Nigeria shall be considered. This will first be considered from the global perspective, by comparing the position of the Nigeria's level of oil export dependence with other oil dependent countries of the world. Thereafter, the specific case of Nigeria, focusing on the evolution of Nigeria's level of oil export dependence and its effect of Nigeria's macroeconomic factors will be considered.

#### 2.1.2.1 Nigeria's Level of Oil Export Dependence in the Global Perspective

Nigeria is not the only country that is dependent mainly oil export for revenue and foreign exchange earnings. In this sub-section, the focus is to view Nigeria's dependency on oil from the global perspective, by comparing its level of dependence vis-à-vis other countries in the same category. The list of countries considered comprises of oil exporting countries, which may be divisible into net oil exporting and net oil importing countries. The classification regarding whether a net oil exporting countries is an OPEC[8] or non-OPEC member is also considered. Figure 2.14 shows the recent level of oil export dependence of net oil exporting countries. This may be compared with the level of oil export dependence by net oil importing countries as shown in Figure 2.17. Basically, Figure 2.14 shows that the level of oil export dependence among net oil exporting countries is averagely high. This ranges from 99.84 percent in the case of Iraq to 1.14 percent in the case of Papua New Guinea.

Apparently, between 2011 and 2015, the statistics show that over 50 percent of net oil exporting countries have oil exports contributing more than 60 percent to their total merchandise export (see Figure 2.14). Specifically, in the group of thirty-eight (38) net oil exporting countries, oil export constitutes more than 90 percent of total merchandise export of seven (7) countries, more than 80 percent of total merchandise export of eleven (11) countries, more than 70 percent of total merchandise export of fifteen (15) countries, and more than 60 percent of total merchandise export of nineteen (19) countries (see Figure 2.14).

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[8] The Organization of the Petroleum Exporting Countries (OPEC) was formed with the signing of an agreement in September 1960 by five countries namely Islamic Republic of Iran, Iraq, Kuwait, Saudi Arabia and Venezuela, in Baghdad, Iraq. As of February, 2018, OPEC consists of fourteen (14) members, including the five (5) founding members and nine (9) Full members namely; Algeria, Angola, Ecuador, Equatorial Guinea, Gabon, Libya, Nigeria, Qatar and the United Arab Emirates. According to the U.S. Energy Information Administration (EIA) [https://www.eia.gov/finance/markets/crudeoil/supply-opec.php (Accessed: 02/02/2018)], OPEC member countries produce about 40 percent of the world's crude oil while the remaining is produced by Non-OPEC members. More so, OPEC's oil exports represent about 60 percent of the total petroleum traded internationally, implying that only about 40 percent of the global traded oil is supplied by Non-OPEC oil exporting countries.

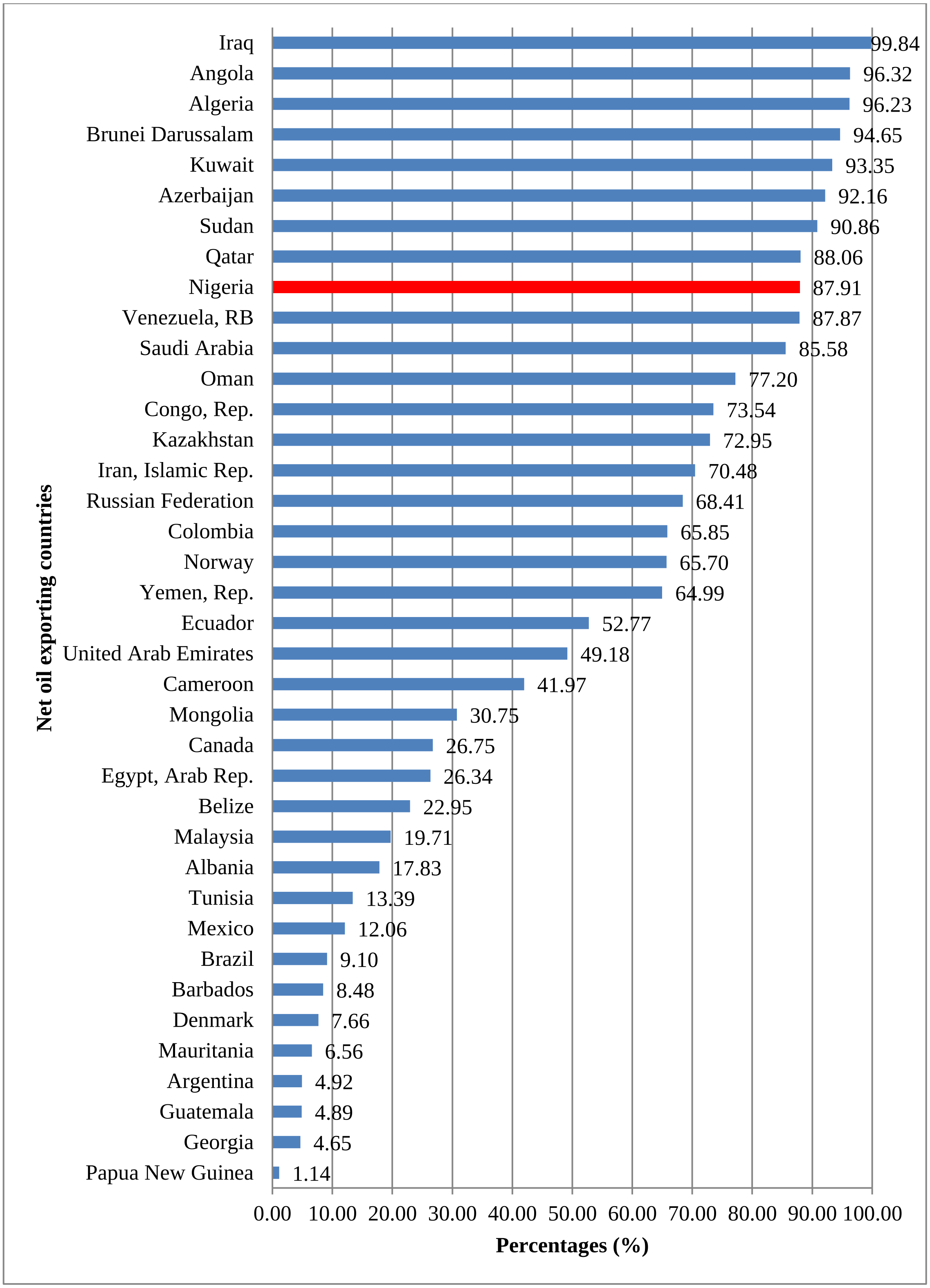


**Figure 2.14: Level of oil export dependence by Net oil exporting countries**

*Source*: Compiled from WDI data (WDI, 2019)

As evident from Figure 2.14, the top ten (10) oil export-dependent countries are; Iraq (99.84%), Angola (96.32%), Algeria (96.23%), Brunei (94.65%), Kuwait (93.35%), Azerbaijan (92.16%), Sudan (90.86%), Qatar (88.06%), Nigeria (87.91%) and Venezuela (87.87%). Whereas, some net oil exporting countries have a diverse merchandise export base, as oil export only constitutes less than 20 percent of their total merchandise export. These countries include Malaysia (19.71%), Tunisia (13.39%), Mexico (12.06%), Brazil (9.10%), Georgia (4.65%) and Papua New Guinea (1.14%).

However, as evidence from Figure 2.15, majority of OPEC countries are heavily dependent on oil export. The exception could only be of United Arab Emirate (UAE) and Ecuador, which have 49.18 and 52.77 percent level of oil export dependence, respectively.

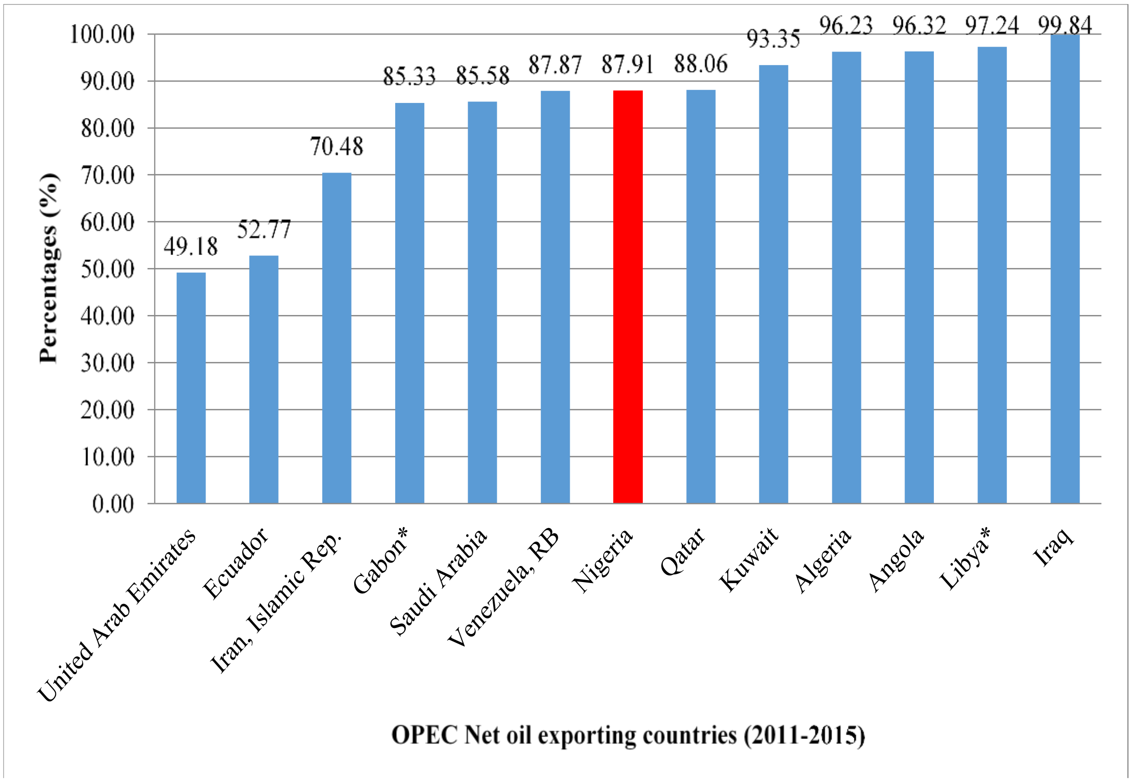


**Figure 2.15: Level of oil export dependence by OPEC net oil exporting countries**

*Source*: Compiled from WDI data (WDI, 2019)

Note: * indicates 2006-2010 average, as data was not yet available for Gabon and Libya between 2011 and 2015. Equatorial Guinea was excluded because it has no record of oil export as a percentage of total merchandise export since 1986.

Nonetheless, although the majority of OPEC net oil exporting countries are heavily dependent on oil export, the problem of high level of oil export dependence is also prominent in some non-OPEC net oil exporting countries. As evident from Figure 2.16, Brunei, Azerbaijan, and Sudan are non-OPEC countries with more than 90 percent dependence on oil export. More so, non-OPEC net oil exporting countries such as Oman, Congo Republic, Kazakhstan, Russia, Colombia, Norway, and Yemen with the level of oil export dependence ranging 65 to 80 percent could also be viewed as being highly dependent on oil export.

However, current account and foreign reserve volatility may be expected to pose minimal problem in the case of net oil importing countries as the majority of them are less dependent on oil export. As evident from Figure 2.17, the level of oil export dependence is less than 30% for the majority (above 83 percent) of net oil importing countries. Major outliers are Trinidad and Tobago, and Ghana whose level of oil export dependence is fairly high at 57.04 and 50.30 percent, respectively.

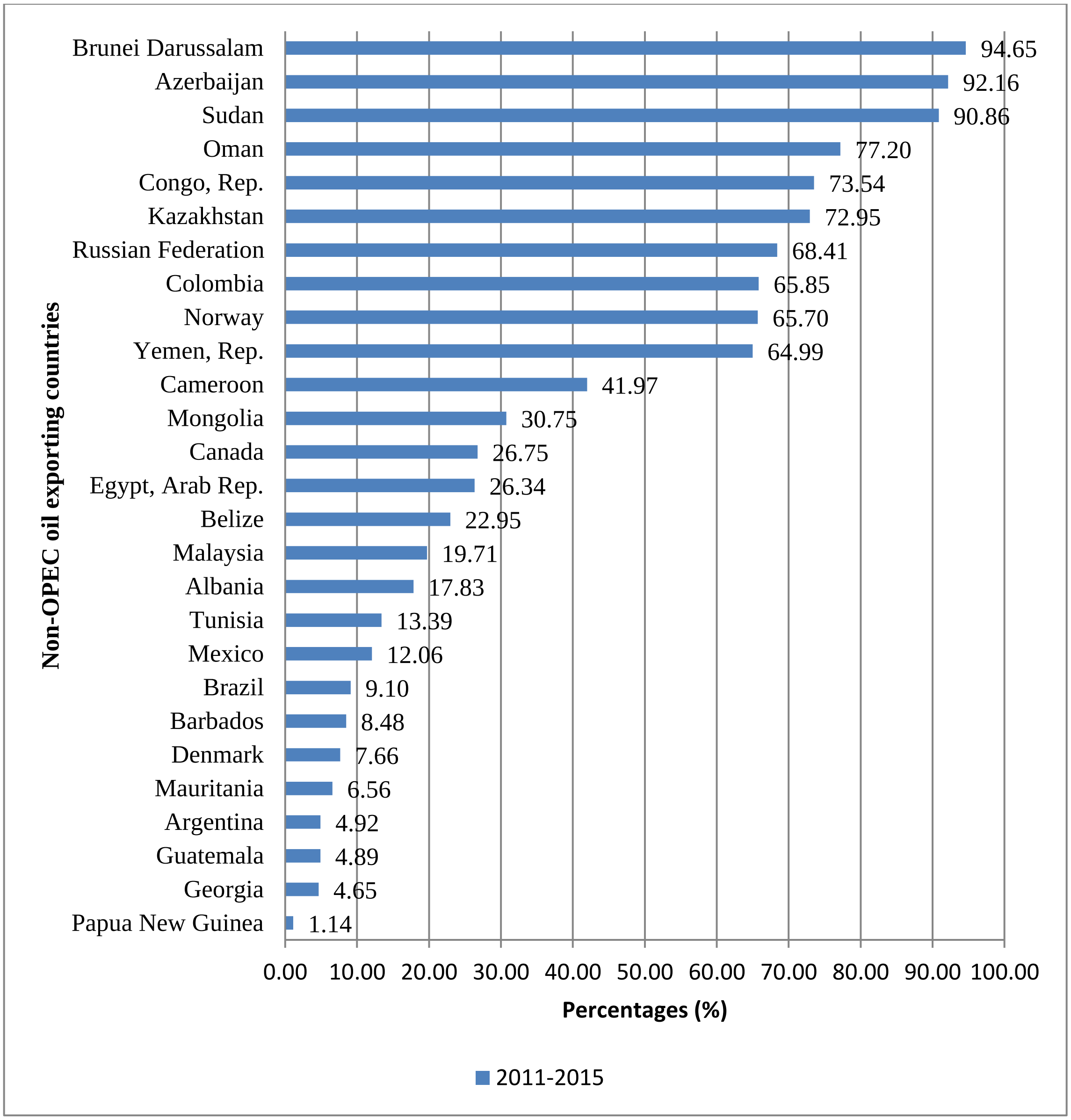


**Figure 2.16: Level of oil export dependence by non-OPEC net oil exporting countries**

*Source*: Compiled from WDI data (WDI, 2019)

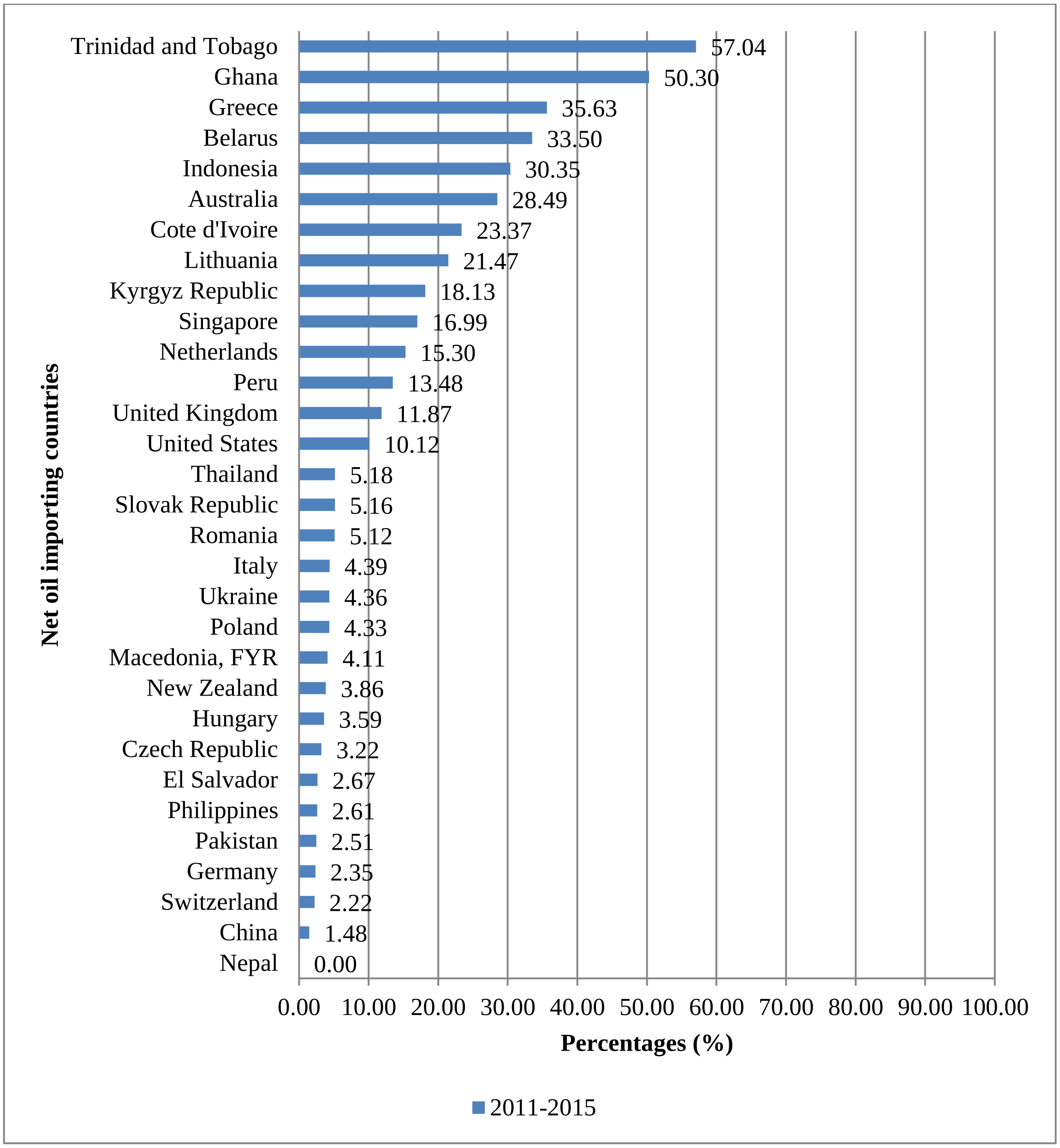


**Figure 2.17: Level of oil export dependence by net oil importing countries**

Source: Compiled from WDI data (WDI, 2019)

#### 2.1.2.2 Nigeria's Trade Structure and Evolution of Oil Export Dependence

Historical review of the trade structure of Nigeria reveals that Nigeria does not rely strongly on oil in the early period after the independence in 1960. Figure 2.18, which shows the percentage contribution of major sectors to Nigeria's total export, reveals that Nigeria's level of oil export dependence was just about 10% between 1960 and 1963. Nigerian export during this period was dominated export of agricultural products, consisting of food exports (about 65%) and agricultural raw materials (about 18%). Fifteen year after 1963, ending in 1978, Nigeria's dependence on oil increased rapidly on an increasing rate, to 93.6%. It then further increased at decreasing rate to a maximum of 99.4 percent in 2002. The Dutch disease was felt in the economy, as the contribution of non-oil sector to export declined abysmally. The contribution of agricultural sector which used to be above 70 percent of total export has now reduced to a very low level of less than 1% in 2002.

As evident in Figure 2.18, Nigeria's level of oil export dependence reduced fairly after 2002 to 87 percent in 2014, but it has again resumed on the rising trend since 2015 through 2017. As government export diversification efforts were intensified between 2011 and 2014, the contribution of contribution of agricultural sector increased (with export of food increasing slowly from 3.05 percent to 4.05 percent and export of agricultural raw materials increasing from 1.2 percent to 5.5 percent), just as the level of oil export dependence reduced from 89.7 percent to 86.9 percent.

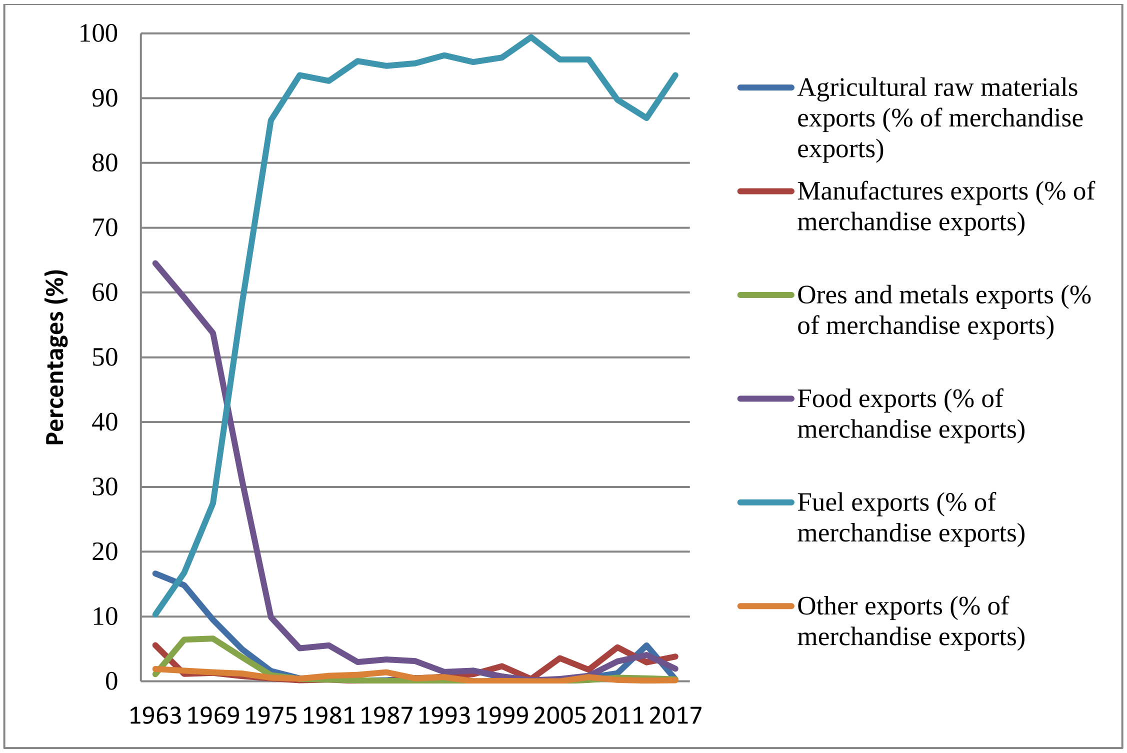


**Figure 2.18: Sectoral exports of Nigeria (1960-2017)**

*Source*: World Development Indicator (WDI) database (WDI, 2019)

The measure of oil export dependence may be distinguished from other measures of oil dependence. Alternative measures of oil dependence such as oil revenue as percentage of total government revenue and oil output as percentage of GDP is presented in Figure 2.19. These measures present mild narrative about Nigeria's level of oil dependence. For instance, oil revenue as percentage of total government revenue suggests that Nigeria's level of oil dependence has been largely between 70% and 80% between 1984 and 2014, which is milder than the 90% pronounced by the oil export to total export measure. In addition, export dependence measure suggests that level of oil dependence has been increasing after 2014 while revenue dependence measure suggests that it has been decreasing. The contribution of oil to total GDP has also been decreasing; falling from the average of 31.7 percent in 1998 to 19.7 percent in 2007, 9.6 percent in 2015 and 8.6 percent in 2018 (see Figure 2.19). This re-instated the argument by Hendrix (2017) about the use of alternative oil dependency measures as indicators of oil export dependence. As evident, although the economy has become more diversified in terms of its revenue sources and economic productivity, its reliance on oil is still high, and the economy is still prone to the vagaries of oil price shocks.

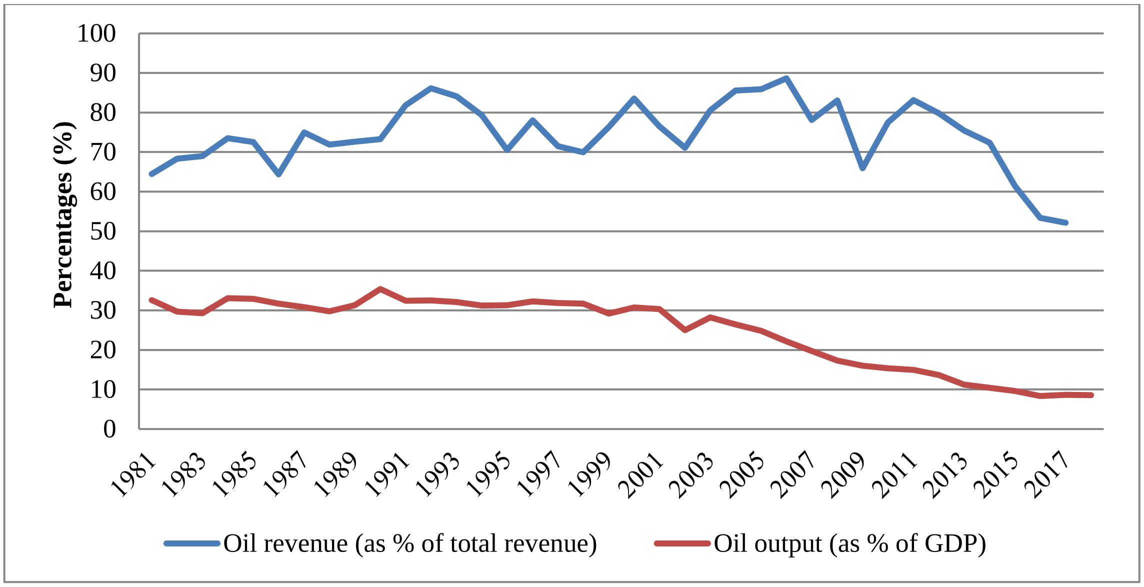


**Figure 2.19: Alternative oil dependency measures**

*Source*: Central Bank of Nigeria (CBN) database

As protectionist policy could also be in form of import substitution rather than export promotion, the level of import dependence of Nigeria is also analyzed. The percentage contribution of different sectors of the economy to total import between 1960 and 2017 is presented in Figure 2.20. The figure reveals that imports of manufacturing products dominated Nigeria importations with contribution higher than 70% since 1960s. Before 2011, the significant import substitution effort or reduction in import dependence was noted in the food import between 1987 and 1993. This may however be due to the effect of Structural Adjustment Programme (SAP) introduced by the federal government of Nigeria in 1986. Apparently, this made food import as a percentage to total import to reduce from 18.34% in 1987 to 6.36% in 1993. It has however increased after then, to remain at 14.94% in 2017. Between 2011 and 2017, Nigeria's dependence on imports of manufacturing products has reduced from 85% to about 60%. This suggests improvement in the manufacturing industry of Nigeria. On the contrary however, reliance on importation of fuel products increased unprecedentedly, from 1.3 percent in 2011 to 22.4 percent in 2017. This points to the fact, that lack of effective and efficient refineries in the country is having bad influence on the country's trade position.

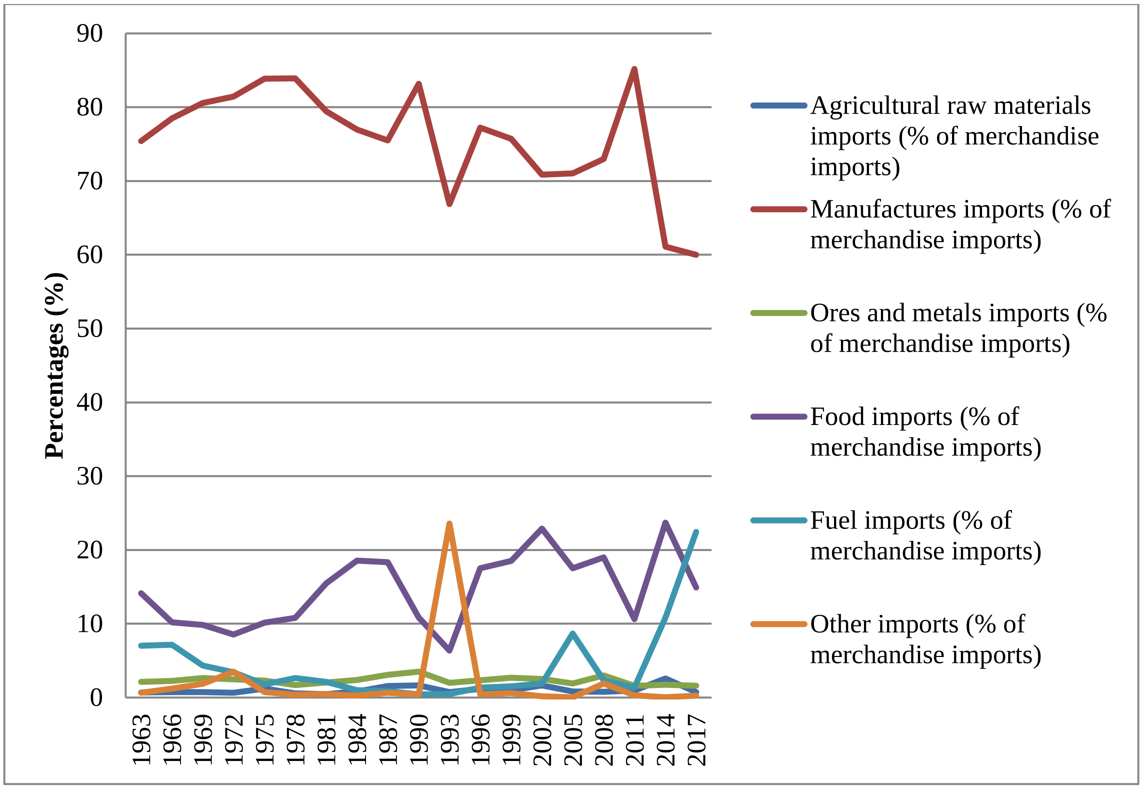


**Figure 2.20: Sectoral imports of Nigeria (1960-2017)**

*Source*: World Development Indicators (WDI)

The previous discussions are on the percentage contribution of oil export, which only shows the relative dominance of oil in Nigeria's export. The absolute contribution of oil export is considered in terms of its Naira value. Figure 2.21 shows Nigeria's total revenue from export and its oil and non-components. As noted from the graph, revenue from oil export is almost equal to the total revenue from export for most of the period between 1981 and 2007. This suggests that the dominance of contribution of oil to total export revenue is about 100% during this period. After 2007, increase in revenue from non-oil becomes notable as it increased from ₦199.25 billion in 2007 to ₦1130.17 billion in 2013 and then slowed to remain at ₦1074.9 billion in 2017. As the price of oil collapse between 2008 and 2009, revenue from oil export reduced by 17.8% from ₦9861.8 billion in 2008 to ₦8105.45 billion in 2009, while revenue from non-oil reduced by 4.75% from ₦525.85 billion to ₦500.86 billion. Similarly, oil price collapse of the 2014 caused revenue from oil to fall sharply by 31.9% from 12006.96 to 8178.81, while non-oil export revenue fell by 31.1% from 953.52 to 656.79. This indicates that non-oil export is less responsive to oil price shocks; hence export diversification towards increasing revenue from non-oil export can make total revenue from export less vulnerable to oil price shocks.

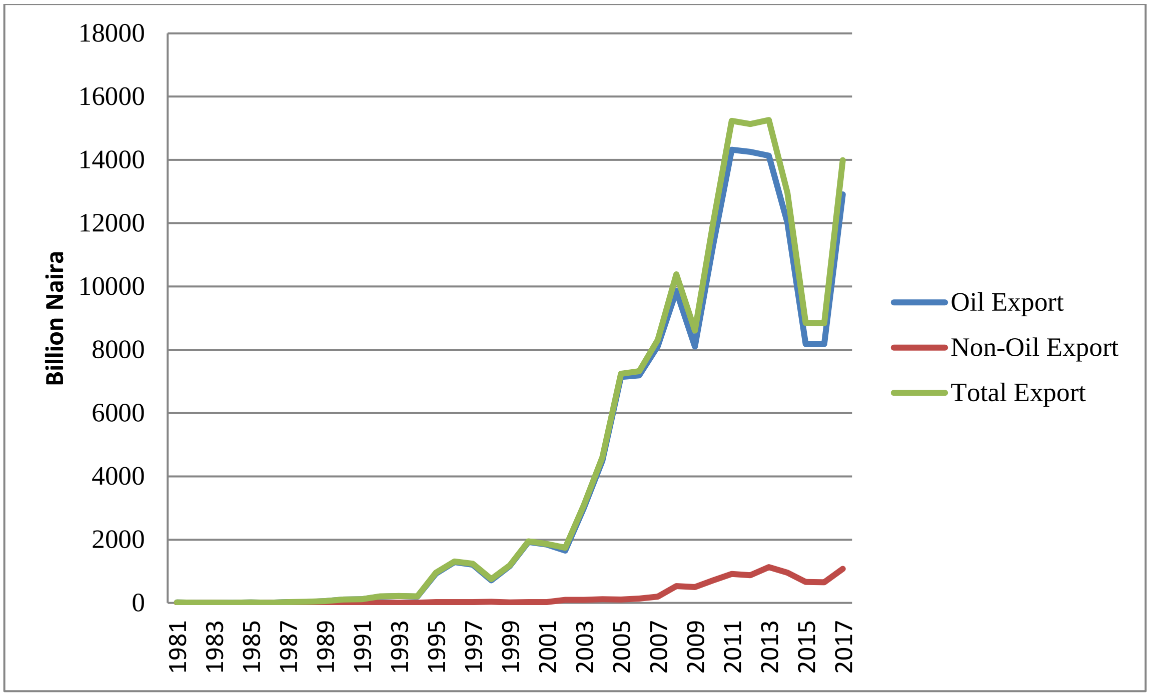


**Figure 2.21: Decomposition of Nigeria's export**

*Source*: CBN database

In addition, Figure 2.22 shows the trend in the total expenditure of Nigeria on imports and its decomposition into oil and non-oil. As evident, import expenditure of Nigeria is dominated by imports of non-oil. As analyzed with Figure 2.20 above, this is comprised mainly of import of manufactured products. Figure 2.22, in addition, shows that expenditure on importation of oil product is increasing very fast; having increased from ₦220.8 billion in 2000 to ₦3064.25 billion in 2012; and from ₦1725.22 billion in 2015 to ₦2615.45 billion in 2017.

The trend in Nigeria's trade balance, decomposed into net export of oil and net export of non-oil is presented in Figure 2.23. The figure shows that trade in oil is continuously in positive trade position, while trade in non-oil is continuously in negative trade position. With total net trade position being positive, it suggests that trade in oil has been financing trade in non-oil successfully. However, a negative trade balance recorded in 2015 and 2016 may not be unattributed to the fall in oil price and consequently revenue from net oil export, as import cannot be adjusted spontaneously. This may explain why CBN excluded 41 items from accessing FX in Nigerian FX market to control importations.

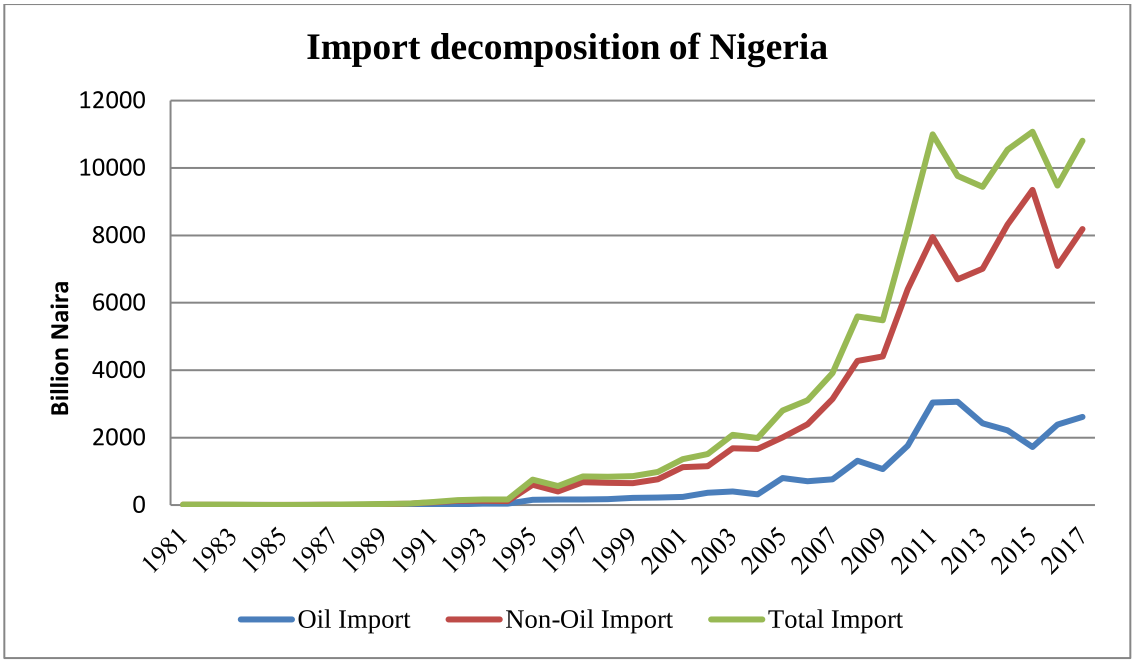


**Figure 2.22: Decomposition of Nigeria's expenditure on import**

*Source*: CBN database

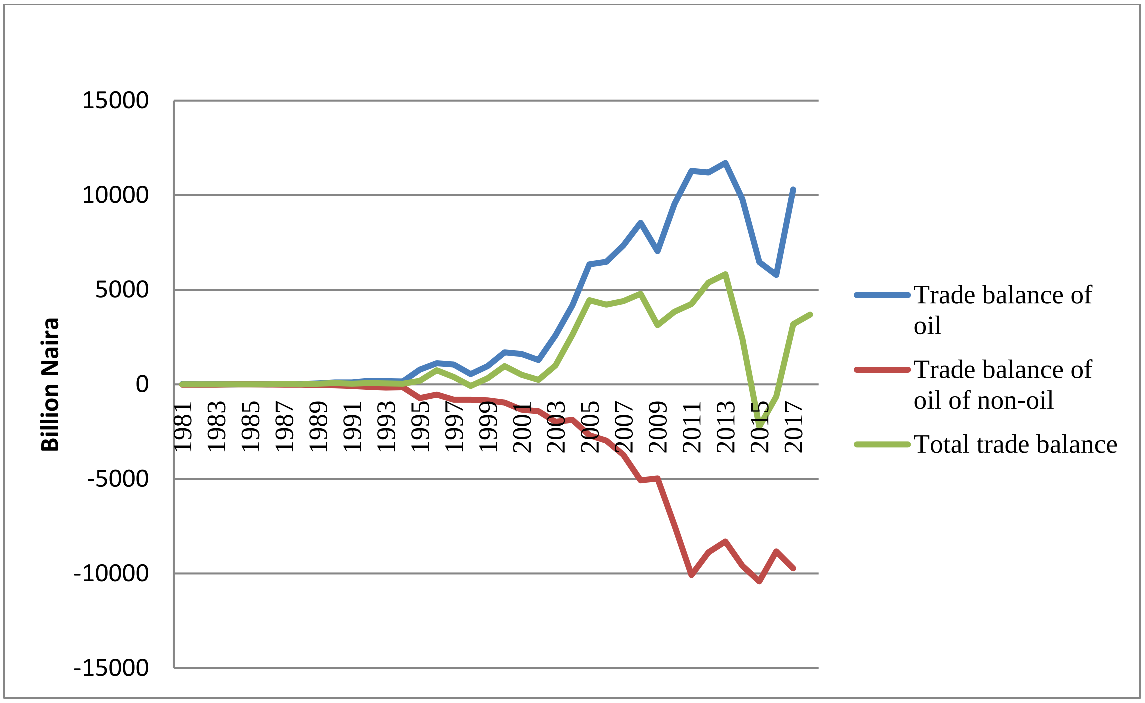


**Figure 2.23: Trends in Nigeria's Trade balance (Net export)**

*Source*: CBN database

### 2.1.2.3 Trend Analysis of the Effect of Oil Price Shocks on the Nigeria economy

The call for economic and export diversification has always been based on the need to mitigate the effect of oil price volatility; which is believed to have distortionary influence on the growth and development of oil dependent economy. In this sub-section, the relationship between oil price and some selected macroeconomic indicators of Nigeria is considered. There are various crude oil prices in the international oil market; such as West Texas Intermediate (WTI), Europe Brent, Dubai fateh, OPEC basket prices, and Nigeria's bonny light price. Even while the prices have very high correlation, we consider bonny light price here, since it is the one quoted by the Nigerian government. The selected macroeconomic indicators are trade balance, external reserves, government revenue and economic growth.

***Oil Price and Trade Balance in Nigeria***

The trend in the relationship between oil price and Nigeria's trade balance is presented in Figure 2.24. The relationship is obviously a positive one. The Nigeria's trade balance is positive for most of the period considered. It was very low before 2003 but appears to respond to rise in crude oil price between 2003 and 2008, making Nigeria's trade balance to increase from ₦1007.65 billion in 2003 to ₦4794.51 billion in 2008. The trade balance also responds to sharp fall in crude oil price during the 2007-2009 Global Financial Crisis (GFC) as it declined to ₦3125.66 billion in 2009. The negative trade balance was recorded in Nigeria between 1981 and 1983 and between 2014 and 2016. These two periods correspond to the period under falling oil price; due to oil gluts of the 1981 and oil price collapse of the 2014. As crude oil price tends to soar up in 2017 through 2018, net trade position has also become positive. This shows the extent of high association of Nigeria's trade position with international crude oil price.

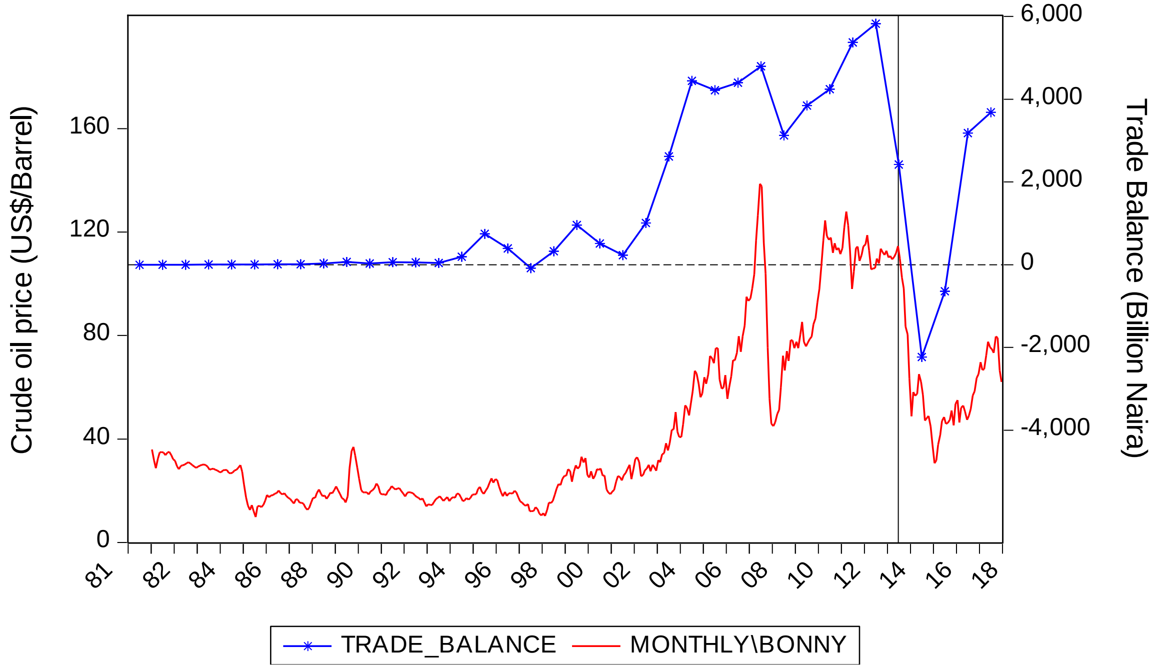


**Figure 2.24: Trends in oil price and trade balance in Nigeria**

*Source*: CBN database

### *Oil Price and External Reserves in Nigeria*

Given that Nigeria trade position has high degree of association with crude oil price, it is not unexpected that accumulation of external reserves will have similar pattern of relationship with crude oil price. This is confirmed in Figure 2.25. Nigeria's external reserves remained fairly stable before 2003, maintaining an average of US$4446.3 million. Between 2003 and 2008 when oil price increased rapidly, external reserves also increased from US$7134.42 million in January 2003 to the historical peak of US$62081.86 million in September 2008. It is also apparent to see that Nigeria external reserves react positively to the 2014 fall in oil price and its rebounding in 2017 to 2018.

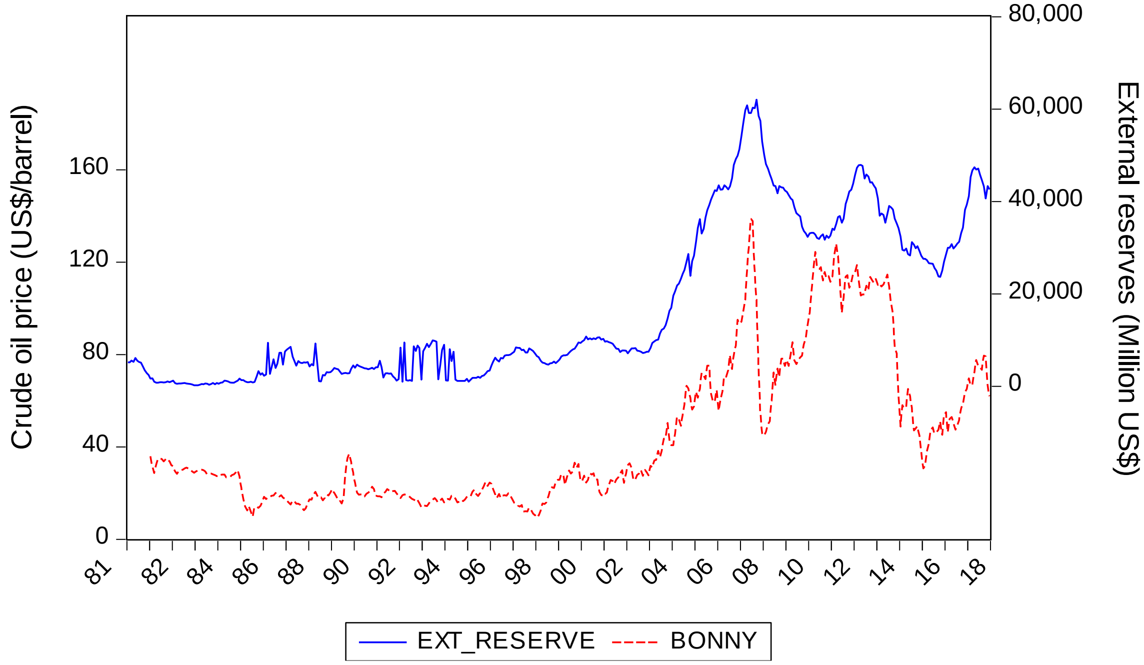


**Figure 2.25: Trends in Oil price and External reserves in Nigeria**

*Source*: CBN database

***Oil Price and Government Revenue in Nigeria***

As noted from Figure 2.19, oil revenue contributes more than 70 percent of Nigeria's total revenue until the recent oil price crash; hence, it is not unexpected that government revenue is affected by swings in crude oil price. This is confirmed in Figure 2.26 below, which shows the trend in the relationship between crude oil price and Nigeria's government revenue. Just like trade balance and external reserves, the relationship between crude oil price and government revenue of Nigeria is almost perfect. It was slow before 2003, rise rapidly between 2003 and 2008, fell between 2008 and 2009, fell between 2014 and 2016, and again in 2017 through 2018, which is the same pattern followed by movements in crude oil price.

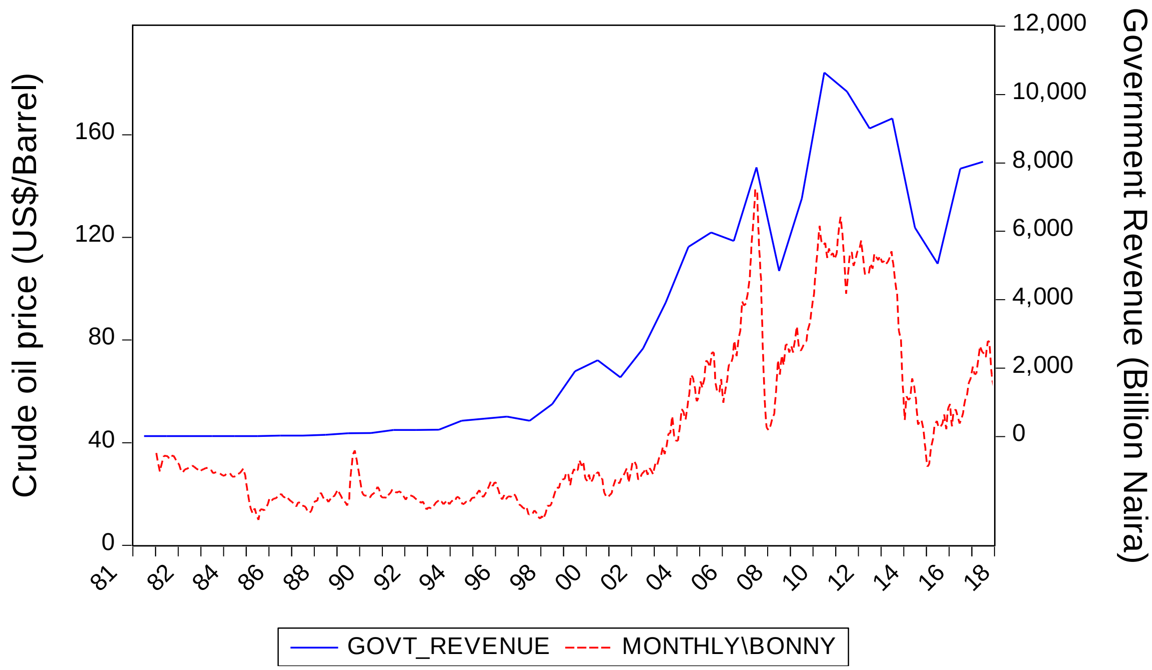


**Figure 2.26: Trends in Oil price and Government revenue in Nigeria**

*Source*: CBN database

***Oil Price and Real GDP growth in Nigeria***

Since Gross Domestic Product (GDP) comprises net trade and government expenditure, it is not unanticipated that changes in oil price will influence Nigeria's economic growth. Figure 2.27 presents the trend in the relationship between crude oil price and real GDP of Nigeria. As evident, Nigeria recorded negative real GDP growth between 1981 and 1983 due to oil glut that caused a fall in oil price. Meanwhile, as opposed to what obtained in the relationship between crude oil price and other economic indicators such as external reserves, trade balance and government revenue, an increase in crude oil price tend to correlate with falling economic growth between 2003 and 2008. Specifically, Nigeria's real GDP fell from 14.6 percent in 2002 to 9.5 percent in 2003 and to 7.2 percent in 2008. This may indicate that some of the revenues realized from increase in crude oil price are not expended on the productive sector of the economy. However, as oil price declined in 2014 through 2016, the growth of the Nigeria's economy slowed and eventually entered recession, and only rebounded after the price of crude oil rebounded in the international oil market. This indicates that there may be asymmetry in the effect of oil price on the real GDP of Nigeria

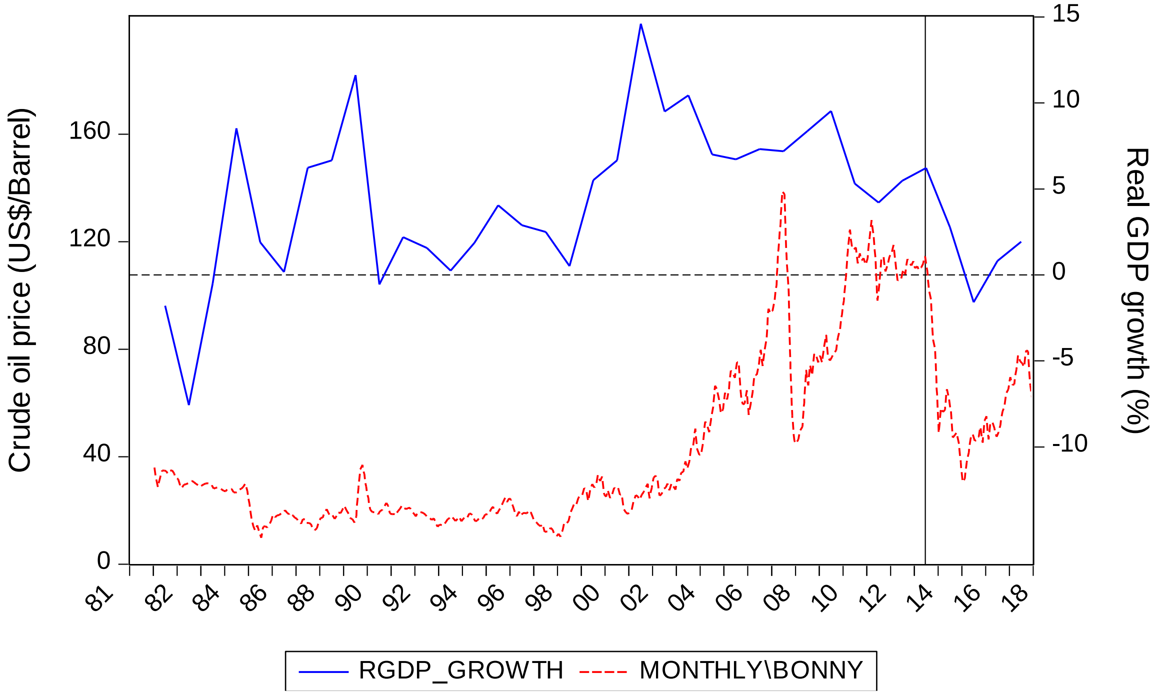


**Figure 2.27: Oil price and real GDP growth in Nigeria**

*Source*: CBN database

### 2.1.3 Oil Export Dependence and Exchange Rate Behaviour in Nigeria

Having discussed oil export dependence and exchange rate behavior of Nigeria separately, the sub-section is prepared to analysis the relationship between the two. Basically, this section discusses the comparative analysis of exchange rate behavior of Nigeria and other oil export dependent countries, the trends in level of oil export dependence and exchange rate behavior in Nigeria, the relationship between the trade sector (oil and non-oil export sector) and FX market in Nigeria, and the recent development in Nigeria for promoting export diversification. These are discussed in turn in the following sub-sections.

#### 2.1.3.1 Exchange rate behaviour in Nigeria and other high oil export dependent countries

The validity of the proposition that the continuous depreciation of Nigerian Naira is due to the country's high level of export dependence is examined by comparing exchange rate behavior of Naira with that of other countries with high oil export dependence, particularly members of OPEC. The flow of exchange rate of 12 members of OPEC from 1980 to 2017 is presented in Figure 2.28 below[9]. The exchange rate of these countries is expressed as local currency units per unit of dollar. The figure shows that Nigerian Naira (NGN) is the fastest depreciating currency. The level of depreciation of Naira is higher than that of Iraqi dinar (IQD), where Iraq is the country with highest level of oil dependence among all oil export dependent countries and among OPEC (see Figures 2.15 and 2.16). The level of depreciation is also higher than that of Angolan Kwanza (AOA), Algerian Dinar (DZD), Kuwaiti Dinar (KWD) and Qatari Rial (QAR), where Angola, Algeria, Kuwait and Qatar are more dependent on oil than Nigeria (see Figure 2.16). The level of depreciation of Naira is also higher than that of countries that have almost the same level of oil export dependence as Nigeria, such as Venezuela, Saudi Arabia and Gabon. This suggests that the cause of the rising rate of Naira depreciation could be attributed to other factors aside from the country's high level of oil export dependence. In other words, there would be other factors that

[9] The list of excludes Iran, which has experienced spiral currency depreciation as a result of frequent wars, and Ecuador, which has dollarized year 2000. It should also be noted that Equatorial Guinea and Gabon use common exchange rate, which CFA franc.

explain changes in Nigeria’s exchange rate better than changes in the country’s level of oil export dependence.

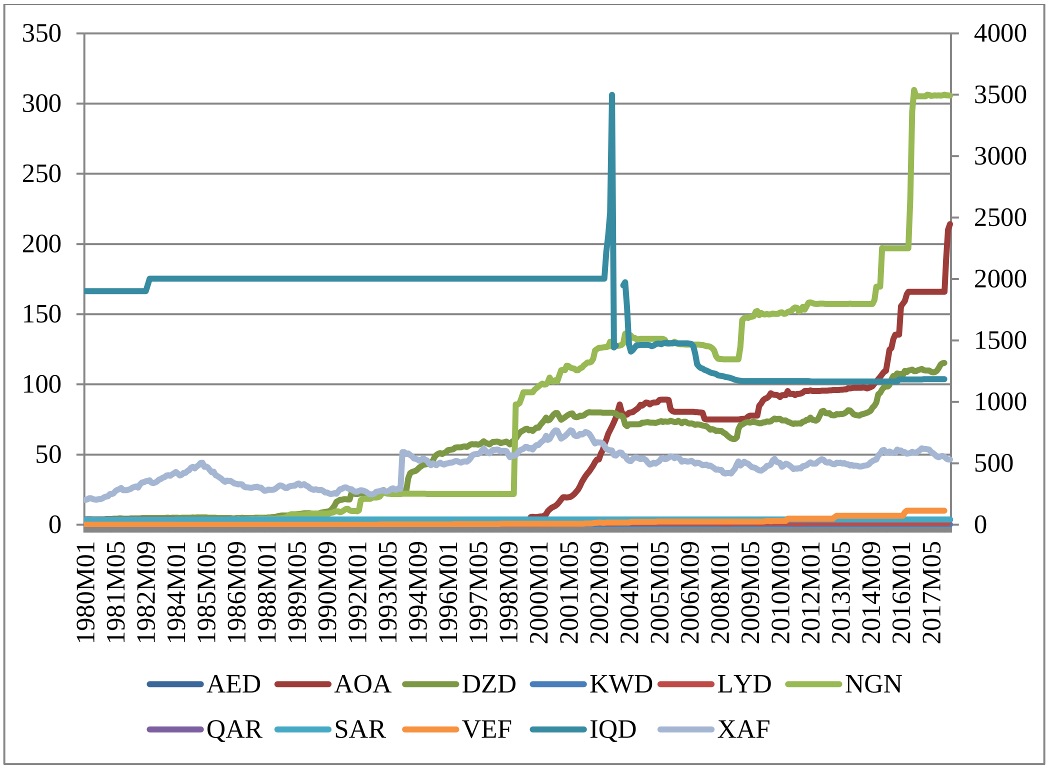


**Figure 2.28: Exchange rate of Nigeria and other OPEC members**

*Source*: International Financial Statistics (IFS) database (IFS, 2019)

Note: AED rep. Arab Emirate Dirham; AOA rep. Angola Kwanza, DZD rep. Algerian Dinar; KWD rep. Kuwaiti Dinar, LYD rep. Libyan Dinar, NGN rep. Nigerian Naira, QAR rep. Qatari Rial; SAR rep. Saudi Arabian Rial; VEF rep. Venezuelan Bolivar; IQD rep. Iraqi Dinar and XAF rep. CFA franc. This is the common currency used by Equatorial Guinea and Gabon among other Francophone West African countries.

Meanwhile, it could also be observed that some of the oil export dependent countries with low rate of depreciation or even currency appreciation adopts fixed exchange rate regime, while those countries that tried any form of floating suffer rising depreciation. Specifically, the current value of Arab Emirate Dirham of AED3.6725/US$ has been maintained since December 1997; the current value of Qatari Rial of QAR3.64/US$ has been maintained since July 1980, and Saudi Arabia has been maintaining Saudi Rial at 3.75/USD since June 1986. Whereas, according the IMF exchange rate regime classification (2016), these three countries, and a host of other countries with high dependence on oil export such as Iraq, Venezeula, Kuwait, Libya, Equatorial Guinea, and Gabon, are practicing conventional peg exchange rate system.

On the other hand, Nigeria has been introducing one form of floating exchange rate system or the other since the introduction of foreign exchange market liberalization in 1986. Thus, According to IMF (2016), Nigeria is classified as using stabilized exchange rate arrangement having changed from other managed arrangement in 2015. Countries with more floating arrangement include Iran, considered to be practicing crawl-like arrangement, and Angola and Algeria, considered practicing other managed arrangement. It is quite noticeable that these four countries are having rising rate of currency depreciation. Save Iran, whose alarming rate of depreciation of Iranian Rial depreciation may be attributed to political unrest in the country, Nigeria Naira is leading with higher rate of depreciation among countries practicing variants of flexible exchange rate regime. Particularly, Nigerian Naira has depreciated from ₦1/US$ in January 1986 to ₦305.7/USD in March 2018. Angolan Kwanza has depreciated from 1 Kwanza/US$ in May 1995 to 214.14 Kwanza/US$ in March 2018, and Algerian Dinar (DZD) has depreciated from 5 Dinar/USD in August 1984 to 115.2 Dinar/USD in December 2017 (see Figure 2.28).

### 2.1.3.2 Trends in Level of Oil Export Dependence and Exchange Rate Behaviour in Nigeria

The behaviour of exchange rate of a country has multi-dimensional economic implications for the residents of the country and foreigners engaging in international transactions with the country or its residents. The welfare of the residents of the country is affected by changes (appreciation or depreciation) in NER. Nominal exchange rate depreciation makes imports more expensive, thus causing increase in general price level and reduction in the welfare of people. For foreigners engaging in international activities such as portfolio investment in the country, NER depreciation will cause loss of investment values on local currency denominated assets, thus discouraging inflow of foreign investments. While exchange rate depreciation also makes export cheaper, it benefits the citizens only where majority are working in the tradable sector. Unlike the NER however, depreciation of RER indicates that domestic goods are relatively cheaper than foreign goods. This will be expected to increase income and welfare of citizens and increase trade competitiveness of the country.

Evidence from the analysis of the Nigerian exchange rate vis-à-vis exchange rate of other high oil export dependent countries suggests that the problem of persistent Naira depreciation cannot only be attributed to the nature of country's dependence on oil export. It also pointed that the problem may be due to adopted exchange rate regime. Barring this argument, this sub-section examines the relationship between changes in level of oil export dependence and changes in exchange rate in Nigeria. This analysis is considered by reviewing historical changes in Nigeria's level of oil export dependence vis-à-vis the nominal and real exchange rates of the Nigerian Naira per US dollar.

The relationship between the oil export dependence and NER in Nigeria between 1960 and 2018 is presented in Figure 2.29, while the relationship between oil export dependence and RER over the same period is presented in Figure 2.30. These figures are partitioned into eight (8) quadrants based on the historical episodes of Nigeria's level of oil export dependence and exchange rate behavior. Under Figure 2.29, quadrant A shows that NER was constant between 1960 and 1969 when Nigeria earned more foreign income from non-oil export than from oil export and Nigeria's level of oil export dependence was less than 50 percent. As evident in Figure 2.30, RER was fairly stable during this period.

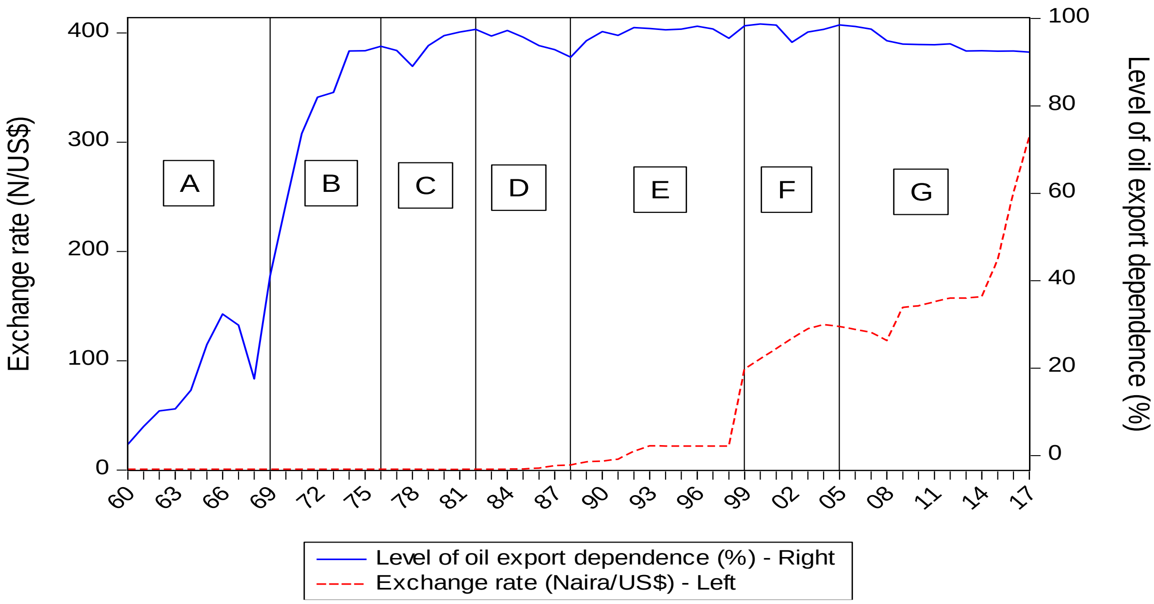


**Figure 2.29: Trend in Nigeria's oil export dependence and nominal exchange rate**

*Source*: CBN database, computation by author

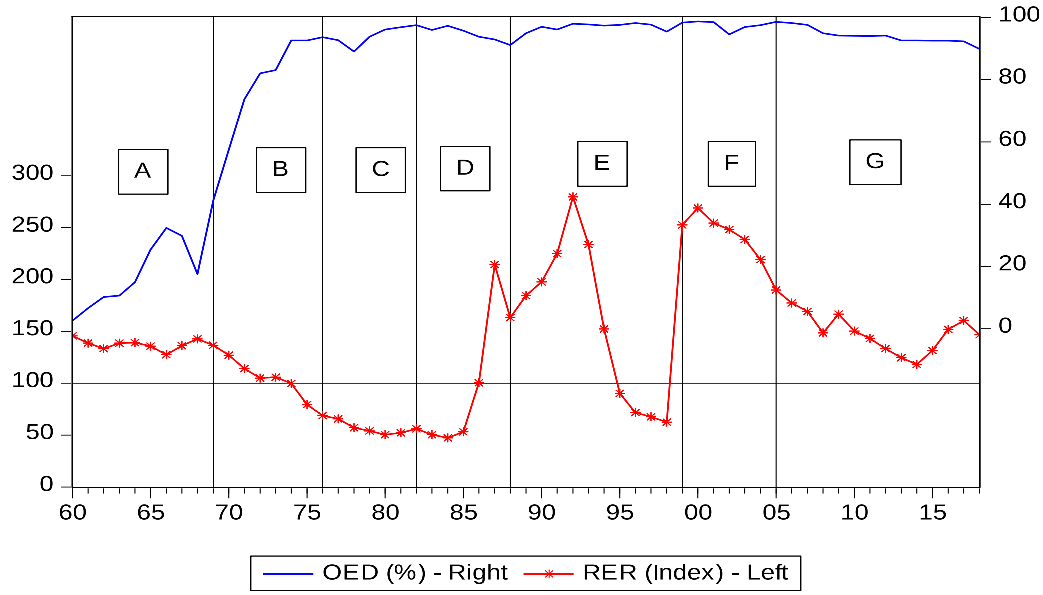


**Figure 2.30: Trend in Nigeria's oil export dependence and real exchange rate**

*Source*: CBN database, computation by author

Under quadrants B and C, Nigeria's level of oil export dependence increased rapidly from 57.5 percent in 1970 to remain at 97.5 percent in 1982. During this period, government established Nigerian Export Promotion Council (NEPC) in 1976; this may be accountable for the fall in level of oil export dependence from 93.6 percent in 1976 to 89.07 percent in 1978. The effect of NEPC however, appears to be transient as level of oil export dependence increased steadily after 1978 to remain at 97.5 percent in 1982. Thus, as level of oil export dependence increased rapidly during this period, Nigeria NER appreciated from ₦0.7143/US$ in 1970 to ₦0.6734/US$ in 1982. Similarly, RER also appreciated from 127 basis points in 1970 to 56 basis points in 1982. This suggests that Nigeria's level of trade competitiveness reduced as Nigeria's level of oil export dependence increased.

Under quadrant D, there was a fall in the level of oil export dependence from 97.5 in 1982 to 91.2 percent in 1988. The fall in Nigeria's level of oil export dependence during this period may be attributed to both oil-export and non-oil export factors. On the part of oil-export factors, there was oil glut in the early 1980s, which reduced earnings from oil export and consequently led to reduction in level of oil export dependence. On the part of non-oil export factors, government introduced non-oil export promotion policies in conjunction with the Structural Adjustment Programme (SAP) in 1986. Among these policies are the incentives to non-oil export producers embedded in the Export Incentives and Miscellaneous Provisions Act of the 1986. Notably, exchange rate depreciated sharply from ₦0.67/USD in 1982 to ₦4.54/USD in 1988. This suggests that fall in level of oil export dependence could cause NER depreciation. However, RER increased from 56 points in 1982 to 163 points in 1988. This suggests that export diversification could stir RER depreciation and enhance trade competitiveness of oil dependent countries.

Meanwhile, under quadrant E and F (1989-2004), there was sustained high level of oil export dependence on the average of 97.1 percent. Some export diversification efforts were also undertaken between 1988 and 1999. These include the establishment of the Nigerian Export –Import Bank (NEXIM) by Act 38 of 1991 and Nigeria Export Processing Zone Authority (NEPZA) by the Nigeria Export Processing Zones Act 63 of 1992. The effectiveness of these institutions appears limited as Nigeria's level of oil export dependence only fell slightly from 97 percent in 1990 to 96.1 percent in 1991 and surprisingly rose to 97.9 percent in 1992 to remain at 98.36 percent in 1999.

After 1999 when civilian government took over in Nigeria, several efforts were also made to reduce the country's level of oil export dependence. However, these efforts were directed at strengthening the existing institutions rather than creating new ones. In effect, Nigeria became the largest producer of cassava in the World in 2003; producing about 34 million metric tons a year (see Fwatshak, 2008). Meanwhile, as evident from the graph, the efforts of the civilian government had no notable impact on the non-oil export performance until after 2004. Evidently, Naira exchange rate depreciated from ₦7.36/USD in 1989 to ₦132.88/USD in 2004. This suggests that keeping a high level of oil export dependence could cause exchange rate to depreciate at a very high rate. As for RER, its volatility increased due to the fixed exchange rate regime operated between 1994 and 1998. However, it was on a falling trend from the beginning of the civilian administration in 1999 till 2014.

Lastly, between 2015 and 2018, government and in conjunction with the Central Bank of Nigeria introduced economic/export diversification policies including the Anchor Borrower's Programme and Non-Oil Export Stimulation Facility (NESF). Accordingly, Nigeria's level of oil export dependence declined from 96.64 percent in 2014 to 89.88 percent in 2018. Despite the fall in OED, NER depreciated from ₦158.55/US$ in 2014 to ₦306.08/US$ in 2018, but RER increased (depreciated) from 118.06 points in 2014 to 146.78 points in 2018. This suggests that lower oil export dependence may increase nominal and RER depreciation. Meanwhile, monetary authority may, nonetheless, be interested in pursuing export diversification policy, if it is interested in growth sustainability rather than exchange rate stability.

#### 2.1.3.3 Institutional Framework on External Trade and FX Market Structure in Nigeria

As earlier discussions suggest the possibility of positive and negative relationship between level of oil export dependence and exchange rate behaviour, it may be helpful to provide information about the institutional framework on external trade and FX market structure in Nigeria to enhance better understanding of the nature of the relationship.

The institutional framework is summarized in Figure 2.31. The Nigerian foreign exchange market is a regulated market; hence, it produced both effective rate and market determined rate. The effective rate is a predetermined rate by the monetary authorities at which exchange rate must sell. It is usually defined with premium band (say +/- 3%, for example) under managed floating regime as in the case of Nigeria. There is also a market determined rate, which may be equal, higher or lower than the effective rate. Where the market determined rate equals the effective rate, no intervention is required by the monetary authority, CBN. Where market determined rate is higher than the effective rate, CBN would be required to sell foreign currency/buy domestic currency in the FX market to ensure effective rate is maintained. If this action is not taken, more domestic currency will be chasing the few available foreign currencies; hence domestic currency will depreciate against foreign currency. This is the common case in the Nigeria FX market. The third situation scarcely happen, and is where market determined rate is lower than the effective rate. The CBN would be required to purchase foreign currency/sell domestic currency in the FX market to ensure effective rate is maintained. If this action is not taken, less domestic currency will be available for largely available foreign currencies; hence, domestic currency will appreciate against foreign currency.

Based on the nature of the Nigeria FX market, the monetary authority, CBN is a major player in the market. The CBN operates as the regulator as well as the buyer/seller of last resort. Being buyer/seller of last resort implies that the CBN buys/sells whatever amount of foreign currency requires for the market to clear. The other player in the market is the private exporters. In this framework, the CBN is joined with the National Petroleum Cooperation (NNPC) as they both manage the foreign exchange earned by the country from exportation of oil. On the other hand, Private exporters consist mainly of traders in non-oil goods. Other private sector players such as investors and speculators also fall in this group.

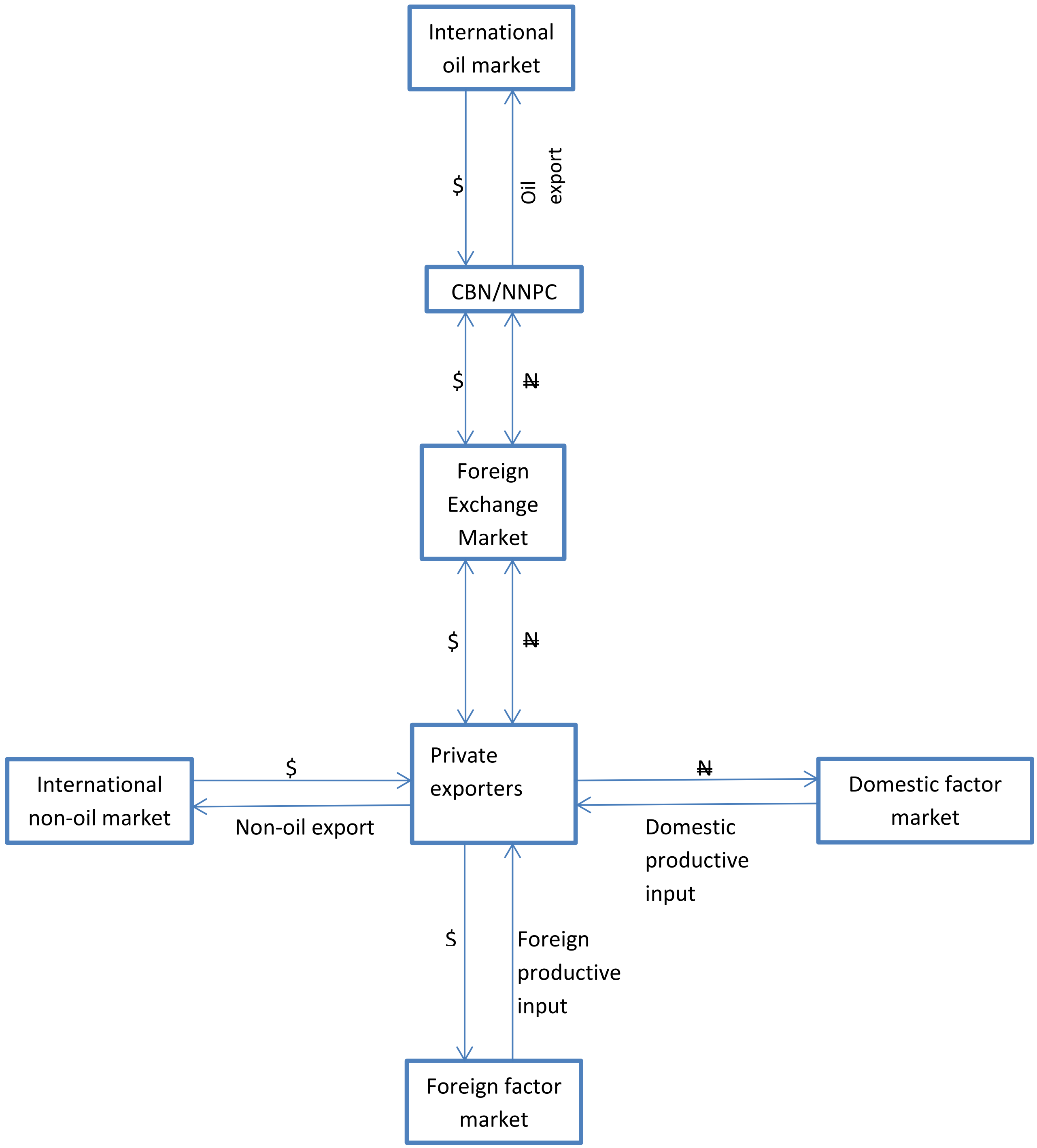


**Figure 2.31: Institutional framework on foreign trade and FX market in Nigeria**

*Source*: Author's presentation

The CBN/NNPC gets foreign exchange ($) from the international oil market after it supplies crude oil to the market. The CBN is the custodian of the national foreign reserves and the largest supplier of foreign exchange to the Nigeria FX market; supplying more than 80% of the forex. Due to its function as the buyer/seller of last resort in the FX market, CBN supplies and demands foreign currency as well as Naira in the FX market. The total CBN foreign currency supplied to the Nigeria FX market between January 2008 and September 2018 is presented in Figure 2.32. It comprises of CBN FX sales through the WDAS/RDAS, Interbank FWD, BDC and Interbank windows. The CBN supplies an average of US$2,977 million between 2008 and 2009, US$2,973.34 million between 2010 and 2011, US$2,615.93 million between 2012 and 2013. The average supply of FX by the CBN increased to US$3,391.2 million between 2014 and 2015, it however fell to US$1,551 million between 2016 and 2017 due to fall in crude oil price and eventually fall in FX inflow. In 2018, the average FX sale of the CBN in the FX market has increased to US$3,046.78 million as crude oil price rebounds.

Like the CBN, private exporters also supply and demand foreign currency and Naira in the FX market. More importantly, private investors that benefitted from the subsidized exchange rate supplied in the official FX market are required by the CBN to repatriate FX earned into the FX market[10]. The demand and supply of domestic and foreign currencies by private exporters in the FX market can be explained from its dealing with three distinct markets; the domestic factor market, foreign factor market, and international non-oil market. Private exporters obtain FX ($) from the international non-oil market as the payment for its supplies of non-oil goods to the market. Part of the dollars obtained is spent in the foreign factor market in payment for importing foreign productive inputs. The remaining part is supplied to the FX market to exchange it for domestic currency equivalent, which will eventually to be used to make payment for the domestic productive inputs obtained from the domestic factor market.

[10] See the memo issued by the CBN in January 2021, titled "NON-REPATRIATION OF EXPORT PROCEEDS BY EXPORTERS".

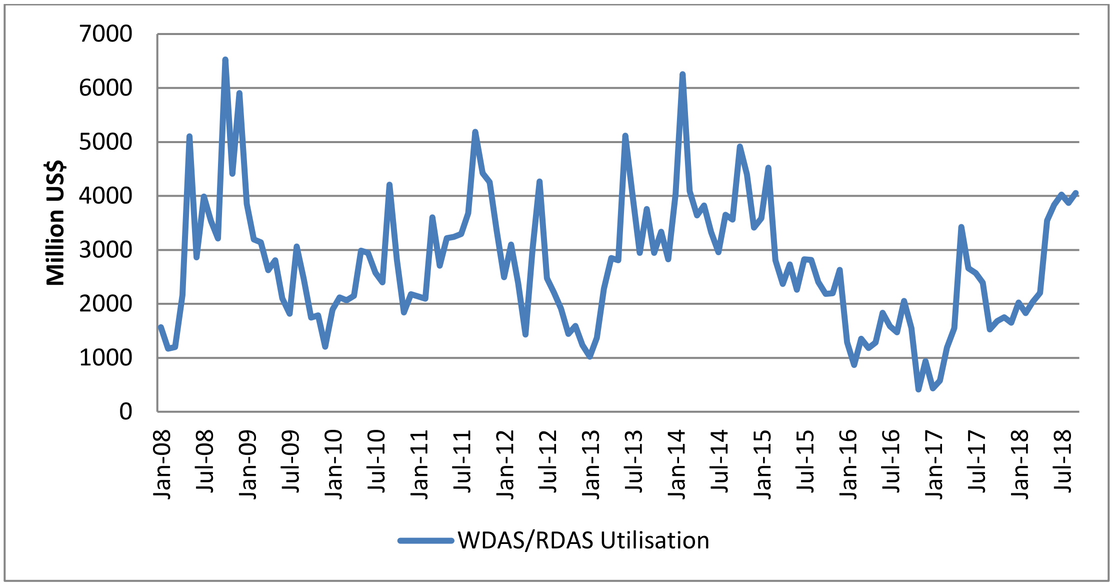


**Figure 2.32: CBN foreign currency supply to the Nigeria foreign exchange market**

*Source*: CBN Statistical bulletin (2018Q3)

Figures 2.33 and 2.34 show the amounts of foreign currencies utilized by the non-oil sector in settling import bills on purchases from foreign factor market. The demand for foreign currency is largely induced from the industrial and manufacturing sector, both of which consume more than 70 percent of the total foreign currencies available in the foreign exchange market (see Figure 2.32). As evident from the figures 2.33 and 2.34, industrial sector is the largest consumer of forex in Nigeria. As noted from Figure 2.34, industrial sector utilized US$879.37 million in 2008, US$628.97 million in 2012, US$671.71 million in 2015 and US$596.98 million in 2018. The manufacturing sector, on the other hand, utilized US$567.53 million in 2008, US$388.79 million in 2012, US$331.12 million in 2015 and US$296.20 million in 2018. Agricultural and Mineral resources sectors are among the least consumers of foreign exchange.

Specifically, Mineral resources sector was the least consumer of foreign exchange between 2008 and 2010, with the average forex utilization of US$17.70 million per month, while Agricultural sector followed with the average of US$26.63 million during this period. Agricultural sector is the least consumer of foreign exchange between 2011 and 2013, with average FX utilization of US$24.74 million, while Mineral resource sector followed with the average FX utilization of US$59.73 million per month. Between 2016 and 2018, Mineral resources sector is the least consumer of FX, with the average forex utilization of US$8.63 million per month, while Agricultural sector followed with the average of US$23.98 million per month.

However, while agricultural sector demands less of FX (less than 2% between 2008 and 2018, see Figure 2.33), FX utilization on import of food products is fairly high; accounting for the average of 20.36% of total FX utilized on imports between 2008 and 2018 (see Figure 2.33). Thus, we may conclude that the FX utilization of agricultural sector is about 22 percent of total FX utilized by the non-oil sector if FX utilization for food products is considered as part of FX utilized in the agricultural sector. Table 2.3 presents the monthly average of sectoral utilization forex between 2008 and 2018, with food products added to agricultural sector. Evidently, Industrial sector remains the largest consumer of FX in the non-oil sector, while Mineral sector is unarguably the least FX consuming sector. The Manufacturing sector usually comes second in the order of FX utilization by non-oil sector.

This position was however lost to Foods products and Agricultural sector between 2011 and 2014 (see Table 2.3).

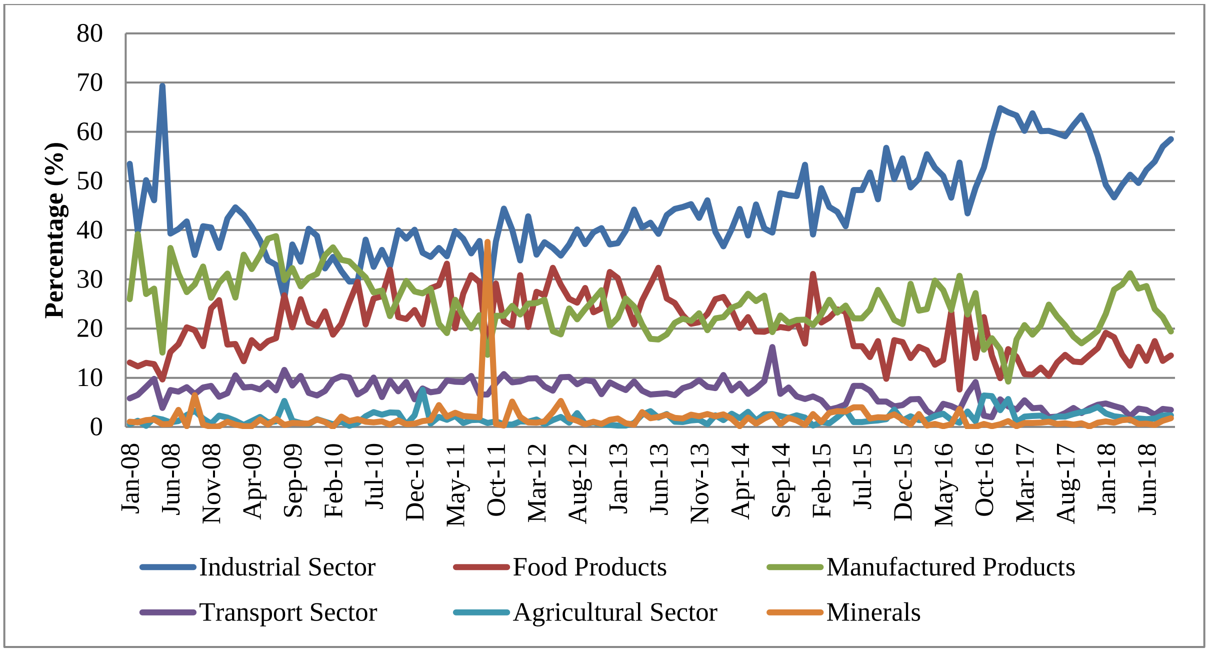


**Figure 2.33: Sectoral contribution to FX utilization for imports**

*Source*: CBN Statistical Bulletin (2018)

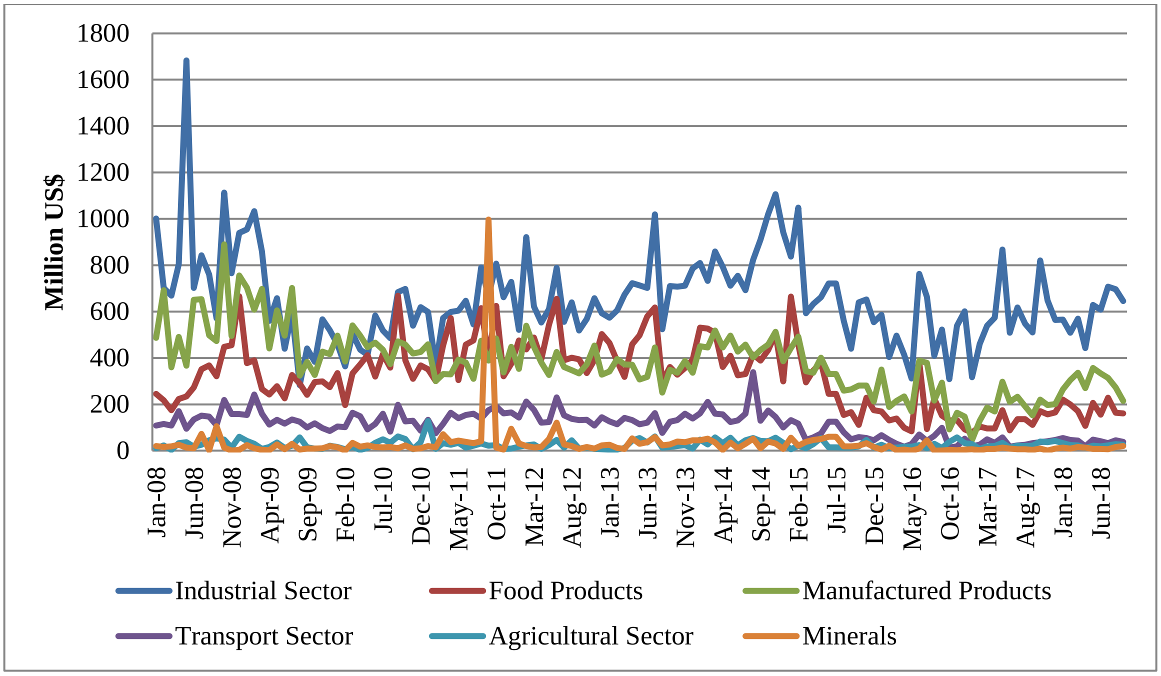


**Figure 2.34: Foreign exchange utilization by sector**

*Source*: CBN Statistical Bulletin (2018)

**Table 2.3: Sectoral FX utilization on imports (2008 - 2018)**

| Period | Industrial Sector (‘Million US$) | Manufactured Products (‘Million US$) | Transport Sector (‘Million US$) | Minerals (‘Million US$) | Food products & Agricultural Sector (‘Million US$) |
|---|---|---|---|---|---|
| 2008 | 879.38 | 567.53 | 139.34 | 25.18 | 361.54 |
| 2009 | 607.65 | 510.56 | 131.42 | 12.90 | 314.95 |
| 2010 | 525.19 | 450.87 | 125.38 | 15.31 | 400.10 |
| 2011 | 632.24 | 385.90 | 147.38 | 117.02 | 466.94 |
| 2012 | 628.97 | 388.79 | 150.96 | 29.54 | 470.53 |
| 2013 | 703.95 | 350.71 | 128.25 | 32.63 | 446.12 |
| 2014 | 846.28 | 452.80 | 165.70 | 29.06 | 462.10 |
| 2015 | 671.71 | 331.12 | 80.15 | 36.57 | 309.89 |
| 2016 | 501.34 | 236.14 | 45.45 | 8.19 | 176.01 |
| 2017 | 581.01 | 185.86 | 33.90 | 6.58 | 150.68 |
| 2018 | 617.03 | 273.54 | 40.87 | 10.57 | 202.27 |

Source: CBN bulletin (2018)

In the case of a free floating exchange rate regime, the forces of demand and supply of FX by the sole activities of operators in the non-oil sector (private exporters, investors and speculators) would clear the FX market. Given the case of managed floating regime in Nigeria, the market will not clear unless with the intervention of the central bank. The problem of export base bias against the private sector further necessitates the presence of CBN in the FX market. Export base bias against the private sector in Nigeria comes in form of weak non-oil export against very strong oil export. This, in effect, results to weak FX supply tendency by the private exporters. The fact that large percentage of inputs, in terms of machineries, equipment, fertilizers and even raw materials, used in the production of non-oil exports are imported from the foreign factor market also made FX demand tendency by the private exporters to be very strong. This will even be stronger if the private exporters decide to play as speculators by hoarding the forex realized from trading in the international non-oil market and demanding more from the FX market, as they are sure of the CBN supply.

Government's effort at reducing level of oil export dependency is aimed at boosting the private exporters' FX supply tendency and reducing their FX demand tendency. For example, if government procures foreign productive inputs used by private exporters and hire it to them at subsidized domestic price; their demand for foreign currency will reduce. This is expected to reduce depreciation pressure on the domestic currency. More so, if government facilitates increase in non-oil output and the access for these outputs to the international non-oil market through its various trade and developmental policies, more forex will be accrued to the private exporters. However, while we can be sure that more forex to private exporters will reduce their FX demand, we can be unsure as to whether this will motivate them to increase forex supply to the FX market. This is possible as the private exporters could decide to act as speculators in the FX market by hoarding their foreign currencies and secure domestic currencies (to be used in payment for goods/services from domestic factor market) from the money market. Meanwhile, without increased FX supply by private exporters to the FX market, lower oil export dependence cannot be seen as causing exchange rate appreciation. Thus, existence of a positive relationship between oil export dependence and exchange rate in Nigeria is doubtful.

#### 2.1.3.4 Recent Development in Nigeria for Promoting Export Diversification

The consequence of the 2014-2016 oil price shock appears to have prompted a renewed call for reduction in the level of oil export dependence in Nigeria. Particularly, as the price of oil fell sharply from $105.79/barrel in June 2014 to $32/barrel in January 2016, inflation rate rose from 8.2 percent in June 2014 to 18.55 percent in December 2016 and economic growth fell from 6.5 percent in 2014Q2 to -2.2 percent in 2016Q3; dragging the economy into recession. Since the level of oil export dependence was as high as about 92.5 percent during this period, it is not surprising that the Nigeria's external reserves fell steadily from $39.065 billion in July 2014 to as low as $23.689 billion in October 2016. This fall in external reserves unambiguously affected the exchange rate behaviour, as the Nigerian exchange rate depreciated by 59.88 percent, from ₦158.55/USD in 2014 to ₦253.49/USD in 2016.

To reduce the effect of oil price shocks and put the Nigerian economy on a sustainable path, Nigerian government has decided to boost the non-oil export sector of the economy. This intention of government was contained in its medium-term development plan, namely; Economic Recovery and Growth Plan, ERGP: 2017-2020. One of the working instruments proposed in the plan was to increase Nigeria's level of oil export diversification from 7.5 percent to 15 percent; or in contrast, to lower level of oil export dependence from 92.5 percent in 2017 to 85 percent by 2020. In pursuing this objective export diversification and lower oil export dependence, federal government has worked in collaboration with the Central Bank of Nigeria (CBN) in ensuring successful implementation of the two main relevant programmes: (i) Anchor Borrowers' Programme (ABP) and (ii) the Non-oil Export Stimulation Fund (NESF). These are discussed in turn as below.

***Anchor Borrowers' Programme (ABP)***

The Anchor Borrowers' Programme (ABP) was introduced by the Central Bank of Nigeria (CBN) in line with its developmental function. The Programme was launched by President Muhammadu Buhari (GCFR) on November 17, 2015 with the aim of creating a linkage between anchor companies involved in the processing of agricultural commodities and the small holder farmers (SHFs).

The programme, which evolved from the consultations with stakeholders comprising Federal Ministry of Agriculture & Rural Development, State Governors, millers of agricultural produce, and smallholder farmers, was designed *to boost agricultural production and non-oil exports in the face of unpredictable crude oil prices and its resultant effect on the revenue profile of Nigeria*. According to the CBN (2016a), the thrust of the ABP is to provide farm inputs in kind and cash to small holder farmers to boost the production of agricultural commodities, stabilize inputs supply to agro processors and address the country's negative balance of payments on food.

By definition, anchor refers to private large-scale integrated processors of agricultural commodities who have entered into an agreement with the SHFs to off-take the harvested produce at the agreed prices or as may be reviewed by the Project Management Team (PMT). The small holder farmers, on the other hand, are defined as farmers in groups/cooperative(s) of between 5 and 20 that engage in the production of identified commodities in Nigeria. The targeted products are the commodities defined as having comparative advantage to the country. These include but not limited to:

- Cereals (Rice, Maize, wheat etc.)
- Cotton
- Roots and Tubers (Cassava, Potatoes, Yam, Ginger etc.)
- Sugarcane
- Tree crops (Oil palm, Cocoa, Rubber etc.)
- Legumes (Soybean, Sesame seed, Cowpea etc.)
- Tomato
- Livestock (Fish, Poultry, Ruminants etc.)
- Any other commodity that will be introduced by the CBN from time to time.

As noted from the CBN (2016a), the fund for ABP is provided from the ₦220 billion Micro, Small and Medium Enterprises Development Fund (MSMEDF). The loan amount for each SHF is determined from the economics of production agreed with stakeholders, and is disbursed through eligible participating financial institutions (PFIs) such as:

- Deposit Money Banks (DMBs)
- Development Finance Institutions (DFIs)
- Microfinance Banks (MFBs)

The interest rate under the ABP is guided by the rate on the ₦220 billion MSMEDF, which is currently at 9% p.a (all inclusive, pre and post disbursement). The PFIs would access loan at 2% from the CBN and lend at a maximum of 9% p.a. The tenor of loans under the ABP is determined as the gestation period of the identified commodities. Loans granted to the SHFs would usually be repaid with the harvested produce that shall be mandatorily delivered to the Anchor at designated collection center in line with the provisions of the Agreement signed. The produce to be delivered is expected to cover the loan principal and interest. The collateral to be pledged by SHFs under the programme includes:

- Cross and several guarantee by farmers in cooperatives
- Tripartite Agreement signed by the parties
- Cross and several guarantee by farmers in cooperatives registered on the National Collateral Registry (NCR)
- Equity Contribution (minimum of 5%) by the farmers

***Non-Oil Export Stimulation Facility (NESF)***

The second notable programme on export diversification is the Non-Oil Export Stimulation Facility (NESF). The NESF was initially launched in June 2016 by the CBN, but was repackaged and re-launched in December 2017. This facility is essentially constituted *to diversify the economy away from oil and to expedite the growth and development of the non-oil export sector* (CBN, 2016b). This is necessary to mitigate the effect of a fall in global prices of crude oil that usually triggers a reduction in Nigeria's revenue and FX earnings. The facility is basically structured to redress the falling export credit and reposition the sector for the purpose of increasing the sector's contribution to revenue generation and economic development. It is expected to increase export financing, access of exporters to low interest credit and offer additional opportunities for them to upscale their businesses and improve their trade competiveness.

To implement the Facility, CBN invests ₦500 billion debentures, to be issued by Nigerian Export-Import Bank (NEXIM) in line with section 31 of CBN Act.

Basically, the Facility has the objectives to:

- Improve access of exporters to concessionary finance to expand and diversify the non-oil export baskets;
- Attract new investments and encourage re-investments in value-added non-oil exports production and non-traditional exports;
- Shore up non-oil export sector productivity and create more jobs;
- Support export oriented companies to upscale and expand their export operations as well as capabilities;
- Diversify and increase the level of contribution of non-oil exports revenue towards sustainable economic development; and
- Broaden the scope of export financing instruments.

The Non-Oil Export Stimulation Facility (ESF) is managed by the Nigerian Export – Import Bank (NEXIM). This is the institution responsible for the day-to-day administration of the Facility and rendition of periodic reports on the performance of ESF to CBN. To access the facility, a participating financial institution (PFI) will submit request to NEXIM on its behalf or on behalf of other parties in the prescribed format. The application will be processed by NEXIM within 20 working days of receipt, and all appraised applications by NEXIM shall be forwarded to the Central Bank of Nigeria for consideration and approval.

Only export-oriented enterprises shall be eligible under the NESF, such enterprises include:

- A company duly incorporated in Nigeria under Companies and Allied Matters Act (CAMA).
- An Enterprise with verifiable export off-take contract(s).
- An Enterprise with satisfactory credit reports from at least two Credit Bureaus in line with the provisions of CBN Circular BSD/DIR/GEN/CIR/04/014 dated April 30, 2010.

- Eligible Bank Asset (EBA) purchased by Asset Management Corporation of Nigeria (AMCON), that may by special approval of the CBN Management, be allowed to participate with respect to acquired projects of national economic importance, proven potentials to export, good prospects to attract new investors and ability to repay EBA obligations to AMCON.

The eligible transactions for funding under the NESF include:

i. Export of goods wholly or partly processed or manufactured in Nigeria;
ii. Export of commodities and services, which are permissible and excluded under existing export prohibition list;
iii. Imports of plant & machinery, spare parts and packaging materials, required for export-oriented production that cannot be produced locally;
iv. Export value chain support services such as transportation, warehousing and quality assurance infrastructure.
v. Resuscitation, expansion, modernization and technology upgrade of non-oil exports industries and;
vi. Stocking Facility/Working capital;

The Participating Financial Institutions (PFIs) eligible to participate under the Facility are:

i. Deposit Money Banks
ii. Development Finance Institutions (DFIs) except NEXIM.

The NESF stipulated a tenor of up to 10 years, not exceeding 28th of December, 2025. The lending limit allowed under the facility is not in excess of 70% of the total cost of the project or transaction subject to a maximum of Five Billion Naira. The repayments of principal components of loans and interest are expected to be made quarterly. The moratorium is project specific and for maximum period of two (2) years, unless in the case of construction where additional moratorium of up to twelve [12] months may be allowed upon additional fee of 0.25% per annum of the loan amount. The procedure for monitoring and evaluation of projects, penalty for defaults and the role and responsibilities of various stakeholders such as the Central Bank of Nigeria (CBN), Nigerian Export – Import Bank (NEXIM) and the Participating Financial Institutions (PFIs) are well detailed in the Non-Oil Export Stimulation Facility (ESF) Guideline published by the CBN (see CBN, 2016b).

### 2.1.4 Trends in Non-Oil Export Performance in Nigeria

The performance of non-oil export, measured as the revenue from non-oil export, is presented in Figure 2.35. The value of Nigerian non-oil export was less than ₦1billion between 1960 and 1986 with the highest value being ₦670 million recorded in 1979. The sharp rise in non-oil export performance in 1979 may be attributed to some measures introduced by the then military government. These measures include Operation Feed the Nation (OFN) introduced in 1976; Agricultural Credit Guarantee Scheme (ACGS) introduced in 1978 and Land use Decree introduced in 1978.

Between 1986 and 1987, the value of non-oil export increased massively by 290 percent from ₦552.1 million in 1986 to ₦2,152 million in 1987. The sudden rise in non-oil export performance may not be unrelated with the introduction of Structural Adjustment Programme (SAP) in 1986. The main objective of SAP is to restructure and diversify the economy, particularly as the occurrence of oil glut in the 1980s pressurized inflow of foreign currencies to the economy. As the SAP effect continues, the performance of the non-oil export sector improved steadily between 1987 and 1994, making the value of Nigeria's non-oil export to increase from ₦2,152 million in 1987 to ₦5,349 million in 1994.

Between 1994 and 1998, revenue from non-oil export increased massively from ₦5,349 million to ₦34,070.2 million in 1998. This relates to the era of pegged exchange rate. The relative increase in non-oil export performance during this period may be attributed to exchange rate stability during the period. As the military handed over to civilian administration in 1999, non-oil export performance increased rapidly. As shown in Figure 2.35, the value of non-oil export increased from ₦19,492.9 million in 1999, and rise steadily to become ₦1,130,170.52 million in 2013. Three successive government administrations ruled during this period, and the consistent increase in the value the non-oil export shows that government policies on non-oil export promotion are consistent.

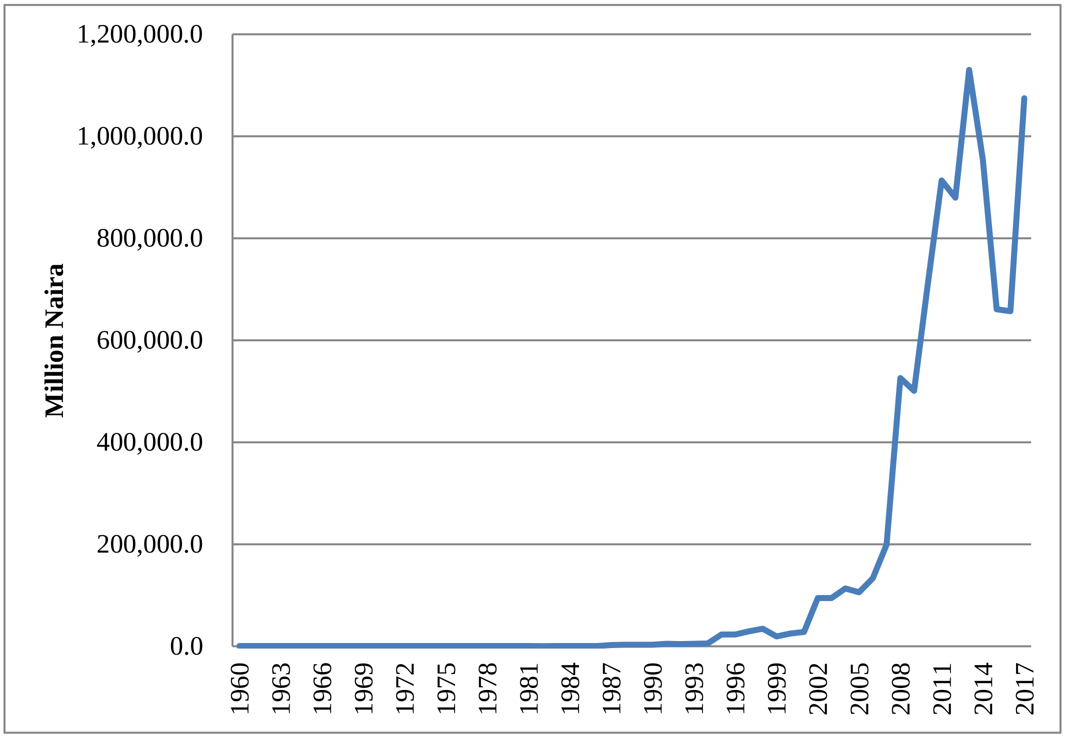


**Figure 2.35: Trends in non-oil export performance**

*Source*: Central Bank of Nigeria (CBN)

As may be observed, the rate at which the value of non-oil export increased between 2005 and 2013 is massive. The period covers the era of the 2007-2009 Global Financial Crisis (GFC); however, the crisis appears to have positive rather than negative impact on the non-oil export sector performance. This further justifies the aptness of diversification from oil export. As evident from the figure, the value of non-oil export dropped in 2014 through 2016. This weak performance may be attributable to weak government potential to support the non-oil sector, as crude oil price and government revenue declined during this period.

Between 2015 and 2017 however, the new administration has introduced a number of policies. This includes Presidential Enabling Business Environment Council (PEBEC) introduced in July 2016 with the aim of improving the business environment in the country. This has led to the commissioning of Sunti Golden Sugar Estates in Niger State recently (March 2018). The Sunti Golden Sugar Estates would be the largest Agro-allied investments in Nigeria. Supplementary efforts by the Central Bank of Nigeria (CBN) ranges from Anchor Borrowers' Programme (ABP) initiated in 2015 (which has led to increase in domestic production of rice and other agricultural commodities), to the recently introduced Non-oil Export Stimulation Fund (NESF), whose vision is to diversify the revenue base of the economy and to expedite the growth and development of the non-oil export sector (CBN, 2016a; CBN, 2016b).

Meanwhile, although the effect of the recent policies is becoming noticeable, it is well below the average performance of the period years. Table 2.4 shows a 3-year average of non-oil export of Nigeria by products between 2001 and 2017, obtained from ITC Trademap.[11] The products exported by Nigeria to the world numbered 97 items and 96 items excluding Mineral fuels, mineral oils, and products of their distillation; bituminous substances. The 96 non-oil items were categorized into seven as presented in Table 2.4. The detail of the categorization is presented in Table 1A in the Appendix.

[11] The values for 2004 and 2005 were not provided from the source.

**Table 2.4: Nigeria non-oil export by products**

| Exported products | 2001-2003 | 2006-2008 | 2009-2011 | 2012-2014 | 2015-2017 |
|---|---|---|---|---|---|
| | Million USD | | | | |
| Live animals and Agricultural input materials | 162.50 | 391.97 | 660.78 | 1,245.54 | 458.31 |
| Agricultural products and edible materials | 53.74 | 2,293.5 | 8,319.98 | 13,991.3 | 2,798.8 |
| Manufacturing products and Transport materials | 1,068.0 | 4,270.5 | 4,384.04 | 6,471.93 | 3,693.1 |
| Non-oil mineral resources | 37.48 | 747.74 | 1,977.57 | 2,102.09 | 658.34 |
| Furniture, Wears and Textile materials | 325.45 | 2,024.2 | 13,467.5 | 16,921.5 | 637.14 |
| Arms and Ammunition | 0.21 | 46.26 | 98.92 | 1,992.47 | 493.25 |
| Cosmetics and Washing Materials | 30.48 | 592.36 | 150.80 | 307.08 | 71.21 |

Source: Computed from ITC Trademap data

As evident in Table 2.4, steady rising performance is observed for all non-oil export products of Nigeria between 2001 and 2014. Specifically, export of live animals and agricultural input materials increased from US$162.50 million in 2001-2003 to US$1,245.54 million in 2012-2014. Export of agricultural products and edible materials increased from US$53.74 million in 2001-2003 to US$2,798.81 million in 2012-2014. More so, export of Manufacturing products and Transport materials, which includes the export of Ships, boats and floating structures, Machinery, mechanical appliances, nuclear reactors, boilers; parts thereof, also increased from US$1,067.99 million in 2001-2003 to US$3,693.09 million in 2012-2014.

Similarly, the rising trend is also observed in the case of export of non-oil mineral resources (such as Lead, Iron ore, Steel, Copper, Zinc, Ceramic products, etc). This increased from USD37.48 million in 2001-2003 to USD658.34 million in 2012-2014. Export of Furniture, Wears and Textile materials (such as Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; Carpets and other textile floor coverings, etc) also increased, as well as export of Arms and Ammunition (such as Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations, etc) over the same period. For Cosmetics and Washing Materials, it witnessed a fall in value in the 2009-2011 periods, although it started recovered in 2012-2014 periods.

However, further evidence from the Table 2.4 shows that export of non-oil products declined severely during the 2015-2017 periods. As noted earlier, this weak performance may be due to weak government's potential to support the non-oil sector, as crude oil price and government revenue declined during this period. Meanwhile, as evidence shows that the non-oil export performance has been increasing since 2016 (see Figure 2.36), it suggests that new non-oil export promotion strategies introduced by the government and corroborated by the CBN have been yielding results. Evidence from Figure 2.36 shows that the effect of the recent government's non-oil export promotion strategies has manifested in sectors exporting Live animals and Agricultural input materials, Agricultural products and edible materials, Manufacturing products and Transport materials and Non-oil mineral resources, while sectors exporting Furniture, Wears and Textile materials, Arms and Ammunition and Cosmetics and Washing Materials are yet to feel the impact.

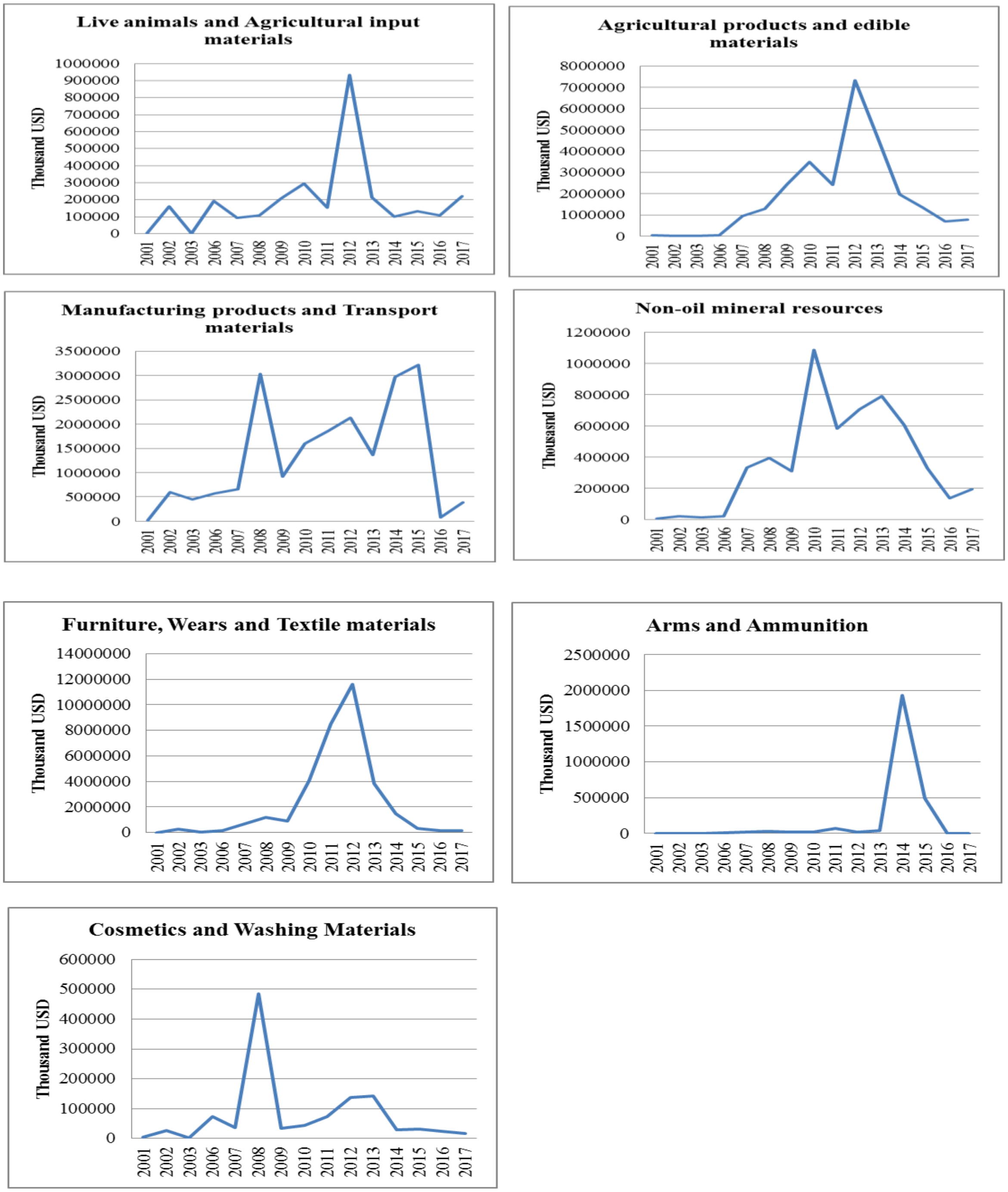


**Figure 2.36: Trends in non-oil export performance by product**

*Source*: Author from ITC Trademap data

### 2.2 Theoretical Review of Literature

This section deals with review of relevant hypothesis, theories and models that could possibly explain the nature of the potential relationship between oil export dependence and exchange rate behaviour.

#### 2.2.1 Dutch Disease and Resource Curse Hypotheses

Theoretical analysis of the effect of extreme reliance on natural resources has usually been based on two interrelated hypotheses; the "Dutch Disease" hypothesis and the "Resource Curse" hypothesis. Dutch Disease[12] syndrome hypothesized that new discovery of natural resources would cause appreciation of the RER, a decline of manufacturing (non-resource output), and an increase in real wages (Dülger et al. 2013). Pioneered by Sachs and Warner (1995), Resource Curse hypothesis explains that the too much dependence of a country on naturally endowed resource limit the growth potential in other sectors of the economy, turning the resource abundance to a curse (Shahbaz et al., 2019). Apparently, these hypotheses indicate that high (low) oil dependency would cause RER appreciation (depreciation), depreciation (appreciation) in NER and slow (rapid) economic growth; however, the relationship could be better analyzed using veritable theoretical economic model.

The relationship between oil export dependence and exchange rate behaviour can be analyzed under the tradition flow (simple) model, modern (Asset-based) exchange rate models (Monetary and Portfolio Balance models) and open economy macroeconomic models (Mundell-Fleming and Mundell-Fleming-Dornbusch).

#### 2.2.2 Traditional Flow (Simple) Exchange Rate Model

The simple model of exchange rate determination is the conventional theory of exchange rate determination often used before the introduction of new set of theories attempting to explain exchange rate behaviour, generally known as the modern asset-market approach to

[12] The term 'Dutch Disease' was in fact first used by The Economist, in reference to the adverse impact of North Sea natural gas discoveries on the Dutch manufacturing sector (Corden, 1984).

exchange rate determination (Pilbeam, 1998). The basic tenet of this model is that the exchange rate (price) of a currency can be analyzed like any other price using the tools of supply and demand. Thus, the model presumes that the exchange rate of Naira can be determined by the intervention of the demand and supply of Naira in the FX market. Exchange rate is defined as domestic currency units per unit of foreign currency. Thus, domestic currency depreciates if exchange rate increases and appreciates if exchange rate decreases.

Assuming Nigeria is the domestic country and USA is the foreign country, a change in ₦/US$ exchange rate will be dependent on the flow of international trade and the attendant flow of FX between the two countries. As US dollar appreciates, USA exports become more expensive to Nigerians; hence, few dollars are demanded. This yields a downward sloping demand curve for US dollar. Similarly, as US dollar depreciates, Nigeria exports become more expensive to US residents; hence less is demanded and few dollars are supplied. This yields an upward sloping supply of US dollar. Figure 2.37 below presents the demand and supply schedule for US dollar in the Naira/USD FX market, where Pe and Qe represent equilibrium exchange rate and equilibrium quantity demanded and supplied, respectively.

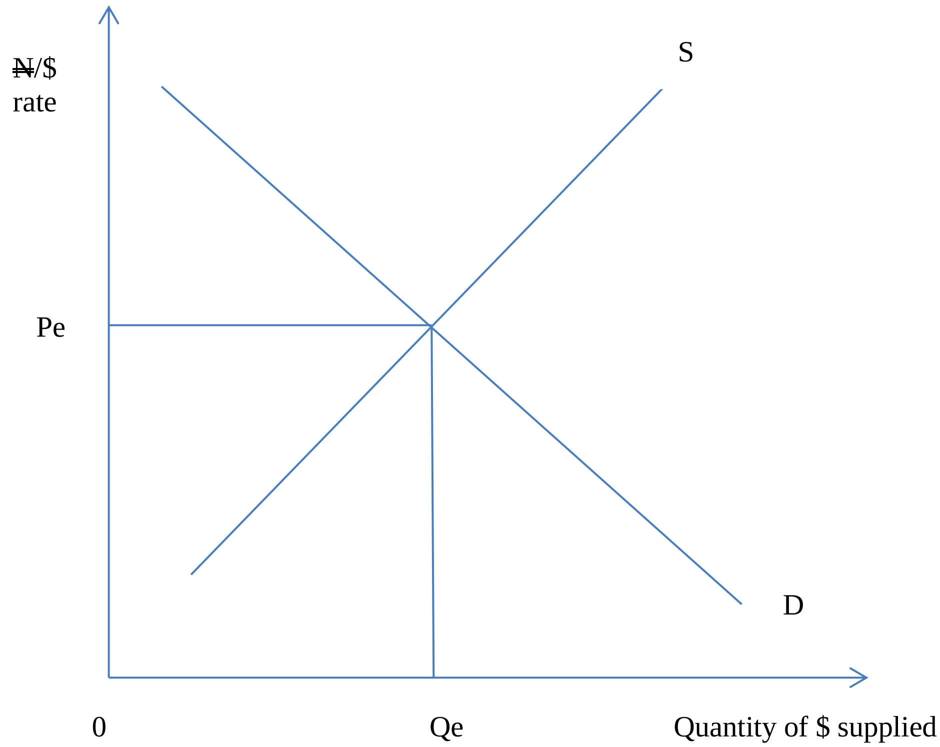


**Figure 2.37: Demand and supply schedules for Naira/USD exchange rate**

Under this framework, assuming there is a ready market the non-oil export produced by Nigeria, a relative increase in supply of non-oil export (lower oil export dependence) will mean an increase in supply of dollar in the market. This implies that the supply schedule will shift to the right (say to $S_1$ in Figure 2.38). This will lead to appreciation of Naira. However, given that expansion in Nigeria's non-oil export is dependent on importations of foreign goods, the demand for dollar will also increase. Depending on the degree of reliance of the non-oil sector being promote on imports. The demand for dollar may shift to $D_1$ where a little exchange rate appreciation can still be obtained, or shift to $D_2$ where exchange rate eventually depreciates (see Figure 2.38). Thus, we may conclude that the gross effect of oil export dependence on exchange rate follows the resource curse hypothesis, but the net effect is uncertain. The limitation of this model is that it does not distinguish between exports, in other words, it does not separate oil export from non-oil export. The implication of this is that increase in oil export will have similar effect as the increase in non-oil export. Thus, a relative increase in supply of oil export than non-oil export (higher oil export dependence) will also lead to increase in supply of dollar. This makes the relationship between changes in level of oil export dependence and exchange rate behavior to be inconclusive in this model.

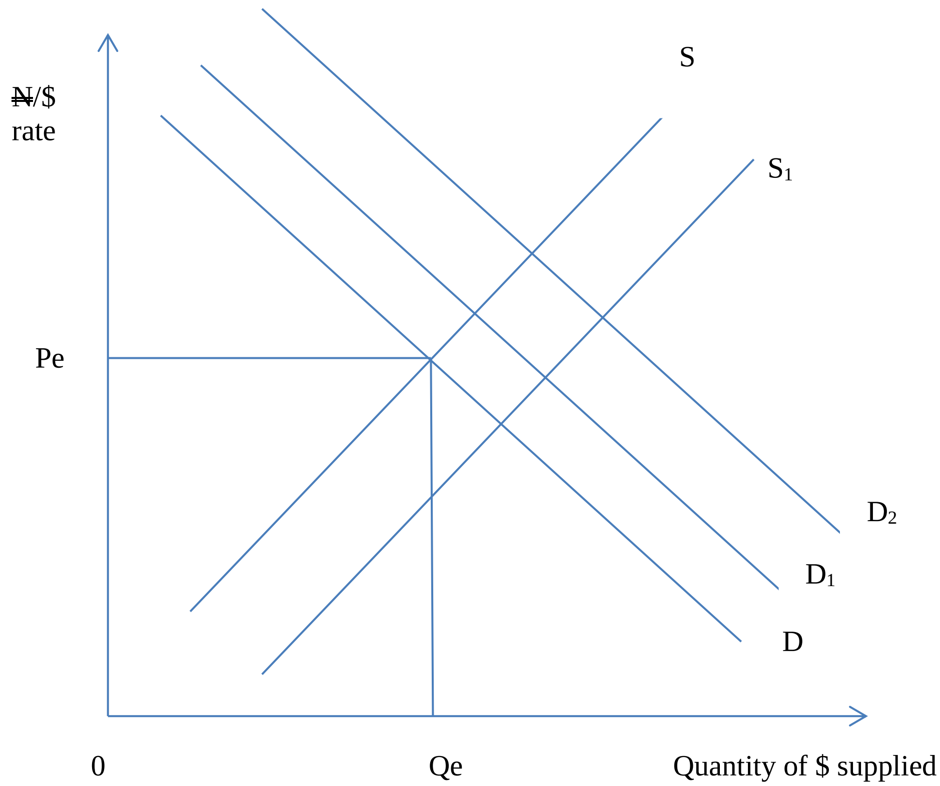


**Figure 2.38: Effect of oil export dependence on exchange rate in simple model**

### 2.2.3 Modern Theory of Exchange Rate Determination

The flow model only deals with the flow of goods while ignoring the flow of capital. The modern theory to exchange rate determination, also referred to as asset-market approach, focused mainly on capital flow. Two basic models of exchange rate determination can be categorized under this approach: monetary approach (which takes the exchange rate as the relative price of monies) and portfolio balance approach (which takes exchange rate as the relative price of bonds). The two views differ as regards the assumption made on the substitutability between domestic and foreign bonds; however, they share the common hypothesis of perfect capital mobility. Specifically, the monetary approach assumes perfect substitutability between domestic and foreign bonds, such that asset holders are indifferent as to which they hold, and bond supplies become irrelevant. Conversely, in the portfolio approach, domestic and foreign bonds are imperfect substitutes, and their supplies become relevant (Pilbeam, 1998). The implication of the monetary and portfolio balance approaches for exchange rate is further discussed.

#### 2.2.3.1 Monetary Models of Exchange Rate Determination

Monetary approach to exchange rate determination relates the relationship between the stock of money and exchange rate, where the exchange rate is assumed to be flexible. There are three common views of monetary approach:

(i) flex-price model
(ii) sticky-price model, and
(iii) currency substitution model.

For the three models, available assets are domestic and foreign monies and domestic and foreign bonds. Meanwhile, to examine the changes in exchange rate, the focus is usually on the money market, as bonds have no independent role to play in the determination of exchange rate (Hallwood and MacDonald, 1994). However, the assumption of non-substitutability of monies holds except under the currency substitution model.

***Flex-price monetary approach***

Under the flex-price monetary approach, money market consists of money demand and money supply relationships in the home and foreign countries. The money demand equation is a typical Cagan demand for money function expressed in logarithm form, money supply is assumed to be exogenously determined by the monetary authorities, and the money market is always in equilibrium. The reduced form for exchange rate model under flex-price monetary approach is

$$s_t = \left(m_t - m_t^*\right) - \alpha_1 \left(y - y^*\right)_t + \alpha_2 \left(i - i^*\right)_t \qquad (2.1)$$

where $s$ is the logarithm of exchange rate, $m$ and $m^*$ represent natural logarithm of domestic and foreign money supply respectively, $y$ and $y^*$ represent logarithm of the level of real national income respectively, and $i$ and $i^*$ represent domestic and foreign interest rate respectively. $\alpha_1$ is interpreted as the income elasticity of demand for money and $\alpha_2$ is a semi-elasticity of interest rate. If equation (2.1) is interpreted relative to the domestic factors (say money supply, $m$), an increase in domestic money supply relative to increase in foreign money supply will lead to exchange rate depreciation (x% increase in $s$). Similar analysis can be made for changes in income level and interest rate. The effect of the foreign variables is equal and opposite.

Given the situation in Nigeria, the effect of oil export dependence on exchange rate in this model can be analyzed through changes in domestic interest rate. Apparently, lower oil export dependence in Nigeria is motivated by the CBN by encouraging investments in non-oil export sector. This is done through such policies as Anchor Borrows' Programme and Non-oil Export Simulation Facility under which ₦200 million and ₦500 million, respectively were earmarked for non-oil exporters at low interest rate. Thus, since this model stated that a lower domestic interest rate will lead to exchange rate appreciation; it suggests lower (higher) oil export dependence will lead to exchange rate appreciation (depreciation). This relationship supports the resource-curse hypothesis.

*Sticky-price monetary approach*

This version of the monetary approach to exchange rate was due to Dornbusch (1976). One of the major deficiencies of the flexible price monetary model is that it assumes that PPP holds continuously and that goods prices are as flexible upwards and downwards as exchange rates. This model has the same properties as the flex-price monetary approach in the long run; however, it differs fundamentally with its short run properties, as it assumed that prices are sticky in the short-run. Basically, this model explains large and prolonged departures of the exchange rate from PPP. Through this model, Dornbusch also introduced the concept of "overshooting", which occur as a result of the discrepancy of adjustment speed in goods and asset market; while asset market adjusts instantly, goods market adjusts slowly over time. Given that PPP is not holding in the short run, the expected change in the exchange rate is equal to a constant proportion $\phi$ of the difference between the equilibrium value $\overline{s}_t$ and the current level $s_t$ :

$$\Delta s_{t+1}^{e} = \phi\left(\overline{s} - s\right)_t \qquad 0 < \phi < 1 \qquad (2.2)$$

Furthermore, the sticky price model assumes that output is fixed at full employment level and money market is in equilibrium at all times. Consider an unexpected increase in domestic money supply from the initial equilibrium, the exchange rate, and price level must change in proportion to the increase in money supply in the long run. But in the short prices are sticky therefore goods market equilibrium is not immediately attained and the money market is not cleared via a price increase. Instead, the money market is cleared in the short run by a fall in the domestic interest rate. Hence, exchange rate jump is expected in the short run. This short run Dornbusch model was also analysed by Frankel (1979), who defines a general model for short-run exchange rate (see Pilbeam, 1998).

In the sticky price model, exchange rate overshoots the new long-run equilibrium exchange rate. This follows from the uncovered interest parity equation which implies that the home interest rate can be below the foreign rate only if market participants expect the exchange rate to appreciate; which can only occur if the current spot rate moves by more than the long-run exchange rate. The overshooting of the exchange rate can be captured by equation

(2.3), which may be referred to as an exchange rate multiplier (in response to a change in money supply):

$$\frac{ds}{dm} = 1 + \frac{1}{\alpha_2 \phi} \tag{2.3}$$

Equation (2.3) reveals that the extent of any exchange rate overshooting is seen to depend upon the interest rate semi-elasticity of the demand for money, defined by $\alpha_2$, and the degree of regressivity of exchange rate expectations, defined by $\phi$.

The underlying difference between the flexible price and sticky price models is that the sticky price model assumes that prices in the goods market are sticky downward in the short run. Since money market is not affected by the assumption of sticky price and domestic interest rate also has positive effect in the sticky price model, it implies that the conclusion from sticky price model will be similar to that of the flexible price model. In other words, lower (higher) oil export dependence will lead to exchange rate appreciation (depreciation), which supports the resource-curse hypothesis.

***Currency substitution approach***

The flexible and stick price monetary approaches to exchange rate determination relied on the implicit assumption that domestic residents do not hold foreign money; hence, it has been assumed that the elasticity of substitution in demand between national money supplies is zero. This is probably an unrealistic assumption. This is because, in a regime of floating exchange rates, multinational corporations involved in trade and investment and speculators have an incentive to hold a basket of currencies in order to minimize the risk of revaluation effects of potential exchange rate changes on their wealth. Basically, the currency substitution approach assumes that monetary services may be provided by domestic and foreign currencies; hence the demand for money function is defined as:

$$m_t - p_t = \Omega + \alpha_1 y_t + \alpha_2 i_t \tag{2.4}$$

where $m_t$ is demand for money, $p_t$ is price level, $y_t$ is income level and $i_t$ is the nominal interest rate. $\Omega$ is a parameter which captures the degree of currency substitution towards the domestic currency. According to King et al. (1977), $\Omega$ is dependent on the expected exchange rate which is also assumed to depend on expected monetary growth, $\Delta m^e$. In this model, the uncertainty with which monetary growth expectations are held is represented by the variance of monetary growth, $\text{var}(\Delta m^e)$. Hence, the degree of substitution parameter can be defined as:

$$\Omega = \beta_0 \Delta m_t^e + \beta_1 \text{ var}(\Delta m_t^e) \qquad \beta_0 < 0, \beta_1 < 0 \tag{2.5}$$

Substituting (2.5) into (2.4) and assuming that money demand equals money supply and substituting for prices in the exchange rate function ($s_t = p_t - p_t^*$), the exchange rate expression becomes:

$$s_t = m_t - \beta_0 \Delta m_t^e - \beta_1 \text{ var}(\Delta m_t^e) - \alpha_1 y_t + \alpha_2 i_t - p_t^* \tag{2.6}$$

More so, assuming uncovered interest rate parity condition holds, and that $\Delta s_t^e = \Delta m_t^e$ (which is a kind of super-neutrality assumption), the exchange rate equation under the currency substitution approach can be represented as:

$$s_t = m_t + (\alpha_2 - \beta_0) \Delta m_t^e - \beta_1 \text{ var}(\Delta m_t^e) - \alpha_1 y_t + \alpha_2 i_t + [i^* - p^*]_t \tag{2.7}$$

Equation (2.7) represents the exchange rate equation under the currency substitution approach. The term in the square bracket denotes the influence of the foreign country. Aside from the traditional money effects of *m* and *y* on the exchange rate, equation (2.7) also reveals the effect of currency substitution on the exchange rate. Since $(\alpha_2 - \beta_0) > 0$, it implies that the higher the opportunity of currency substitution, the higher the pressure on the exchange rate to depreciate (see Hallwood and MacDonald, 1994).

Apparently, since the effect of currency substitution is attributed to money supply and the positive relationship between exchange rate and domestic interest rate holds, it implies that the conclusion from currency substitution model will be similar to that of the flexible price and sticky price models. In other words, lower (higher) oil export dependence will lead to exchange rate appreciation (depreciation), which supports the resource-curse hypothesis.

#### 2.2.3.2 Portfolio Balance Model

The portfolio balance model was pioneered by McKinnon and Oates (1966), McKinnon (1969) and Branson (1968, 1975). One of the criticisms of the monetary model is that it ignores the possibility of portfolio diversification, which it does by assuming that domestic and foreign bonds are perfect substitutes. Portfolio balance model takes care of this and acknowledges the existence of portfolio diversification by assuming that domestic and foreign bonds are imperfect substitutes. Basically, the fact that a number of factors, such as differential tax risk, liquidity consideration, political risk, default risk, and exchange risk, vary for different countries suggests that non-money assets (equity and bonds) are unlikely to be viewed as perfect substitutes (Pilbeam, 1998). Just like international investors would hold portfolio currencies to minimize exchange risk (as under currency substitution), risk-averse international investors would hold a portfolio of non-money assets in the proportion that minimizes his risk and maximizes his returns (see Oloko, 2018).

The portfolio balance model describes the relationship between asset holdings and the exchange rate. It is a simple version of many portfolio balance models because it utilizes the assumption of static exchange-rate expectations. The assumption of imperfect substitutability of home and foreign bonds is assumed to be driven by exchange rate risk. This suggests that uncovered interest rate parity (UIP) does not hold. This tends to the existence of risk premium; hence UIP under the portfolio view of the exchange rate is defined as:

$$i - i^{*} - \Delta s^{e} = \lambda \tag{2.8}$$

where $\lambda$ is a risk premium. A negative risk premium implies that foreign assets are considered riskier than domestic assets; hence, return on foreign country's assets ($i^{*} + \Delta s^{e}$) is greater than the return on the home country's assets ($i$). If investors perceive that a currency has become riskier, they are likely to reallocate their bond portfolios in favour of less risky assets. This may explain the large depreciation of the US dollar witnessed in

1977-1978 (see Hallwood and MacDonald, 1994). Furthermore, it may be explained that a risk-averse investor shifts from more risky assets to less risky assets, the currency of a country with less risky assets appreciates and currency of country will more risky assets depreciate (see Oyinlola et al. 2012; Salisu and Oloko, 2015a).

The above analysis shows that portfolio balance model only deals with capital movement, hence its capacity to movement in goods between countries and eventually effect of export diversification is limited.

### 2.2.4 Balance of Payments Approach to Exchange Rate Determination

The flow model focuses mainly on the movements in current account, while the asset price models focused mainly on the movements in capital account. The balance of payment approach to exchange rate determination combines the strength of the earlier two approaches by determining exchange rate behaviour based on the combination of movements in both current and capital accounts. This approach is usually explained by the Mundell-Fleming (MF) model. The Mundell-Fleming-Dournbush (MFD) has also been identified with the introduction of the assumption of deviation between domestic and foreign prices.

#### 2.2.4.1 The Mundell-Fleming (MF) model

This model has its origin from the papers published by James Fleming (1962) and Robert Mundell (1962; 1963). Their main contribution was to incorporate international capital movements into the formal macroeconomic models based on the Keynesian IS-LM framework. Their paper led to some important implications regarding the effectiveness of fiscal and monetary policy for the attainment of internal and external balance. The baseline Mundell-Fleming [MF, hereafter] model is a model of a small open economy facing a given world interest rate and a perfectly elastic supply of imports at a given price in terms of foreign currency. More especially, the basic MF model is assumed to deal with four assets: a domestic and a foreign bond, each having an identical maturity, and a domestic and a foreign currency. The bonds are assumed to be perfect substitutes while monies are assumed to be non-substitutable, held only in the country of issue.

Furthermore, exchange rate expectation is assumed to be static, and arbitrage is expected to ensure bond yields are continually equalized. This assumption of static exchange rate expectation (that is, $\Delta S^e = 0$) implies that domestic interest rate will always be equal to foreign interest rate[13].

The framework for analysis under the Mundell-Fleming model relies on the IS, LM and BP schedules which define equilibrium in the goods market, money market and balance of payment, respectively. Money market equilibrium is defined as a situation where the demand for real money balances is equal to the real supply of money balances. This can be expressed as:

$$L = \frac{M}{P} \tag{2.9}$$

where $L$ is the real demand for money, $M$ is the supply of money (computed as domestic currency plus the domestic value of foreign reserves), and $P$ is the price of domestic output (which is assumed constant). Equilibrium in the goods market is given by

$$Y = D = A(i,Y) + T(Q,Y) + G \tag{2.10}$$

where $A_i < 0, \; 1 > A_Y > 0, \; T_Q > 0$ and $T_Y < 0$. Hence, $Y$ is the domestic output determined by aggregate demand, $D$. Similar to its definition under the absorption approach, $A$ is absorption. It is a negative function of interest rate (through investment and perhaps consumption) and a positive function of income. The marginal propensity to absorb, or spend, lies between zero and unity; and $T$, the trade balance, or net exports, depends on income and the competitiveness term $Q(= SP^*/P)$. Assume that domestic and foreign price levels are constant; normalized to unity, hence, competitiveness is determined by the NER. The assumption that $T_Q$ is positive reflects that Marshall-Lerner condition is assumed to hold continuously.

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13 Recall that uncovered interest rate parity (UIP) $\Delta s^e_{t+k} = i_t - i^*_t$. Thus, if $\Delta s^e_{t+k} = 0$, $i_t = i^*_t$.

The balance of payments equilibrium condition in the MF model is given by:

$$B = T(Q,Y) + C(i) \tag{2.11}$$

where $T_Y < 0$, $T_Q > 0$, $C_i = \infty$ and $B$ equals the change in reserves, which will be zero, with the flexible exchange rate. The small country assumption coupled with the assumption that expectations are static implies that only the domestic rate of interest enters the capital flow function. The value of the partial derivative $C_i$ reflects the perfect mobility of capital assumption. One of the important conclusions from the model is that an increase in income, by causing the current account balance to deteriorate, requires an increase in $S$ (depreciation) to maintain equilibrium in the balance of payments (Hallwood and MacDonald, 1994). The model also has implications for changes in monetary and fiscal policies under fixed and floating exchange rate regimes (see Hallwood and MacDonald, 1994; Pilbeam, 1998).

Of interest from the propositions of the model is that, it indicated that fiscal policy is ineffective at influencing real output under the assumption of free capital mobility and floating exchange rate regime. As the effect of changes in fiscal policy are similar to that of changes in protectionist policy, an increase in net export will be expected to lead to an outward shift in IS curve, which will put upward pressure on domestic interest rate. A higher domestic interest rate will prompt more inflow of capital which will lead to exchange rate appreciation (see Figure 2.39). An exchange rate appreciation will later reduce export and increase import, making IS curve to return back to its original position. Thus, the net export is unchanged at a given P. This holds since, for a given price level, P, the level of income is unchanged – it is determined entirely by the money market in this model (See Romer, 1986; Pilbeam, 1998).

However, under the assumption of free capital mobility and fixed exchange rate regime, as the IS curve shifts to the right which prompt an increase in interest rate, there is higher inflow of foreign capital which will tend to cause appreciation of the exchange rate. The monetary authority will intervene by buying foreign currency (accumulate foreign reserves) and selling domestic currency to ensure that the exchange rate remained unchanged. This will cause increase in money supply in the economy. Hence, the LM shifts to the right and output increases (see Figure 2.40). This presupposes that the effect of changes in level of oil export dependence or changes in export generally on exchange rate and output of an economy may be dependent on the exchange rate regime operated by such country. In the case of a country operating managed floating like the case of Nigeria, the effect of changes in level of oil export dependence may be expected to split between exchange rate and output.

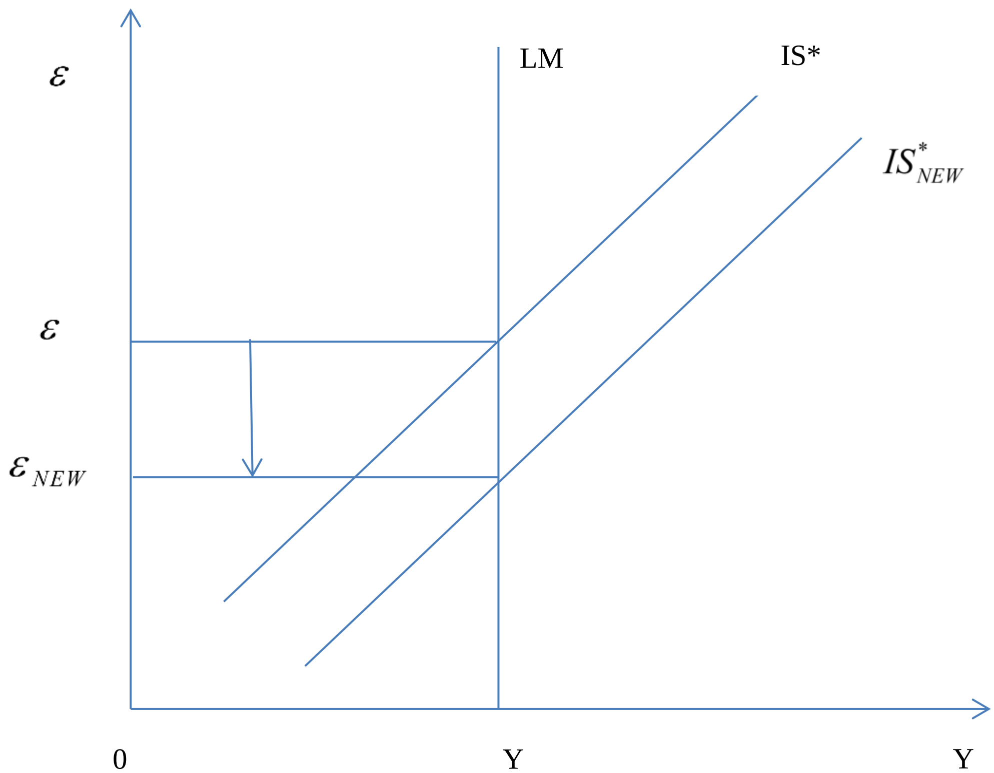



**Figure 2.39: Effect of net export on exchange rate in the MF model (under floating regime)**

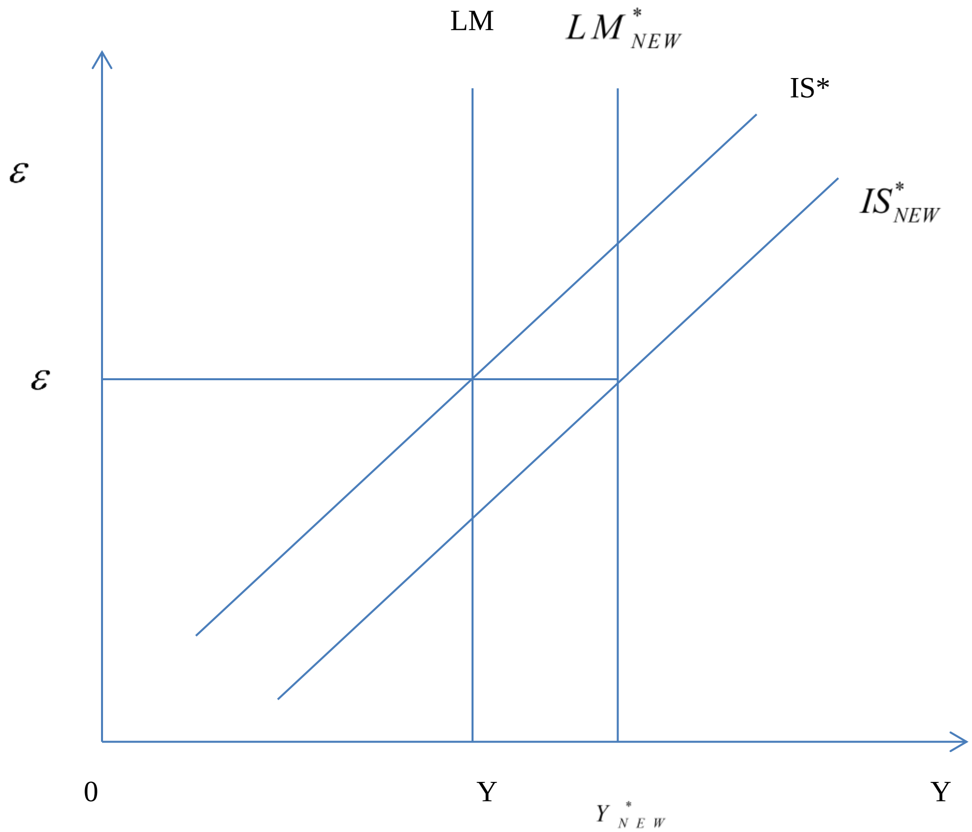



**Figure 2.40: Effect of net export on exchange rate in MF model (under fixed regime)**

#### 2.2.4.2 The Mundell-Fleming-Dournbusch (MFD) Model

The Mundell-Fleming (MF) and Mundell-Fleming-Dournbush (MFD) types of open economy macroeconomic models are distinguishable based on the assumption about the purchasing power parity (PPP), which implies fixed domestic price with foreign price. Basically, the Mundell-Fleming (MF) (Mundell 1962; 1963; Fleming, 1962) model assumes that domestic and foreign prices are fixed, hence, NER is not distinguishable from RER. The Mundell-Fleming-Dournbush (MFD) model, on the other hand, assumes domestic price flexibility, which distinguishes NER from RER. Thus, while both MF and MFD models consist of three equations: Aggregate output (IS) equation, Real money balances (LM) equation, Asset market (IP) or Balance of Payment (BP) equation, the MFD model also has RER equation and price adjustment equation (see Terra, 2015).

Specifically, the IS curve under the Mundell-Fleming-Dornbusch model, where domestic prices are not equal to foreign prices (P $\neq$ P*) is presented as:

$$y_t^d = \bar{y} + \delta\left(q_t - \bar{q}\right) \quad (2.12)$$

where $y_t^d$ is the aggregate demand, $\bar{y}$ is the logarithm of the natural rate of output, defined as the level of production sustainable in the long run without generating bottlenecks or inflationary pressure. $\delta$ is the parameter that measures the impact of deviations of the RER from its equilibrium value on the aggregate demand. The RER can be defined as below;

$$q_t \equiv s_t + p^* - p \quad (2.13)$$

where $s$ is the log of NER, $p^*$ is the logarithm of international price level and $p$ is the logarithm of domestic price level. The international price level is taken as constant, while domestic price is predetermined and adjusts sluggishly according the following equation;

$$p_{t+1} - p_t = \gamma\left(y_t^d - \bar{y}\right) + \left(s_{t+1} - s_t\right) \quad (2.14)$$

According to equation (2.14), two forces determine price adjustment. The first is the excess of aggregate demand over the natural level of output that aggravates inflationary pressure, and second, is the variation in NER passed on to prices (Terra, 2015).

Thus, under the assumption of free capital mobility and flexible exchange rate regime presented in Figure 2.39, increase in non-oil export (lower oil export dependence) will increase total export and shift the IS curve outwards. This will cause exchange rate appreciation (at a given real exchange rate) but have no effect on output (since appreciation will later constrain export and productivity). No effect on output implies no effect on RER. Where NER is fixed (in Figure 2.40), an increase in non-oil export (lower oil export dependence) will increase total export and cause the IS curve to shift outward. With pegged NER, there will be increase in money supply to keep real money balances unchanged. This will cause RER to depreciate and further promotes productivity; shifting IS curve from Y to $Y^*_{NEW}$. Therefore, lower oil export dependence may be expected to have no effect on RER under floating exchange rate regime, but is expected to cause real exchange depreciation under fixed exchange rate regime.

### 2.2.5 Mundell-Fleming Model with Managed Floating Exchange System

The study relies on the managed floating exchange rate model by Lai et al. (1985), which modifies the Mundell-Fleming (MF) framework by incorporating the intervention policy of "leaning against the wind". Due to continuous increase in the use of intervention policy in the FX market and adoption of managed floating exchange rate policy since the collapse of Bretton Wood system, Lai et al. (1985) constructed this model to examine the impact of the intervention policy on the effectiveness of macroeconomic policies under managed floating exchange rate regime. Alternative theoretical models for the analysis of macroeconomic performance under dual (multiple) exchange rate system include the dual exchange rate models by Flood (1978), Lizondo (1987), Ghei and Kigue (1992), Marion (1994) and Park (1995). Lai et al.'s model was considered in this study as it was developed within the Mundell-Fleming open economy macroeconomic framework. With its economy-wide approach rather than the single equation approach by alternative models, Lai et al.'s model appears the most consistent theoretical analytical framework for the analysis of the relationship between oil export dependence and exchange rate behaviour in Nigeria, where managed floating exchange rate regime is being operated.

Basically, the Lai et al. (1985) model consists of four (4) equations; the three (3) original equations of the MF model (Aggregate demand (IS) equation, Real money balances (LM) equation and the Balance of Payment (BP) equation) and the external reserves gain equation, which was added by Lai et al. (1985) to describe the behaviour of foreign exchange authority operating two exchange rates (controlled and flexible). In Lai et al.'s model, equilibrium in domestic goods market for an open economy is described by

$$I(r,y)-S(y)+G+eB(y,e)=0 \qquad I_y, S_y<1,\ -B_y>0,\ I_r<0,$$
and $B_e>0$ by assuming that Marshall-Lerner condition is satisfied (2.15)

where I = investment expenditure, $r$ = interest rate, $y$ = domestic output, S = saving, $G$ = government expenditure, $B$ = balance of trade, and $e$ = exchange rate (defined as the domestic currency price of a unit of foreign exchange). Note: $S=Y-C=I+G$, hence, $I-S+G=0$. The marginal propensity to invest ($I_y$) and marginal propensity to save ($S_y$) are expected to be less than unity ($I_y, S_y<1$). Government expenditure is autonomous. High income is expected to have adverse impact on net export due to increase in import ($-B_y>0$). Lower interest rate is expected to stimulate investment ($I_r<0$) and exchange rate depreciation is expected to facilitate trade surplus ($B_e>0$ ).

Furthermore, equilibrium in the money market obtains when the demand for nominal balances equals the supply of money:

$$L(y,r,e)=M_{-1}+H \qquad L_y>0, L_r<0, \text{ and } L_e>0 \qquad (2.16)$$

where $L$ = nominal money demand, $y$ = domestic output, $r$ = interest rate, $e$ = exchange rate (defined as the domestic currency price of a unit of foreign exchange), $M_{-1}$ = money supply in the last period and $H$ = exogenous change in the money supply. The theoretical expectations are that higher domestic output, higher interest rate and exchange rate depreciation will cause higher nominal money demand.

More so, the equilibrium condition for the FX market is described by

$$B(y,e)+K(r,y)=R-R_{-1}=F \qquad K_r>0,\ K_y>0 \qquad (2.17)$$

where $B$ = balance of trade, $y$ = domestic output, $r$ = interest rate, $e$ = exchange rate (defined as the domestic currency price of a unit of foreign exchange), K = net capital inflow, R = foreign reserve, $R_{-1}$ = foreign reserve in the last period, and F = balance of payments. In equation (2.17), higher domestic output/income and higher interest rate are expected to attract higher inflow of capital investment. The country will record external reserve gain (accumulate reserves) or surplus balance of payment when $R - R_{-1} = F > 0$.

The last equation is on the behaviour of the foreign exchange authorities. According to the intervention policy of "leaning against the wind" in the spot market, the FX market authorities stand ready to purchase (sell) foreign reserve whenever the domestic currency tends to appreciate (depreciate). This implies

$$F = R - R_{-1} = E(e - e^*), \qquad \frac{dE}{d(e - e^*)} < 0$$

where $e^*$ is the pre-announced publicly known target exchange rate that the authorities attempt to defend, exogenously determined.

For simplicity, $E$ was assumed to be in linear form, thus, the above equation can be rewritten as

$$F = R - R_{-1} = -\xi(e - e^*), \qquad \xi > 0 \tag{2.18}$$

In equation (2.18), $\xi$ can be interpreted as the willingness of the monetary authority to intervene in the FX rate market such that officially announced exchange rate is maintained or the premium between flexible and officially exchange rate is minimized. For instance, if $\xi \to \infty$, the government is determined to intervene in the FX market to maintain the officially announced exchange rate, our model amounts to a pure fixed exchange rate model. In this case, monetary authority will defend the official rate until reserve gain is zero. If $\xi \to 0$, the government is determined to refrain from intervening in the FX market. The monetary authority will accumulate reserves perpetually and model becomes a pure flexible exchange rate one. In reality, $\xi$ may be within these two extreme cases (i.e., $0 < \xi < \infty$) and corresponds to a managed float.

In this model, equilibrium RER (nominal equals real, as domestic prices are assumed to be equal to foreign prices), $\bar{\varepsilon}$ , is determined by simultaneously solving the IS equation (eq. 2.15), the LM equation (eq. 2.16) and the (reduced form) Balance of Payment equation (eq. 2.18). Hence, RER can be defined as follows:

$$\bar{\varepsilon} = \bar{\varepsilon}\left(\xi, r, G, L\right) \tag{2.19}$$

Equation (2.19) indicates that equilibrium RER is determined by the willingness of the monetary authority to intervene in the FX market, interest rate, government expenditure and nominal demand for money, which is equal to the supply of money (see eq. 2.16). Following the "leaning against the wind" assumption for intervention policy (see eq. 2.18), RER is expected to have negative relationship with the monetary authority's willingness to intervene in the FX market, such that;

$$\frac{\partial \bar{\varepsilon}}{\partial \xi} < 0 \tag{2.20}$$

The effect of money demand, interest rate and government expenditure on RER can be defined as follows (see also, Hsing, 2010).

$$\frac{\partial \bar{\varepsilon}}{\partial L} = -\frac{1 - V_y}{\left|J\right|} > 0 \tag{2.21}$$

$$\frac{\partial \bar{\varepsilon}}{\partial r} = -\frac{\left[L_r\left(1 - V_y\right) + L_y V_r\right]}{\left|J\right|} > 0 \tag{2.22}$$

$$\frac{\partial \bar{\varepsilon}}{\partial G} = -\frac{V_G L_y}{\left|J\right|} < 0 \tag{2.23}$$

where $\left|J\right|$ is the endogenous-variable Jacobian with a negative value. Therefore, the equilibrium RER is expected to have a positive relationship with money supply and interest rate, and have negative relationship with government expenditure. The managed floating MFD model adopted in this study modifies the conventional MFD model under the assumption of free capital mobility and free floating exchange rate system. Thus, in a $(Y, \varepsilon)$ cross, IS curve is upward sloping, as higher real output are expected to increase with exchange rate depreciation (higher exchange rate). Meanwhile, LM curve can be perfectly inelastic, when exchange rate is not considered as a monetary policy. It can also be downward sloping or perfectly elastic, when exchange rate is considered (partly or fully) as a monetary policy (as the case with this model, where exchange rate is used as a monetary policy instrument in itself). The downward sloping LM curve (in the $(Y, \varepsilon)$ space) is possible, as exchange rate depreciation causes higher demand for money, which crowds out investment and reduce output.

In the case where the LM curve is perfectly inelastic, only monetary policy (shock) is effective in stimulating the real output and only fiscal policy (real shocks including trade shock) can influence RER. This is the case of full flexible exchange rate regime. In other words, the willingness of the monetary authority to intervene in the FX market is zero ($\xi \rightarrow 0$) and exchange rate is not considered as a monetary policy instrument. This may be explained by Figure2.41. The original equilibrium is defined by the interaction of the IS and LM, where the equilibrium real income is Y and the equilibrium RER is $\varepsilon$. An increase in real economic activity (including higher government expenditure or higher exports) will cause the IS curve to shift to the right. With perfectly zero willingness of the monetary authority to intervene in the FX market, exchange rate will appreciate from $\varepsilon$ to $\varepsilon_1$, and real output will remain at Y. As explained earlier, monetary policy changes, such as changes in money supply or changes in interest rate can be used to effect a change in real output under this condition.

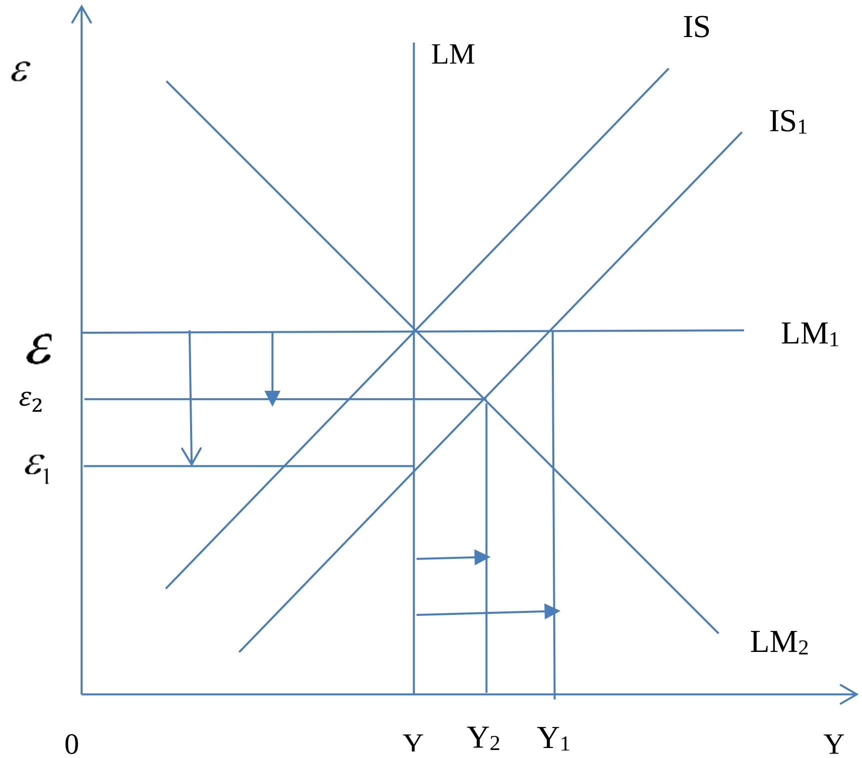



**Figure 2.41: Exchange rate behaviour in the MF model (under managed floating regime)**

In another extreme case, where LM curve is perfectly elastic, monetary authority is fully committed to intervene in the FX rate market, such that $\xi \rightarrow 0$. In this case, monetary policy is ineffective and all changes in real economic activity will have impact on real output while the RER remains constant. As evident in Figure 2.41, an increase in real economic activity that shifts the IS curve from IS to $IS_1$ only causes real output to increase from Y to $Y_1$, while the RER remains constant at $\varepsilon$. In the intermediate case, where the LM curve is downward sloping, monetary authority is partly willing to intervene in the FX rate market, such that the intervention coefficient ranges between zero and infinity (i.e., $0 < \xi < \infty$). In this case, fiscal and monetary policies (real and nominal shocks) have the potential to influence real output and RER. As evident in Figure 2.41, an increase in real economic activity shifts the IS curve from IS to $IS_1$, causing real output to increase from Y to $Y_2$, while the RER to appreciates from $\varepsilon$ to $\varepsilon_2$. Hence, the effect of real economic shocks on exchange rate under managed floating exchange rate regime is dependent on the degree of commitment of the monetary authority to intervene in the FX market. The more committed the monetary authority is in intervening in the FX market and defending the bound between the fixed and the floating exchange rates, the flatter the LM curve and the lower the potential of real economic shocks cause RER appreciation.

Suppose there is an increase in non-oil export such that the country reduced its level of oil export dependence, this shifts the IS curve outward (from $IS_0$ to $IS_1$) leading to exchange rate appreciation (from $\varepsilon_0$ to $\varepsilon_1$) and increase in real output (from $Y_0$ to $Y_1$) (see Figure 2.42). This expansion in real output may be regarded as higher economic diversification as the proportion of non-oil output to total output is expected to increase. The component of floating exchange rate in the managed floating system will pressure the economy to reverse this relationship. This suggests that the effect of changes in level of oil export dependence on exchange rate and real output may be a short run effect. Evidently, RER appreciation due to reduction in level of oil export dependence will prompt importations to increase, and put pressure on RER to depreciate and on real output to reduce. In other words, there will be pressure for the economy to move from point B to point A as import increases as a result of exchange rate appreciation.

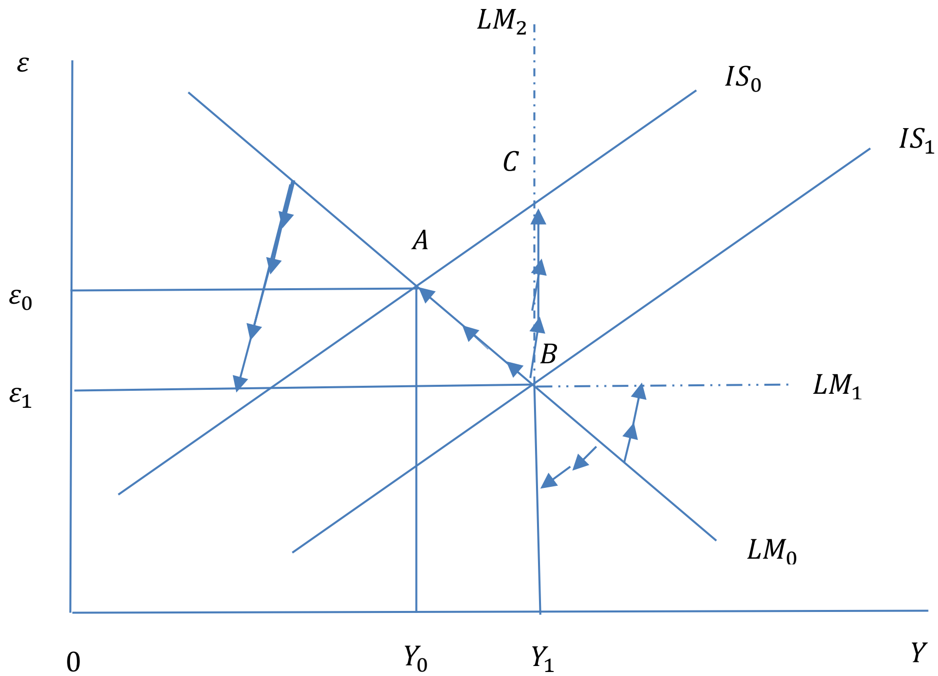



**Figure 2.42: Oil export dependence and exchange rate under different levels of commitment to defend exchange rate**

One way to prevent this movement (and remain on point B) is for the monetary authority to increase its commitment to exchange rate intervention (to the extent of becoming operator of fixed exchange rate regime). This will change the slope of the LM curve from LM to $LM_1$. With this change, output will remain high (at $Y_1$), showing higher economic diversification, while exchange rate will maintain appreciation by remaining at $\varepsilon_2$. However, as evident in eq. (2.18), higher commitment of the monetary authority to intervention causes diminution of foreign reserves. As the monetary authority do not have unlimited external reserves to defend the currency, it will have to allow some degree of currency depreciation. This may explain why Nigeria will RER appreciation and the monetary authority will announce currency devaluation intermittently.

***What if the monetary authority adopts full floating exchange rate system?***

Adoption of full floating exchange rate system will mean that the slope of the LM curve will shift from $LM_0$ to $LM_2$. Economic diversification gain will be maintained as output will remained high (at $Y_1$). However, exchange rate will depreciate freely and settle at a point (point C) higher than the point it was before export diversification or reduction in level of oil export dependence was achieved. After a new equilibrium is established at point C, further export diversification or reduction in level of oil export dependence will have no effect of output, implying that lower oil export dependence will not cause economic diversification under free floating exchange rate system. However, it will cause instantaneous exchange rate appreciation which will be reversed in the “longer” term due to high demand for imports.

### 2.2.6 Mundell-Fleming-Dornbusch Model with Managed Floating Exchange Rate System

This Lai et al. (1985) model was operationalized under Mundell-Fleming theoretical framework. As discussed above (in section 2.2.5), the model concludes that the effect of real economic shocks (such as changes in net export) on exchange rate under managed floating exchange rate regime is dependent on the degree of commitment of the monetary authority to intervene in the FX market. The more the monetary authority is committed to intervene in the FX market (to maintain constant bound between the fixed and the floating exchange rates), the flatter the LM curve and the lower the potential of real economic shocks cause RER appreciation (see Figure 2.41).

Meanwhile, the Mundell-Fleming upon which the managed floating model by Lai et al. (1985) was founded assumes that purchasing power parity holds (holds) and the domestic and foreign prices are fixed. This implies that RER is the same as the NER. We propose to relax this assumption in this study for two main reasons. First, Nigeria's inflation is higher than the global average (see Tule et al., 2019). Second, Nigeria's real and NERs have diverged over the years. While NER faces persistent depreciation, RER faces appreciation threat. Relaxing this assumption of fixed domestic and foreign prices makes it possible to examine the effect of oil export dependence on nominal and real exchange rates.

Dornbusch (1976) introduced sticky price exchange rate model, which incorporates rational expectation and gradual domestic price adjustment. The model assumes that domestic prices in the goods market are sticky downward and adjust slowly from short run to long run. The sticky price assumption stipulates the existence of nominal and real exchange rate "over-shooting", which explains that immediate response of exchange rate is larger than its long run response. A Mundell-Fleming model augmented with sticky price assumption is referred to as Mundell-Fleming-Dornbusch (MFD) model (see Lee and Chinn, 1998; Daly, 2006; Ebaidalla, 2016). With the dynamic adjustment in prices, the MFD model can explain the short run and long run effects of money, aggregate supply, and aggregate demand shocks on exchange rate (see Clarida, 1994).

Based on its important features, this study incorporates the managed floating exchange rate model by Lai et al. (1985) in the MFD theoretical framework to have the modified Mundell-Fleming-Dornbusch model for the study. Without incorporating the proposed managed floating exchange rate model, MFD theoretical framework comprises of the following four equations;

$$y_t^d = d_t + \eta\left(s_t - p_t\right) - \delta\left(i_t - E\left(p_{t+1} - p_t\right)\right) \tag{2.24}$$

$$p_t = \left(1-\theta\right)E_{t-1}p_t^e + \theta p_t^e \tag{2.25}$$

$$m_t - p_t = y_t - \lambda i_t \quad (2.26)$$

$$i_t = E_t\left(s_{t+1} - s_t\right) \quad (2.27)$$

where the variables are described as log differences between domestic and foreign (the USA) countries except exchange rate (see Lee and Chinn, 1998; Daly, 2006; Ebaidalla, 2016). Eq. (2.24) is the IS equation relating output demand ( $y_t^d$ ) to relative demand shocks ( $d_t$ ), real exchange rate ( $s_t - p_t$ ) and expected real interest rate ( $i_t - E\left(p_{t+1} - p_t\right)$ ). In this equation, output demand is increasing in the relative demand shock and RER, and decreasing in real interest differential in favour of the home country (Clarida and Gali 1994).

Equation (2.25) is the price-setting equation, which explains that price level ( $p_t$ ) adjusts gradually towards the long run equilibrium level ( $p_t^e$ ). Specifically, the price level in period *t* ( $p_t$ ) is considered as the average of the market clearing price expected in period *t-1* to prevail in t ( $E_{t-1}p_t^e$ ) and the price that would clear the output market in period *t* ( $p_t^e$ ). The parameter $\theta$ is the relative weight attached to the expectation of the long run price in period *t-1* and in period t. When $\theta = 1$, prices are fully flexible and output is supply-determined. However, when $\theta = 0$, prices are fixed and determined 1 period in advance (Daly, 2006). Eq. (2.26) is the LM equation, which relates the demand for real balances ( $m_t - p_t$ ) to output ( $y_t$ ) and nominal interest rate ( $i_t$ ). Equation (2.27) is defined as the interest parity condition. This expressed the relationship between domestic and foreign interest rates in terms of expected current and future exchange rates. With constant exchange rate expectation, higher (lower) domestic interest rate above (below) the foreign interest rate will require appreciation (depreciation) for equilibrium to be restored.

The managed floating model by Lai et al. (1985) was operationalized within the Mundell-Fleming-Dornbusch framework to suit the analysis of the relationship between oil export dependence the behaviour of Nigeria's exchange rate. The modified Mundell-Fleming-Dornbusch model consists of six (6) equations. This contains the four equations in the MF model and additional two equations. These are the equations for RER and exchange rate intervention. The modified MFD is described below.

$$y^d - \bar{y} = \eta_1 (q - \bar{q}) - \eta_2 (q - \bar{q}) - \delta \left( i_t + E(p_{t+1} - p_t) \right) \tag{2.28}$$

where $i_t + E(p_{t+1} - p_t)$ is the real interest rate, $r$ .

Eq. (2.28) is the modified IS equation. $y^d - \bar{y}$ is the deviation between logarithm of aggregate demand and logarithm of the natural rate of output, while $\bar{y}$ is the natural rate of output is defined as the level of production sustainable in the long run without generating bottlenecks or inflationary pressure. This is similar to $d_t$ in eq. (2.24). Also, $\eta_1$ and $\eta_2$ are the parameters that measure the impact of deviations of the RER from its equilibrium value on the aggregate demand. There are two parameters for RER in this modified IS curve, unlike the original MFD model described above, where there is only one parameter. The reason for this is that, net export has been decomposed into aggregate demand enhancing and aggregate demand contrasting variables to incorporate oil export dependence in the IS equation.

### 2.2.7 Gaps in the Theoretical Literature

The most appropriate theoretical model appears to be the Mundell-Fleming-Dornbusch (MFD) model, as it is capable of examining the effect of changes in oil export dependency on not only NER, but also RER and aggregate output. Earlier studies have relied on alternative models which deal with only NER (see Alley, 2018) or only RER (see Longe, 2019). Most especially when dealing with the case of Nigeria (where intermediate exchange rate system is being operated), the use of alternative to general equilibrium model may produce incomplete results. This study fills gap in the theoretical literature by employing Mundell-Fleming-Dornbusch (MFD) general equilibrium macroeconomic framework.

The use of alternative balance of payment model of exchange rate determination, the Mundell-Fleming model, was not considered as it assumed that PPP holds, such that domestic and foreign prices are equal. With this assumption, the responses of NER and RER are assumed to be synonymous. Meanwhile, in this study, Nigeria, which is the domestic country, cannot be assumed to have similar inflation rate with the United States, which is the foreign country. This is because Nigeria is a high inflation country, while United States is a low inflation country. Hence, assuming that PPP holds and prices in these countries are the same may be an over-simplified assumption. The use of MFD model is preferred as it deals with this over-simplification problem by the MF model.

## 2.3 Methodological Review of Literature

In analyzing the relationship between exchange rate behaviour and oil export dependence or oil export diversification in oil export countries, prominent methods that have been used can be categorized into two; (i) Single equation modelling approach (ii) Multiple equation modelling approach.

### 2.3.1 Single Equation Modelling Techniques

In single equation models, exchange rate is expressed as a function of its determinants, which are usually selected based on the traditional or modern theories of exchange rate. The commonly used single equation method in the analysis of the relationship between exchange rate behaviour and oil export dependence is the Autoregressive Distributed Lag model (ARDL) by Pesaran and Shin (1999) and Pesaran et al. (2001). This model determines the short run and long run relationship between oil export dependence and exchange rate using Bound Testing cointegration approach. This method has been employed in time series analysis on the relationship between exchange rate and oil export dependence or export diversification in oil dependent countries by Asteriou et al. (2016), Alley (2018), Longe et al. (2019) and in panel form by Tran et al. (2017).

The main advantage of approach is its ability to deal with different orders of integration; that is, 1(0) and I(1) variables can be combined (see Alley, 2018). Alternative single equation method is the residual-based cointegration test by Engle and Granger (1987). The Engle and Granger cointegration model is only relevant when the dependent and the independent variables are I(1). The flexibility of the ARDL model makes it more acceptable to researchers in recent time. Given the possibility of the existence of reverse causality between oil export dependence and exchange rate behaviour (see Tran et al., 2017), the problem of endogeniety may be susceptible in the use of single equation model. While some studies on oil export dependence and exchange rate behaviour have not considered correcting for possible endogeneity in modelling the relationship, Twerefou (2017) noted that the problem of endogeneity can be dealt with using endogeneity consistent estimator such as Generalized Method of Moment (GMM).

### 2.3.2 Multiple Equation Modelling Techniques

Multiple equation modelling approach involves the use of more than one equation, which are solved simultaneously to determine an empirical relationship. The Vector Autoregressive (VAR) model provides a basis for some of the multivariate models for empirical analysis. These include the Granger causality test, developed by Granger (1969). This method tests the nature and direction of causality between two variables. There is possibility of having bi-directional causality, unidirectional causality or no causality in the relationship between the two variables. Bi-directional causality occurs when past values of the first variable play important role in determining the current value of the second variable, and vice versa. A unidirectional causality implies that reverse causality does not hold. In other words, past values of one variable determines the current value of the other, and no vice versa. When there is no causality, it implies that the two variables do not predict each other. Meanwhile, it must be noted that this method is only suitable when the variables in the model are all stationary (Amiri and Ventelou, 2012). This appears to be the case in all the existing literature on oil export dependence – exchange rate relationship. In case where variables are of different order of integration, the alternative method; Toda-Yamomoto non-causality test by Toda and Yamamoto (1995), would have to be considered for examining the causal relationship (see Amiri and Ventelou, 2012).

The Vector Autoregressive (VAR) model also provides a basis for Johansen cointegration approach by Johansen and Juselius (1990) and Johansen (1995) and its short run form, the vector error correction model (VECM). This method was adopted by Uduh (2017). According to Johansen and Juselius (1990), the efficiency of the Johansen cointegration method is dependent on the stationarity of all variables in the model; which is a condition often missed in an empirical analysis. The stringent condition place by Johansen cointegration method on the analysis of long run and short run relationship appears was later removed by the introduction of Autoregressive Distributed Lag model (ARDL) model by Pesaran and Shin (1999) and Pesaran et al. (2001). Although this is a single equation model, it is more efficient than Johansen cointegration technique when dealing with different orders of integration (see Alley, 2018). One fundamental problem with VAR model is that it is “a theoretic”; implying that it does not allow for the imposition of economic theory in analysing empirical relationship. Also, it only examines lagged effects in the feedback relationship. Whereas, the assumption of the Mundell-Fleming-Dornbusch model suggests that contemporaneous effect may be significant. This is apparent from the over-shooting postulation of the of Dornbusch model, which suggests that response of exchange rate usually over-shoot its short to medium term response due to downward stickiness of prices in the goods market.

### 2.3.3 Gaps in the Methodological Literature

Apparently, the single equation modelling techniques (for example, ARDL, Engle and Granger) deal with single equation and could not possibly be used to analyze the potential simultaneous effect of oil export dependence on exchange rate and economic growth, as suggested by the Mundell-Fleming-Dornbusch model. On the other hand, the multivariate models (such as VAR and VECM) used in the previous studies are ‘a theoretic’ and ignores the possibility of significant contemporaneous effect on the effect of oil export dependence on exchange rate and economic growth. Therefore, determination of the appropriate method to analyze the potential simultaneous effect of oil export dependence on exchange rate and economic growth is an important methodological gap in the literature.

This study fills this gap by employing system of equation model in Structural Vector Autoregressive (SVAR) model. Alternative methods could be Dynamic Stochastic General Equilibrium (DSGE) model and Computable General Equilibrium (CGE) model. These methods are not only ‘theoretic’ but are also multivariate in nature; which gives them the ability to analyze the potential simultaneous effect of oil export dependence on exchange rates and economic growth (see Agénor, et al., 2018). SVAR is chosen ahead of the CGE due to data economy; as it requires less data. It was chosen ahead of DSGE due to less complexity in terms of model identifying restrictions.

### 2.4 Empirical Review of Literature

This section deals with review of empirical literature that are relevant to the analysis of the relationship between oil export dependence and exchange rate behaviour. These include issues on the measurement of oil export dependence, resource dependence and economic growth, oil export dependence and exchange rate relationship and external Reserves and exchange rate behaviour. Lastly, the gap in the empirical literature is highlighted and discussed.

#### 2.4.1 Measures of Oil Export Dependence

Studies on export dependence either deal with general export dependence or specific export dependence. When dealing with general export dependence, various indexes computed using extensive list of all tradable goods of the concerned countries are used. These indexes include; Hirschman-Herfindahl Index (HHI) and Normalized Herfindahl Index (NH) (see Agosin, 2008; Haouas and Heshmati, 2014; Balavac and Pugh, 2016; Tran et al., 2017), Theil index (see Liu and Zhang, 2015; Sekkat, 2016), export diversification index (see Al-Marhubi, 2000; Nwosa, 2018) and export sophistication index (see Makhlouf et al., 2015).

Specific export dependence implies dependence on export of a specific good (usually commodity goods). In measuring specific export dependence, variables and ratios are often used. For example, income from non-oil export and/or total trade was used as proxy for oil export diversification in studies by Akinlo and Adejumo (2014), Imonghele and Ismaila (2015), Asteriou et al. (2016), and Alley (2018). While, on the other hand, Shafiullah et al. (2017) and Uduh (2017) used oil export to total export ratio; Fernandes and Karnik (2009), Antonakakis et al. (2017), Badeeb and Lean (2017) and Adelaja and Akaeze (2018) employed the use of oil share as a percentage of GDP, oil rents as a percentage of GDP, and/or oil revenues per capita as proxy for oil export dependence. Thus, while the use of oil export as a percentage of total export as proxy for oil export dependence is not new, it was not employed by the relevant study in the case of Nigeria such as Adelaja and Akaeze (2018) and Alley (2018).

### 2.4.2 Resource Dependence and Economic Growth

Majority of studies on the economic consequences of resource dependence have focused mainly on economic growth. The first study often referenced in this regard is Sachs and Warner (1995). The study analyzed the effect of resource abundance on economic growth in a sample of 91 countries between 1971 and 1990 and finds that natural resource-rich economies tend to grow slowly compared to their resource-poor counterparts. This originates the use of the term “resource curse,” which has sparked great debate in the literature. While some studies such as Sachs and Warner (1999), Satti et al. (2014), and Ansari (2016) find evidence in support of Sachs and Warner (1995) results, others studies such as Davis (1995) and Brunschweiler (2008) find that the relationship is rather positive. On the middle course, however, we have studies such as Alexeer and Conrad (2009) and Gerelmaa and Kotani (2016) which show that Sachs and Warner (1995) result hold in the short run but not in the long run. This suggests that the effect of oil dependency on economic growth can be responsive to methodology employed and country studied (see also, Antonakakis et al., 2017). In the case of Nigeria, Olaleye et al. (2013) find that there is a long-run relationship between oil export diversification and economic growth. This result is incomplete as information would be required on whether oil export diversification would increase or retard economic growth

### 2.4.3 Oil Export Dependence and Exchange Rate Relationship

The results from studies on oil export dependence-exchange rate relationship have been mixed. More relevant studies include Alley (2018), Asterious et al. (2016), Krugman (1987), and Tran et al. (2017). Specifically, Asterious et al. (2016) analyzed the relationship between exchange rate volatility and international trade volumes in Mexico, Indonesia, Nigeria, and Turkey. They find that in the long term, there is no linkage between exchange rate volatility and international trade activities except for Turkey. Tran et al. (2017) assume no knowledge of the causality and thus investigated causal between export diversification and RER among the middle-income countries of Asia and Latin America. Empirical evidence from their study is that there is a two-way causality between the two variables export diversification and RER. Krugman (1987) indicated that the discovery of tradable resources (e.g., oil) in a country leads to a real appreciation of its exchange rate and crowds out other tradable sectors of its economy. Alley (2018), which investigated the case of Nigeria, found that increase in non-oil exports (or lower oil export dependence) leads to appreciation of USD-Naira exchange rate both in the short run and the long run. This result appears incomplete, as not it does not explain the effect on happens to RER and economic growth. The study also assumes Nigeria is operating a floating exchange rate regime by ignoring the role external reserves.

### 2.4.4 External Reserves and Exchange Rate Behaviour

The relationship between external reserves and exchange rate behaviour has been widely investigated. For example, Aizenman et al. (2012) find that relatively small increases in the average holdings of reserves by Latin American economies makes implementation of fixed exchange rate regime more effective to insulate the economy from external shocks. Kasman and Ayhan (2008) find that, in the case of Turkey, foreign reserves cause change in RER but NER causes changes in foreign reserves. Ramachandran and Srinivasan (2007) find that India's competitiveness causes large stockpile of reserves and volatility of external transactions has moderate impact on reserve demand in India. Other relevant studies include Agénor et al. (2018), Seghezza et al. (2017), Abdul-Rahaman and Yao (2019) and Akdogan (2020). According to Akdogan (2020), the intervention model is improved once growth of reserves is included in the model. In addition, Aizenman and Hutchison (2012) find that countries relied primarily on exchange rate deprecation rather than reserve loss to absorb most of the exchange market pressure shock during 2008–2009 crisis. On the case of Nigeria, Ndako (2015) finds existence of long-run relationship between real exchange rate, interest rate differential and foreign exchange reserves, while Nwachukwu et al. (2016) find that causality runs from external reserves to NER. Although these are evidence that accounting for external reserves in modelling exchange rate behaviour is important, this has been ignored in earlier studies on oil export dependence and exchange rate relationship in Nigeria.

### 2.4.5 Gaps in the Empirical Literature

This study proposes to investigate the relationship between oil export dependence and exchange rate in Nigeria. Although Nigeria's case has been considered, new evidence is required due to some knowledge gap in the existing literature. First, previous studies on oil export dependence-exchange rate relationship in Nigeria does not use ratio of oil export to total export as proxy for oil export dependence. Meanwhile, Hendrix (2017) noted that it is the ratio of oil export to total export that truly reflects the extent of countries exposure to external shocks from oil market. Second, earlier studies assumes that Nigeria operate a floating exchange rate regime by ignoring the role of foreign reserves in exchange rate determination; which may be erroneous. This suggests that the results produced by those studies may be biased. Third, and most importantly, earlier results produced result on only exchange rate. Whereas, application of intermediate exchange rate regime in Nigeria suggests changes in oil export dependence could possibly influence simultaneous effect on exchange rate and economic growth. Fourth, Dutch disease analysis by Dülger et al. (2013) suggests that manufacturing sector growth enhances exchange rate in Russia. Meanwhile, literature on export diversification in Nigeria has focused on aggregate non-oil sector (see for example, Alley, 2018), making it difficult to assess the potential of individual sector to enhance exchange rate. Decomposition of non-oil sector in assessment of the effect of oil export dependence is also an important gap this study proposed to fill. The summary of literature review is presented in Table 2.5 below.

**Table 2.5: Summary of Relevant Literature**

| Authors | Country studies | Period Covered | Diversification Variables considered | Methodology | Findings |
|---|---|---|---|---|---|
| Adelaja and Akaeze (2018) | Fifty-three (53) major oil-producing countries | 1995-2014 | Economic diversification is measured as oil sector supply to GDP ratio. Other variables include: property right, GDP and exchange rate | Random effects model | Diversification has a positive and significant impact on oil supply. |
| Agosin (2008) | Emerging economies: Korea, Taiwan, Mauritius, Finland, China, and Chile. | 1980-2003 | Initial GDP per capita, initial openness (trade as a percentage of GDP), and average fixed capital formation. Export diversification was defined as 1-HHI(i.e.Hirschman -Herfindahl export concentration index) | Ordinary least squares and instrumental variables. | Export diversification, alone and interacted with per capital export volume growth, is found to be highly significant in explaining per capita GDP growth. There is also a positive relationship. |
| Akinlo and Adejumo (2014) | Nigeria | 1986(1)–2008(4) | | error correction approach | Exchange rate, exchange rate volatility and foreign income have significant positive effects on non-oil exports in the long run. |
| Alley (2018) | Nigeria | monthly data from January 2008 to Dec. 2015 | non-oil export performance | VAR and ARDL | Increase in non-oil exports led to an appreciation of USD-Naira exchange rate both in the short run and the long run. |
| Al-Marhubi (2000) | 91 countries | 1961 to 1988 | Three (3) factors: the number of products exported at the three-digit SITC level, the diversification index, and concentration index | Heteroscedasticity-consistent OLS | Export diversification promotes economic growth |

| | | | | | |
|---|---|---|---|---|---|
| Alsharif et al. (2017) | Korea | 1973:1 through 1993:2 | | Multivariate cointegration and error-correction techniques. | Real exchange-rate uncertainty has a negative effect on exports in the short-run as well as the long-run. |
| Amin Gutierrez de Pifieres and Ferrantino (1997) | Chile | 1962-1991 | Three (3) measures: the variance of the traditionality index, a measure of the change in export composition, a measure of the change in the export composition. | Granger-Sim tests | Chilean growth has been accompanied by export diversification since the mid-1970s. |
| Antonakakis et al. (2017) | 76 countries classified by different income groupings and level of development | 1980–2012. | i. Oil share as a percentage of GDP, ii. Oil rents as a percentage of GDP, iii. Oil revenues per capita | Panel Vector Auto-Regressive (PVAR) | Oil dependence is not growth-enhancing in countries with the weak quality of political institutions. |
| Asteriou et al. (2016) | Mexico, Indonesia, Nigeria, and Turkey | | | Granger causality and ARDL | In the long term, there is no linkage between exchange rate volatility and international trade activities except for Turkey |
| Badeeb and Lean (2017) | Yemen | 1982–2012 | the ratio of oil resource to GDP | Granger causality test, based on a VECM framework, | The positive effect of financial development on economic growth decreases with the increasing oil dependence. |
| Bahmani-Oskooee and Mohammadian (2017) | Japan | 1973QI-2015QIV | | Nonlinear ARDL approach | Exchange rate changes do have asymmetric effects on domestic production in Japan. |
| Bahmani-Oskooee and Saha (2016) | Brazil, Canada, Chile, Indonesia, Japan, Korea, Malaysia, Mexico, and the U.K. | | | Nonlinear ARDL approach to cointegration and error-correction modelling | Exchange rate changes have asymmetric effects on stock prices, though the effects are mostly short-run. |

| | | | | | |
|---|---|---|---|---|---|
| Balavac and Pugh (2016) | Twenty-five (25) transition economies | 1996-2010 | Hirschman-Herfindahl index, overall Theil index and the within component of the Theil index | System GMM | Diversification may attenuate the output volatility effects of countries at lower levels of diversification. |
| Broda (2004) | Seventy-five (75) developing countries | 1973–96 | De facto exchange rate regime classification by IMF | Panel VAR | Responses of real variables to terms-of-trade shocks are significantly different across regimes. |
| Dreyer (1978) | 130 developing countries | 1973 | being the share of the largest single export category in total exports of the country (for structural diversification) | probability model | trade openness and export diversification have a significant impact on the choice of exchange rate regime |
| Esu and Udonwa (2015) | Nigeria | 1980 – 2011 | Non-oil export trade | Ordinary Least Square (OLS) and ECM | Diversification in important |
| Fernandes and Karnik (2009) | UAE | 1980-2001 | Non-oil-sector GDP | 18 equation compact macro-econometric model with OLS and dynamic simulation techniques | UAE is, indeed, quite dependent on the oil sector. |
| Hagen and Zhou (2002) | 25 transition economies in Europe and the CIS. | 1990 through the end of 1999. | Degree of openness, geographical concentration of foreign trade (GEOCON), commodity concentration of foreign trade (COMCON), per capita real GDP (PCGDP), and real GDP. | Static and dynamics choice model | Regime choices are influenced by inflation rates, cumulative inflation differentials, and the availability of international reserves. |
| Haouas and Heshmati (2014) | UAE | 1970-2007 | Normalized-Hirschman Index (NH) | ARIMA | The UAE is facing an oil curse. |

| | | | | | |
|---|---|---|---|---|---|
| Herzer and Nowak-Lehnmann (2006) | Chile | 1962–2001 | The ratio of manufactured exports to total exports | Cointegration and VECM | Export diversification plays an important role in economic growth. |
| Holden et al. (1979) | cross-sectional data for 75 countries | average of 1974-1975 | Percentage of total exports accounted for by the largest export in terms of the two-digit Standard International Trade Classification (SITC). | Ordinary least squares (OLS) | 42% of the variance of the flexibility measure is explained by the identified variables have included |
| Imoughele and Ismaila (2015) | Nigeria | 1986 to 2013 | | OLS and Cointegration test | The effective exchange rate has a significant impact on the growth of non-oil export |
| Joya (2015) | 123 countries | 1990–2011 | Composite indicator to measure diversification using input-output data. | | The direct effects of natural resources on growth are positive, their adverse indirect effects through volatility could be larger. |
| Kandil and Nandwa (2015) | Five Arab oil-producing countries: Saudi Arabia, the UAE, Sudan, Algeria, and Yemen | 1990 and 2009 | Oil revenue volatility | OLS and fixed-effects panel methods | This study proposes the adoption of a transparent broad basket, band, and crawl (BBC) regime |
| Korhonen and Juurikkala (2009) | OPEC countries | 1975 to 2005. | | Pooled mean group and mean group estimators | Price of oil has a clear, statistically significant effect on real exchange rates in our group of oil-producing countries. |
| Liu and Zhang (2015) | 72 developing countries | 1974-2010 | Theil index | Linear probability model (LPM) | Diversification of export products has a positive but insignificant effect on the choice of fixed exchange-rate regimes. |

| | | | | | |
|---|---|---|---|---|---|
| Makhlouf et al. (2015) | 116 countries | | Export diversification index and export sophistication index | Fixed effect | Openness can be positively associated with both specialization and diversification |
| Nwosa (2018) | Nigeria | 1962 to 2015 | Export diversification index | ARDL regression | Trade policy had not enhanced export diversification in Nigeria |
| Olaleye et al. (2013) | Nigeria | 1983 to 2012 | Oil export share of the total export, | Cointegration and Granger causality test | There is a long-run relationship between oil export diversification and economic growth. |
| Oriavwote and Eshenake (2015) | Nigeria | 1980 to 2014 | | Johansen co-integration test and VECM | Real Effective Exchange Rate and the degree of openness have a positive and significant impact on non-oil exports in Nigeria |
| Oyinlola and Oloko (2018) | Nigeria | 1985M01 to 2017M07 | | Nonlinear ARDL model by Shin et al. (2014). | Long run but no short-run exchange rate asymmetry effect on the Nigerian stock market |
| Ren et al. (2018) | 30 countries | Monthly data is from 2002M1 to 2016M9 and the quarterly data is from 1999Q1 to 2016Q3. | | Common correlated effects (CCE) estimation | The monetary model in growth rates can outperform random walk with and without drift in the prediction |
| Sannassee et al. (2014) | Mauritius | 1980 to 2010 | | | The positive relationship between export diversification and economic growth in Mauritius both in the short run and long run. |
| Sekkat (2016) | 55 low and middle countries | 1985-2009; | Herfindahl indexes, Theil indexes, and Share of manufactures in total exports | GMM method | No support is found for an impact of misalignment (neither over nor undervaluation) on exports |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | diversification within manufactures |
| Tran et al. (2017) | Middle-income countries of Asia and Latin America | 1995 to 2013. | Herfindahl-Hirschman concentration Index (HHI) | Panel Granger causality test. | There is a two-way causality between the two variables |
| Uduh (2017) | Nigeria | 1980 and 2013 | | Johansen co-integration test | There is a long-run relationship between exchange rate and cocoa export |

Source: Compiled by the Researcher

# CHAPTER THREE

# METHODOLOGY

## 3.0 Overview

This chapter presents the methodology for the analysis of oil export dependence as a factor influencing exchange rate behaviour in Nigeria. It starts with the specification and description of the underlying model. This is followed by the preliminary analysis which comprises of the descriptive statistic and unit root tests. The estimation procedure for the method of analysis and post-estimation analysis are also discussed.

## 3.1 Model Specification

In analysing the effect of oil export dependence in the MFD framework, trade sector was separated into trade in oil sector and trade in non-oil sector, such that there are net export of oil and net export of non-oil. The decomposition of net export into oil and non-oil net export components yields the expression in equation 3.1.

$$NX = (X_O + X_N) - (M_O + M_N) \tag{3.1}$$

Given the definition of oil export dependence (OED) as the proportion of oil export to total exports, OED can be defined as:

$$OED = \frac{X_O}{X} \tag{3.2}$$

$$OED = \frac{X_O}{X_O + X_N} \tag{3.2'}$$

where $X$ is the total export, which is the summation of export of oil ( $X_O$ ) and export of non-oil ( $X_N$ ). Eq. (3.2) suggests that OED is exclusively a negative function of non-oil export and a positive function of oil export. In other words, OED reduces (increases) as non-oil export increases (reduces), but increases (reduces) as oil export increases (decreases). As oil export and non-oil export change concurrently during in reality, it suggests that non-oil export must be increase at a faster rate that the rate of reduction in oil export for reduction in level of oil export dependence to be achieved (see Table A2 in Appendix for more details).

From eq. (3.2), it is also clear that total export is negatively related to OED.

$$X = \frac{X_O}{OED} \qquad (3.3)$$

Thus, as the level of oil export dependence falls, total export is expected to increase, *ceteris paribus*. This implies that, export diversification in oil dependent countries will cause total export to increase. The relationship between non-oil export, oil export dependence and total export can be summarized in the transmission chain below;

$$\uparrow X_N \Rightarrow \downarrow OED \Rightarrow \uparrow X \qquad (3.4a)$$

Equation 3.3 also suggests that lower OED could also be caused by fall in export of oil, but this will cause total export to reduce rather than increase, as positive relationship exists between oil export and OED with positive relationship between OED and total export help constant, such that

$$\downarrow X_O \Rightarrow \downarrow OED \Rightarrow \downarrow X \qquad (3.4b)$$

Substitute eq. (3.3) into eq. (3.1), net export can be expressed as;

$$NX = \frac{X_O}{OED} - M \qquad (3.5')$$

$$NX = \frac{X_O - M*(OED)}{OED} \qquad (3.5)$$

where $M$ is the total import. By implication, eq. (3.5) suggests that a change in the current account balance of an oil dependent country can be influenced by change in the export of oil, change in import level, and change in the level of oil export dependence. An increase in export of oil and a lower OED (from export diversification) are expected to increase country's trade surplus, while import is expected to reduce it. At a moderate level of oil export dependence (when OED=0.5), half of country's import must be sufficiently covered by revenue from export of oil for the country be in a positive net export position (that is, $NX \geq 0,\ if\ X_O \geq \frac{1}{2}M$ ).

With the definition of oil export dependence as the percentage of oil export to total merchandise export, $OED = \frac{X_0}{X_0 + X_N}$, net export in terms of OED can be defined as $NX = \frac{X_O}{OED} - M$. This implies that oil export is still positively related to aggregate demand, while total import and oil export dependence are inversely related. However, a re-definition of OED ( $OED = \frac{1}{1 + \frac{X_N}{X_O}}$ ) reveals that non-oil export must increase at a faster rate than oil export for level of oil export dependence to really increase (see Appendix A2 for details). This can be analysed with transmission in (eq. 3.6) below:

$$\downarrow OED \Rightarrow \overset{-VE}{\partial OED / \partial X_N} > \overset{+VE}{\partial OED / \partial X_O} \tag{3.6}$$

This suggests reduction OED may be stimulated by lower oil export if export diversification is weak.

The managed floating model by Lai et al. (1985) was operationalized within the Mundell-Fleming-Dornbusch framework to suit the analysis of the relationship between oil export dependence the behaviour of Nigeria's exchange rate. The managed floating MFD model adopted in this study modifies the conventional MFD model under the assumption of free capital mobility and free floating exchange rate system. The modified Mundell-Fleming-Dornbusch model consists of six (6) equations. This contains the four equations in the MF model and additional two equations. These are the equations for RER and exchange rate intervention. The modified MFD is described below.

$$y^d - \bar{y} = \eta_1\left(q - \bar{q}\right) - \eta_2\left(q - \bar{q}\right) - \delta\left(i_t + E\left(p_{t+1} - p_t\right)\right) \qquad (3.7)$$

where $i_t + E\left(p_{t+1} - p_t\right)$ is the real interest rate, $r$.

Eq. (3.7) is the modified IS equation. $y^d - \bar{y}$ is the deviation between logarithm of aggregate demand and logarithm of the natural rate of output, while $\bar{y}$ is the natural rate of output is defined as the level of production sustainable in the long run without generating bottlenecks or inflationary pressure. This is similar to $d_t$ in eq. (2.24). Also, $\eta_1$ and $\eta_2$ are the parameters that measure the impact of deviations of the RER from its equilibrium value on the aggregate demand. There are two parameters for RER in this modified IS curve, unlike the original MFD model described above, where there is only one parameter. The reason for this is that, net export has been decomposed into aggregate demand enhancing and aggregate demand contrasting variables to incorporate oil export dependence in the IS equation. With the definition of oil export dependence as the percentage of oil export to total merchandise export, $OED = \frac{X_0}{X_0 + X_N}$, net export in terms of OED can be defined as $NX = \frac{X_O}{OED} - M$. This implies that oil export is still a positively related to aggregate demand, while total import and oil export dependence are inversely related. In terms of RER, RER depreciation is expected to increase oil export while RER deprecation is expected to reduce total import and level of oil export dependence. This explains why $\eta_1$ is positive and $\eta_2$ is negative. Lastly, $\delta$ is the measure of the impact of RER on aggregate demand. This also has negative relationship on aggregate demand.

More so, $q_t$ is the logarithm of RER and $\bar{q}$ is the level (in logarithm) of the RER compatible with the longrun equilibrium of the economy. The RER can be defined as below;

$$q_t \equiv s_t + p_t^* - p_t \tag{3.8}$$

where $s$ is the log of NER defined as the domestic currency units per unit of foreign currency, $p^*$ is the logarithm of international price level and $p$ is the logarithm of domestic price level. The international price level is taken as constant, while domestic price is predetermined and adjusts sluggishly according the following equation;

$$p_{t+1} - p_t = \gamma\left(y_t^d - \bar{y}\right) + \left(s_{t+1} - s_t\right) \tag{3.9}$$

According to equation (3.9), two forces determine price adjustment. The first is the excess of aggregate demand over the natural level of output that aggravates inflationary pressure, and second, is the variation in NER passed on to prices. Compared to the price setting equation in the original MFD model, $\theta$ was set to unity to show that prices are as expected and the changes in prices are set in relation to output in accordance with the short run Phillip curve.

The fourth equation is the LM equation. This is the monetary policy equation and exchange rate is part of the instrument of monetary policy where a country operate managed floating exchange rate regime (see Lai et al., 1985). Notably, the money equation is the original MFD model (see eq. 2.26) expressed real money balances as a function of income and interest rate. This study extends the model by incorporating exchange rate, that is, the flexible exchange rate. This is defined as the domestic price per unit of foreign currency.

$$m_t - p_t = y_t - \lambda i_t + \gamma s_t \tag{3.10}$$

The LM equation shows that higher income and NER depreciation causes higher demand for real money balances, while higher interest rate causes lower demand for real money balances.

In this modified model, the assumption of free capital mobility was replaced with imperfect capital mobility. Hence, intervention is required for FX market to clear. The equilibrium condition for the FX market is, thus, described as:

$$CF\left(r_t - r_t^*\right) + TB\left(s\right) = \Delta R_t \tag{3.11}$$

Eq. (3.11) is the balance of payments equation. It shows that monetary authority adjusts external reserves to ensure balance of payment equilibrium. $CF\left(r_t - r_t^*\right)$ represents the net capital flow, which is dependent on RER differential, while $TB\left(s\right)$ is the trade balance, which is dependent on the flexible exchange rate (see Lai et al., 1985). This will consist of export of oil, total import and level of oil export dependence (since $NX = \frac{X_O}{OED} - M$ ).

Lastly, there is exchange rate intervention equation, which is specified according to Lai et al. (1985). This was not present in the original MFD model already described. The exchange rate intervention equation can be specified as:

$$\Delta R = -\xi(s - s^*), \qquad \xi > 0 \tag{3.12}$$

where $\Delta R_t$ is the change in the country's official external reserves, $s^*$ is the official exchange rate and $\xi$ is willingness of the monetary authority to intervene in the FX market such that officially announced exchange rate is maintained or the premium between flexible and officially exchange rate is maintained. Under managed floating exchange rate system, $\xi$ is expected to fall between zero and infinity (i.e., $0 < \xi < \infty$ ). With the "leaning against the wind" assumption for intervention policy, external reserves diminish when the monetary authority increases its willingness to intervene in the FX market, and it increases when the authority reduces its willingness to intervene in the FX market. This explains the negative relationship between change in external reserves and the willingness of the monetary authority to intervene in the FX market. Thus, the equilibrium in the good market, money market and exchange rate market can be determined by simultaneously solving the IS equation (eq. 3.7), the LM equation (eq. 3.10) and the Balance of Payment equation (eq. 3.11) using appropriate methodology.

### 3.2 Descriptive Statistics

This sub-section presents the summary statistics of the distribution of each series in the model. It describes measures of location, measures of variation and measures of symmetric or asymmetric (skewness and kurtosis) feature of the series which provide information about the shape of the distribution. The measures of location to be considered are the mean; which is the simple average of the distribution. This is measured as the summation of all series divided by the number of the series. The median is the middle value of the series after arrangement in ascending or descending order. The mode is not considered because of the potential problem of bi-modal or multi-modal in time series data. The closer the mean and the median, the more symmetry the series and the closer it is to the normal distribution.

The measures of variation considered are the range and standard deviation. The range is defined by the maximum and the minimum value of the series, and the standard deviation shows the standardized value of the deviation of the series from their means. The lower the standard deviation, the more stable the series and the closer the distribution to the normal distribution. In addition, standard deviation could be used as a preliminary measure of the degree of volatility; the higher the standard deviation, the higher the volatility (see Salisu and Oloko, 2015b).

The measures of symmetric nature of the series provide information about the shape of the distribution relative to the normal distribution. These are the skewness statistic and the kurtosis statistics. A normally distributed series is expected to have its skewness statistic to be zero; this is a typical feature of a symmetric series. A series is positively skewed when its skewness statistic is positive or in other words, when it is extreme to the right (its tail is longer towards right than left). Similarly, a series is negatively skewed if its skewness statistic is negative; in other words, when it is extreme to the left (if its tail is longer towards left than the right).

The second measure of the symmetric feature is the kurtosis statistic which measures the peakedness and tailedness of the series relative to the normally distributed series. Kurtosis could be measured using kurtosis statistic or excess kurtosis statistic. Kurtosis statistic suggests that a normally distributed series will have a kurtosis statistic equal or approximated to 3 (mesokurtic); hence, if the kurtosis statistic of a series is greater than 3, such series is said to be leptokurtic; meaning that it is having peak top and fat tail. On the other hand, if the kurtosis statistic of a series is less than 3, such series is said to be platykurtic; meaning that it is having a flat top and thin tail. However, where kurtosis is measured using excess kurtosis statistic, the interpretation is similar except that the excess kurtosis statistic for a normally distributed series will be zero and any series with excess kurtosis that is greater than zero (positive) is leptokurtic while any series with excess kurtosis that is less than zero (negative) is platykurtic.

Meanwhile, a combination of both the skewness and kurtosis statistics has been found to be highly useful in assessing the normality of the series. This study employs Jarque – Bera statistic as a measure of normality of series that combine both skewness and kurtosis statistics. The Jarque – Bera statistic test of normality is a test of the joint hypothesis that skewness and kurtosis coefficients are 0 and 3 respectively, such that JB statistic is expected to be 0. Hence, if the value of the JB statistic is significantly different from zero, which will happen if the p-value of the statistic in an application is sufficiently low, the null hypothesis that the residuals are normally distributed will be rejected. But if the p-value is reasonably high, which will happen if the value of the statistic is close to zero, we do not reject the normality assumption (Gujarati, 2004).

## 3.3 Unit Root Tests

As time series analyses usually require examination of the nature of stationarity of the series involved, this study will conduct stationarity test for the series involved to avoid spurious regression. Test for stationarity is also called the unit root test. Stationarity of series implies that the series are time-invariant in their unconditional moments (mean, variance and covariance). Empirically, it is expected that all series to be used for estimation are stationary as the use of non-stationary series will result in spurious regression. Stylized facts of time series variables suggest that time series data are usually I(1) in nature, that is, they are stationary only after the first difference. There are different approaches to testing for stationarity of a series. This study employs two approaches, namely; Augmented Dickey-Fuller (ADF) test and Phillip-Perron (PP) test.

The essence of using two tests of stationarity is to examine the robustness and consistency of the unit root result. The null hypothesis for ADF and PP test is that the series has unit root; implying that the series is not stationary. To test for the order of integration I(d) or stationarity of economic series, the researcher needs to test the stationarity at the level and at first difference. If the series is stationary at level, then the series is not integrated, meaning it is I(0). The letter *d*, which defines the order of integration, is zero (0) in this case. However, if the series is not stationary at level but after first difference, the series is defined as I(1). It is also possible for a series to be I(d>1), however, such transformation may not fit well in economic analysis.

### 3.3.1 Augmented Dickey-Fuller (ADF) Test

Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) test are the unit root tests proposed by Dickey and Fuller (1979 and 1981). ADF test advanced the DF test to include extra lagged terms of the dependent variable in order to eliminate autocorrelation. The key assumption of the two tests is that testing for non-stationarity is equivalent to testing for the existence of a unit root. The test equation for DF test is an autoregressive model defined as $y_t = \delta y_{t-1} + u_t$. In this model, the null hypothesis of unit root is not rejected if $\delta$ is not significantly different from 1. Hence, the null hypothesis is ($H_0 : \delta = 1$) and the alternative hypothesis is $H_0 : \delta < 1$. However, when the test equation is reparameterized and the DF test is expressed as, $\Delta y_t = \gamma y_{t-1} + u_t$ where $\gamma = \delta - 1$, then, the null hypothesis is $H_0 : \gamma = 0$, and the alternative hypothesis is $H_0 : \gamma < 0$.

DF also proposed two other alternative test equations for unit root. The first includes a constant in the random walk process earlier specified, while the other includes a non-stochastic trend. These two tests can be specified as $\Delta y_t = \alpha + \gamma y_{t-1} + u_t$ and $\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + u_t$, respectively. Notwithstanding, the test for significance of unit root in any of the three test equations remains on the '*t*' test of the coefficient of the lagged dependent variable $y_{t-1}$.

ADF test is an extension of the DF test with the extra lagged terms of the dependent variable in order to eliminate autocorrelation. The lag length on these extra lag terms is determined either by the Schwartz Bayesian Criterion (SBC) or Akaike Information Criterion (AlC). As ADF is superior to the DF test, ADF will be used in this study, and the test will be conducted using the best of the three test equations. Hence, the ADF unit root test will be examined under the following three equations:

*ADF unit root with none (no constant and no deterministic trend)*:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \phi_i y_{t-i} + u_t \tag{3.13}$$

*ADF unit root with constant (constant and no deterministic trend)*:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{i=1}^{p} \phi_i y_{t-i} + u_t \tag{3.14}$$

*ADF unit root with constant and trend (constant and deterministic trend)*:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \phi_i y_{t-i} + u_t \tag{3.15}$$

The ADF test is estimated with Ordinary Least Square estimator (OLS), with the number of lags for the dependent variable selected using AIC or SBC, or more usefully by the lag length necessary to whiten the residuals (i.e. after each case we check whether the residuals of the ADF regression are autocorrelated or not through LM tests and not the DW test). The null hypothesis for the ADF is similar to that of DF test, implying that the test conclusion is based on the '$t$' test on the coefficient of the lagged dependent variable $y_{t-1}$ and that null hypothesis remains $H_0 : \gamma = 0$ the alternative hypothesis is $H_0 : \gamma < 0$. Since the actual data generating process is unknown to the researcher, the three tests will be employed and the best model shall be considered as the one that detects unit root most efficiently.

### 3.3.2 Phillips-Perron (PP) Test

The distribution theory for Dickey-Fuller tests is based on the assumption that the error terms are statistically independent and have a constant variance. So, when using the ADF methodology, it is required that the error terms are uncorrelated and that they really have a constant variance. While this assumption appears too restrictive, Phillips and Perron (1988) developed a generalization of the ADF test procedure that allows for fairly mild assumptions concerning the distribution of errors. The test regression for the Phillips-Perron (PP) test is the AR(l) process, this is specified as below:

$$\Delta y_t = \pi y_{t-1} + e_t \tag{3.16}$$

This specification is similar to that of the DF test; however, the difference is in the asymptotic for the residual $e_t$, which is different from that of DF and ADF, $u_t$. As stated earlier, the error term is assumed to be normally distributed under the DF and ADF tests, and the problem of autocorrelation in the DF test is corrected with lagged dependent variable in the ADF test. In PP test, however, any serial correlation and heteroskedasticity in the errors $u_t$ are corrected non-parametrically, by modifying the Dickey-Fuller test statistics. In other words, one advantage of the PP tests over the ADF tests is that the PP tests are robust to general forms of heteroskedasticity in the error term $u_t$. Hence, PP test statistics can be viewed as Dickey-Fuller statistics that have been made robust to serial correlation by using the Newey–West (1987) heteroskedasticity and autocorrelation consistent covariance matrix estimator.

Just like the ADF test, PP test would also be specified with no constant no trend, with constant only and with constant and trend in this study.

*PP unit root with no constant no trend (no constant and no deterministic trend)*:

$$\Delta y_t = \pi y_{t-1} + e_t \tag{3.17}$$

*PP unit root with constant (constant and no deterministic trend)*:

$$\Delta y_t = \alpha + \pi y_{t-1} + e_t \qquad (3.18)$$

*PP unit root with constant (constant and no deterministic trend)*:

$$\Delta y_t = \alpha + \beta t + \pi y_{t-1} + e_t \qquad (3.19)$$

The PP test equations (3.17, 4.18 & 3.19) are also estimated with OLS. The null hypothesis for the PP is similar to that of ADF test, implying that the test conclusion is based on the '*t'* test on the coefficient of the lagged dependent variable $y_{t-1}$ and that null hypothesis remains $H_0 : \pi = 0$ the alternative hypothesis is $H_0 : \pi < 0$. Since the actual data generating process is unknown to the researcher, the three test equations will be employed and the best model shall be considered as the one that detects unit root most efficiently.

## 3.4 Estimation Procedure and Empirical Framework

In dealing with the first objective of this study, which is to examine how oil export dependence affects exchange rate behaviour in Nigeria, Structural Vector Autoregressive with block exogeneity (SVARX) model was employed. As a system equation model, this is considered suitable for the implementation of the Mundell-Fleming-Dornbusch theoretical framework. For the second objective, which is to examine the exchange rate stabilising potential of different non-oil sectors, simulation approach based on the estimated coefficients from sector-based SVARX model was employed.

### 3.4.1 SVAR Model with Block Exogeneity

The Structural Vector Autoregression (SVAR) model are the new class of econometric models introduced by Sims (1981), Bernanke (1986), and Shapiro Watson (1988) do deal with the problem associated with the Vector Autoregression (VAR) model, such as lack of economic meaning and failure to address issue of expectation (Lucas critique) (see Khan et al., 2010). The Structural Vector Autoregressive (SVAR) model has been employed by different studies in examining the effect of macroeconomic and trade shocks on exchange rate behaviour (see for example, Dungey and Pagan, 2000; Daly, 2006; Inoue and Hamori, 2009; Khan et al., 2010; Narayan, 2013; Effiong, 2014; Ebaidalla, 2016). Some of the attractions of SVAR model include its flexibility, which allows for long-run and contemporaneous restrictions, following for example, Blanchard and Quah (1989) and Clarida and Gali (1994) identification restrictions. Another attraction is its ability to deal with the problem of endogeneity often associated with single equation model (see Dungey and Pagan, 2000).

Notably, the SVAR model, like the basic VAR model, describes all variables in the model as endogenous variables. Meanwhile, oil export dependence is defined in this study to be partly external (depending on oil market) and partly exogenous (dependent on non-oil market/export diversification). While the external components of oil export dependence can be captured within the SVAR model (see for example Olubusoye et al., 2016), the exogenous component cannot. This necessitates the use of SVARX in this study, which is an SVAR model augmented with block of exogenous variables. Other exogenous variables considered are total imports and official exchange rate. These exogenous variables can be influenced by the Nigerian government to moderate the behaviour of Nigeria's exchange rates.

Estimation procedure for SVARX model, like some other time series econometric models, usually starts with unit root test. As stated earlier, this is to avoid the problem of spurious regression. Unit root test define the nature of stationarity of the series, and conclude whether the variables are I(0) or I(1). In this study, seven variables will be considered, so, it is not unlikely to have variables of having mixed orders of integration (that is, being mix of I(0) and I(1)). Where this occurs, the researcher will ensure that the variables enter into the model in their stationary form. This may be through log transformation or first differencing or both. Meanwhile, variation in the orders of integration will affect the long run shock impact of the variables; while shock to I(0) series will be temporary, shock to I(1) series can be temporary or permanent, depending on the restrictions imposed by the researcher (see Ouliaris et al., 2016).

The next step after unit root is to specify and estimate the unrestricted VARX model. For the current study, the unrestricted VARX model for eq. 7 will be specified as:

$$z_t = B_1 z_{t-1} + ... + B_p z_{t-p} + C_t x_t + e_t \tag{3.20}$$

where $z_t = (oed,\ ygap,\ \inf,\ rintdiff,\ dres,\ exr,\ rer)'$, $e_t$ is the 7x1 vector of the $z_t$ variables and $B_j$ is 7x7 matrix of the coefficients of lagged values of $z_t$. More so, *oed* indicates log of oil export dependence, *ygap* is output gap, *rintdiff* represents real interest rate differential, *dres* is the log of change in external reserves, *exr* is the log of the gap between Bureau De Change (BDC) and the official NERs $(e_2 - e_1)$, and *rer* is the real exchange rate defined as the foreign price relative to domestic price of common basket of goods). The block exogeneity vector is defined as $x_t = (m,\ e_1,\ nox)'$, where $m$ is the total import, $e_1$ is the change in the official exchange rate, and *nox* is the non-oil export, while $C_t$ is the 7x3 matrix of the exogeneous variables (see Tables A3 and A4 in Appendix for data list and transformation of variables, respectively).

One important issue when estimating an unrestricted VAR(X) is the selection of optimal lag length. It has been confirmed that more lags improve the fitness of the model but it reduces the degrees of freedom and increases the danger of over-fitting. This study will use the minimum of lag selected by Akaike Information criterion (AIC) and the Schwarz-Bayesian criterion (SBC). These two statistics are measures of the trade-off fit against loss of degrees of freedom so that the best lag length is the one that minimise the two.

In the next step, the SVAR model is specified by distinguishing between contemporaneous and lagged effects. More generally, SVAR could be written as $A_0 z_t = A_1 z_{t-1} + C_t + B\eta_t$, with $\text{var}(\eta_{it})$ set to unity and with $A_0$ and $B$ chosen to capture the contemporaneous interactions among the $z_t$ and among the standard deviations of the shocks, respectively, while $C_t$ is the vector of exogenous variables. But unfortunately, the model cannot be estimated directly due to identification issues, but instead we can re-parameterize to have an unrestricted VAR of the form: $A_0^{-1} C(L) z_t + A_0^{-1} B\eta_t$. To obtain the actual solution, there is need to impose restrictions on our VAR to identify an underlying structure. There are three types of restrictions, these are: (i) making the system recursive, (ii) imposing parametric restrictions on the $A_0$ matrix and (iii) imposing parametric restrictions on the impulse responses to the shocks $\varepsilon_t$ (Ouliaris et al., 2016).

In this study, we employ SVARX method, based on the assumption of the Mundell-Fleming-Dornbusch model. The final equation after necessary restrictions is

$$Ae_t = B\eta_t + C_t \tag{3.21}$$

The restriction condition for identification stated that, if there are k variables, the symmetry property above imposes k(k+1)/2 restrictions on the $2k^2$ unknown elements in A and B. Hence an additional k(3k-1)/2 restrictions must be imposed. In this study, relying on the Mundell-Fleming-Dornbusch model, A and B matrix can be defined as below:

$$A=\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\ 0 & a_{52} & a_{53} & a_{54} & 1 & a_{56} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix} \qquad B=\begin{bmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & a_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & a_{33} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & a_{55} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & a_{66} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & a_{77} \end{bmatrix}$$

$$C=\begin{bmatrix} 0 & 0 & c_{13} \\ c_{21} & 0 & c_{23} \\ c_{31} & 0 & 0 \\ 0 & c_{42} & 0 \\ c_{51} & 0 & c_{53} \\ c_{61} & c_{62} & c_{63} \\ c_{71} & c_{72} & c_{73} \end{bmatrix}$$

Notably, with seven (7) endogenous variables, a total of 7*[(3*7)-1]/2 = 70 restrictions are required. In the model specified (eq. 3.21), contemporaneous matrix, $A$, consists of 28 coefficients restrictions, while the own shock matrix, $B$, consists of 42 coefficients restrictions. This implies that the mode is exactly identified. For the exogeneity block, C, import (on first column) was restricted from affecting OED and real interest rate differential, official exchange rate was described to affect inflation rate, NER and RER, and non-oil export was designed to affect OED, real output, external reserves, NER and RER.

Suppose $e_t$ is the reduced-form VAR innovations for the SVARX model such that $e_t = A_0^{-1}\eta_t$, the structural innovations would be derived from the reduced-form innovations by imposing exclusion restrictions on $A_0^{-1}$ (see Kilian and Park, 2009). This relationship is presented in the representation below.

$$e_t \equiv \begin{pmatrix} e_{1t}^{oed} \\ e_{2t}^{ygap} \\ e_{3t}^{\inf} \\ e_{4t}^{r\,\mathrm{int}\,diff} \\ e_{5t}^{dres} \\ e_{6t}^{ner} \\ e_{7t}^{rer} \end{pmatrix} = \left[\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\ 0 & a_{52} & a_{53} & a_{54} & 1 & a_{56} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix}\right] \begin{pmatrix} \eta_{1t}^{trade/oed\ shock} \\ \eta_{2t}^{output\ shock} \\ \eta_{3t}^{price\ shock} \\ \eta_{4t}^{monetary\ shock} \\ \eta_{5t}^{forex\ shock} \\ \eta_{6t}^{NER\ shock} \\ \eta_{7t}^{RER\ shock} \end{pmatrix} \qquad (3.22)$$

The structural identifying restrictions of the representation (in eq. 3.22) follow the postulations of the Mundell-Fleming-Dornbusch framework described in section 3.2.2.

***Identifying Restrictions for the SVARX Model***

The main restrictions are discussed as follows:

i. Oil export dependence (OED) shock has contemporaneous effect on other variables in the system (output, inflation, interest rate, nominal exchange rate and real interest rate) except the change in external reserves, but there is no feedback effect of shocks to these variables on OED. This relies on the assumption of small open economy for Nigeria, in which case, the idiosyncrasies of the international oil market can affect macroeconomic performance in Nigeria, but macroeconomic performance of Nigeria does not affect the international oil market (see also Olofin et al., 2021). Meanwhile, OED shock was restricted from affecting external reserves contemporaneously.

Change in external reserves, in this model, was defined the commitment of the monetary authority to defend the gap between official and nominal exchange rate (eq. 3.11), hence, the level of commitment is not expected to change spontaneously as OED increases or decreases.

ii. Nominal exchange rate or the gap between the parallel and official exchange rates is influenced contemporaneously by OED and macroeconomic shocks, such as the output shock, price shock, monetary shock, and foreign exchange shock. However, it was restricted from having contemporaneous effect on OED, output, inflation, and real interest rate differential. It was not restricted from affecting changes in external reserves contemporaneously following the definition of the relationship between exchange rate and external reserves. This indicates that as the gap between the parallel and official exchange rate increases, external reserves increase (see eq. 3.11).

iii. Real exchange rate is influenced contemporaneously by OED and macroeconomic shocks, such as the output shock, price shock, monetary shock, foreign exchange shock and nominal exchange rate shock. However, it was restricted from having contemporaneous effect on OED, output, inflation, real interest rate differential, change in external reserves and nominal exchange rate. Notably, real exchange rate was described to be influenced by NER exchange rate-specific shocks and other relevant macroeconomic shocks.

The dynamic effect of oil export dependence on exchange rate behaviour in the SVARX model can be described using the Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD). These analytical procedure for these two techniques is described below:

***SVAR Impulse Response Function (IRF)***

The SVAR Impulse response function defined the time path of the response of a particular variable to own shock and shock from other variables in the SVAR system. Impulse responses to structural shocks is achieved by using the relation between the VAR and SVAR shocks of $e_t = A_0^{-1}\eta_t$, where the use of $\eta_t$ as against $\varepsilon_t$ indicates an un-normalized form, i.e. the standard deviations of the shocks are absorbed into the diagonal elements of $A_0$. The MA representation for a VAR specified in eq. 3.23 is defined as $z_t = D(L)e_t$, which will produce $z_t = D(L)A_0^{-1}\eta_t = C(L)\eta_t$ as the MA form for SVAR. This implies that $C(L) = D(L)A_0^{-1}$. Therefore, the impulse responses $D_l$ can be regarded as the weights attached to $e_t$ in a Moving Average (MA) representation for $z_t$, and can be resolved recursively. For example,

$$\begin{aligned}
D_0 &= I_n \\
D_1 &= B_1 D_0 \\
D_2 &= B_1 D_1 + B_2 D_0 \\
&\vdots \\
D_j &= B_1 D_{j-1} + B_2 D_{j-2} + \ldots + B_p D_{j-p}
\end{aligned} \tag{3.23}$$

Eq. 3.23 is the MA representation for VAR. As $C(L) = D(L)A_0^{-1}$, MA representation for SVAR can be defined as follows;

$$\begin{aligned}
C_0 &= A_0^{-1} \\
C_1 &= D_1 A_0^{-1} = B_1 D_0 A_0^{-1} = B_1 C_0 \\
C_2 &= D_2 A_0^{-1} = \left(B_1 D_1 + B_2 D_0\right) A_0^{-1} = B_1 C_1 + B_2 C_0 \\
&. \\
&. \\
C_j &= D_j A_0^{-1} = \left(B_1 D_{j-1} + \ldots + B_p D_{j-p}\right) A_0^{-1} = B_1 C_{j-1} + \ldots + B_p C_{j-p}
\end{aligned} \tag{3.24}$$

Finally, since $D_j$ can be computed by knowing just the VAR coefficients $B_1 \ldots B_p$; they do not depend on the structure of the model. Thus, once a structure is proposed that determines $C_0$; all the components of $C_j$ can be found. This presupposes that the key issue for structural impulse responses is how $C_0$ is to be estimated.

***SVAR Forecast Error Variance Decomposition (FEVD)***

It may also be important to decompose the variances of the forecast errors for $z_{jt+h}$ into the percentage explained by each of the shocks, using information at time t. Suppose we have two-variable SVAR model and the variance of the two-step ahead prediction errors is:

$$\begin{aligned} V_2 &= \operatorname{var}(C_0\eta_{t+2}) + 2\operatorname{cov}(C_0\eta_{t+2}, C_1\eta_{t+1}) + \operatorname{var}(C_1\eta_{t+1}) \\ &= C_0C_0^{'} + C_1C_1^{'} \end{aligned} \tag{3.25}$$

since $\operatorname{cov}(\eta_t) = I_2$.

Taking n=2 and partitioning the matrix as

$$C_0 = \begin{bmatrix} c_{11}^0 & c_{12}^0 \\ c_{21}^0 & c_{22}^0 \end{bmatrix}, \qquad C_1 = \begin{bmatrix} c_{11}^1 & c_{12}^1 \\ c_{21}^1 & c_{22}^1 \end{bmatrix} \tag{3.26}$$

the variance of the two-step prediction error for the first variable will be

$$\Delta = \left(c_{11}^0\right)^2 + \left(c_{12}^0\right)^2 + \left(c_{11}^1\right)^2 + \left(c_{12}^1\right)^2 \tag{3.27}$$

Hence the first shock contributes $\left(c_{11}^0\right)^2 + \left(c_{11}^1\right)^2$ to the variance of the prediction error of $z_{1t}$, meaning that the fraction of the 2-step forecast variance accounted for by it will be $\frac{\left(c_{11}^0\right)^2 + \left(c_{11}^1\right)^2}{\Delta}$. Summarily, the Forecast Error Variance Decomposition (FEVD) gives these ratios for forecasts made at *t* into the future but expressed as percentages.

### 3.4.2 Post-estimation Tests

To test for the efficiency of the estimated coefficients different post-estimation tests shall be considered. This shall include the endogeneity test, serial correlation test, Autoregressive conditional heteroscedasticity test, and normality test.

## 3.5 Nature and Sources of Data

This study basically relies on secondary data obtained from relevant institutions. It consists of six decades annual data, from 1960 to 2019. The comprehensive list of data employed in this study, together with their acronyms, units of measurement and sources of data is summarized in Table 3.1.

**Table 3. 1: Variable Description**

| Data description | Index | Freq. | Measurement | Source |
|---|---|---|---|---|
| Level of oil export dependence | OED | Annual | Percentage | CBN (computed as oil export as percentage of total merchandise export) |
| Real exchange rate | RER | Annual (annual average) | Index | Computed as RDAS/WDAS nominal Naira per USD exchange rate multiplied by the ratio of US to Nigeria Consumer Price Index. |
| Nominal exchange rate | NER1 | Annual (annual average) | Naira/USD | CBN (RDAS/WDAS Naira per USD rate) |
| BDC exchange rate | NER2 | Annual (annual average) | Naira/USD | CBN (Bureau De Change Naira per USD rate) |
| Nigeria Consumer Price Index (CPI) | NGCPI | Annual | Index | CBN |
| US Consumer Price Index (CPI) | USCPI | Annual (annual average) | Index | Fred St. Lious (Consumer Price Index – All items) |
| Real interest rate differential in relation to US interest rate | INTD | Annual (annual average) | Percentage | Computed based Nigeria and US interest rate and CPI data from WDI |
| GDP per capita | GDP | Annual | Billion Naira | CBN |
| External reserves | EXTR | Annual (annual average) | Million USD | CBN |

Note: CBN represents Central Bank of Nigeria; Fred St. Lious indicates Federal Reserves of St. Lious; WDI is World Development Indicators; IFS represents International Financial Statistics.

# CHAPTER FOUR

# RESULTS AND DISCUSSION

## 4.0 Overview

This chapter deals with the presentation and discussion of the results from the analyses of the relationship between oil export dependence and Nigeria's exchange rates using Managed Floating augmented Mundell-Fleming-Dornbusch model as the theoretical framework and Structural Vector Autoregressive model with exogenous variables (SVARX) model as the methodological framework. The section is sub-divided into two sub-sections. The first sub-section deals with the presentation of results. This includes the presentation of the results of the descriptive statistics, unit root tests and empirical results of the study, consisting of the contemporaneous coefficients, impulse-responses relation and forecast error variance decomposition. Sensitivity and robustness analysis is conducted by comparing the results obtained under the full sample (1960 to 2019) with the results of the relationship after 1976 when export promotion policy was first introduced in Nigeria. The results for the post-estimation residual diagnostics are also presented. The second-sub-section proffers detailed discussion of the results in accordance with the objectives of the study.

## 4.1 Descriptive Statistics and Stylized Facts

Descriptive statistics are one of the preliminary tests conducted to understand the nature of the data being used for the analysis. These include measures of central tendencies such as the mean, minimum and maximum and measures of variable distribution such as standard deviation, skewness, kurtosis and Jarque-Bera statistics. The descriptive statistics are presented in Table 4.1. The table shows that the number of observations for all the series is sixty (60), indicating full observation for all the variables from 1960 to 2019.

The average level of oil export dependence (OED) in the six decades under consideration is 80.98 percent. The minimum level of OED of 2.60 percent was achieved in 1960 while the maximum level of 98.72 was achieved in the year 2000. The OED is negatively skewed, suggesting that it is has long tail to the left. In other words, the left of the distribution of OED is wider than that of the normal distribution. The kurtosis for OED is higher than 3, implying that OED is leptokurtic. This suggests that the series contains some extremely high values. The Jarque-Bera (JB) statistic which determines normality based on the combined effect of skewness and kurtosis concludes that the null hypothesis that OED is normally distributed is significantly rejected. The nominal GDP of Nigeria (CGDP) ranges between ₦6.79 billion and ₦144.21trillion in the six (6) decades under consideration. The minimum GDP was observed in 1960 while the maximum GDP emerged in 2019. Unlike the OED, Nigeria's nominal GDP is positively skewed. This implies the GDP is skewed to the right of a normal distribution density. Nominal GDP is also having excess kurtosis, as its kurtosis is in excess of 3. The J-B statistic for CGDP is statistically significant, implying that the null hypothesis that CGDP is normally distributed can be rejected.

The broad money supply (BRM) and external reserves (RES) have similar normality property with CGDP. This is apparent as they are both positively skewed and leptokurtic. However, Nigeria's broad money supply has the average of ₦4,579.85 billion in the six (6) decades and ranged between ₦0.28 billion in 1960 to ₦34,776.38 billion in 2019. Whereas, the average value of Nigeria's external reserves during the period is US$12,628.67 million. Nigeria's foreign reserves was at its minimum value US$112.36 million in 1967 while its maximum value of US$53,599.28 million was observed in 2008. More so, the official and the BDC exchange rate are also positively skewed and leptokurtic, and are confirmed to be non-normally distributed by the J-B statistic. The standard deviation of the BDC exchange rate (EXR2) is higher than that of the official exchange rate (EXR1). This suggests that BDC exchange rate is more volatile that the official exchange rate. This is expected, as the monetary authority avoids significant changes in the official exchange rate.

**Table 4. 1: Descriptive Statistics**

| | Mean | Max. | Min. | Std. Dev. | Skew. | Kurt | J-Bera | Obs. |
|---|---|---|---|---|---|---|---|---|
| OED | 80.98 | 98.72 | 2.60 | 29.03 | -1.74 | 4.37 | 34.98*** | 60 |
| CGDP | 19,877.91 | 144,210.50 | 6.79 | 36,510.99 | 1.93 | 5.63 | 54.67*** | 60 |
| BRM | 4,579.85 | 34,776.38 | 0.28 | 9,085.13 | 2.04 | 5.98 | 63.79*** | 60 |
| RES | 12,628.67 | 53,599.28 | 112.36 | 16,893.34 | 1.22 | 2.87 | 14.86*** | 60 |
| EXR1 | 61.43 | 306.92 | 0.55 | 87.01 | 1.38 | 4.05 | 21.72*** | 60 |
| EXR2 | 74.85 | 395.42 | 0.55 | 103.30 | 1.59 | 5.09 | 36.15*** | 60 |
| CPING | 40.08 | 267.51 | 0.07 | 65.60 | 1.88 | 5.78 | 54.60*** | 60 |
| CPIUS | 58.83 | 117.24 | 13.56 | 34.25 | 0.12 | 1.65 | 4.70*** | 60 |
| OX | 3,149.39 | 17,282.25 | 0.01 | 5,108.35 | 1.46 | 3.72 | 22.63*** | 60 |
| NOX | 226.73 | 3,207.02 | 0.20 | 523.81 | 3.61 | 19.02 | 772.08*** | 60 |
| AGRFX | 69.03 | 649.61 | 0.18 | 144.05 | 2.18 | 7.08 | 89.00*** | 60 |
| MFGX | 107.96 | 2,139.81 | 0.0019 | 303.35 | 5.29 | 34.96 | 2,833.62*** | 60 |
| SLMX | 9.62 | 95.92 | 0.0003 | 21.17 | 2.29 | 7.53 | 103.76*** | 60 |

Source: Computed by the Author

Note: OED = Oil Export Dependence (%); CGDP = GDP at current price (₦' Billion); BRM = Broad Money Supply (₦' Billion); RES = External Reserves (US$' Million); EXR1 = Official Exchange Rate (₦/US$); EXR2 = Bureau De Change Exchange Rate (₦/US$); CPING = Consumer Price Index for Nigeria (Index, 2010=100); CPIUS = Consumer Price Index for United States (Index, 2010=100); OX = Oil Export (₦' Billion); NOX = Non-oil Export (₦' Billion). For the purpose of sectoral analysis, NOX is decomposed into Agricultural and Food Export (AGRFX), Manufacturing Export (MGFX) and Solid Minerals Export (SLMX). Asterisk, "***" indicates significance at 1% level.

Furthermore, the average values of oil export (OX) in these six decades periods is ₦3,149.39 billion and the average of non-oil export (NOX) during the period is ₦226.73. This suggests that Nigeria's earnings from oil export is about 14 times more than its earnings from non-oil export. The standard deviation of OX is about 10 times larger than that of the non-oil export, justifying the relative higher volatility of earnings from oil compared to non-oil. This may not be unrelated to the effect of oil price, which is inherently unstable. Earnings from both oil and non-oil exports are not normality distributed as summarized by their J-B statistics. For the purpose of sectoral analysis, NOX is decomposed into Agricultural and Food Export (AGRFX), Manufacturing Export (MGFX) and Solid Minerals Export (SLMX). As evident in Table 5.1, earnings from export of manufactured goods in higher than the earnings from agricultural exports over the six decades being considered. This is also corroborated by their maximum values. While the maximum values of MFGX of ₦2,139.81 billion was achieved in 2019, the maximum values of AGRFX of ₦649.61 was obtained in 2013. This suggests that manufacturing sector has higher value addition than the agriculture and solid mineral sectors. Nonetheless, the standard deviation of MFGX is the highest, compared to of the AGRFX and SLMX, implying that the issue of instability in FX earnings will persist with higher diversification into MFG sector. This suggests that dependence on agriculture sector can general stable but relatively low FX earnings.

The Consumer Price Index (CPI) for Nigeria is used to compute inflation rate, Nigeria's real GDP and real money balances. It was also used, in conjunction with the CPI for the United States, to compute Nigeria's RER. The data for the real variables and inflation rate is presented in Table 5.2. Evidence from the table shows that the average value of Nigeria's real GDP in the six decades period is US$294.17 billion. Its minimum value of US$101.15 billion was obtained in 1968 while its maximum value of US$610.71 billion was obtained in 2014. The table further shows that the RGDP is positively skewed and platykurtic (kurtosis statistic less than 3). The JB statistic shows that RGDP is not normally distributed.

**Table 4. 2: Descriptive Statistics of Real Variables and Inflation rate**

| Variables | Mean | Max. | Min. | Std. Dev. | Skew. | Kurt. | J.-Bera |
|---|---|---|---|---|---|---|---|
| RGDP | 294.17 | 610.71 | 101.15 | 156.23 | 0.66 | 2.17 | 6.12*** |
| RER | 138.86 | 279.68 | 47.30 | 61.70 | 0.42 | 2.51 | 2.36 |
| RINTDIFF | 10.50 | 28.15 | 0.19 | 6.28 | 0.33 | 2.41 | 1.93 |
| INF | 14.07 | 54.72 | -3.80 | 12.05 | 1.64 | 5.45 | 41.25*** |

Source: Computed by the Author

Note: RGDP = Real GDP (₦' Billion); RINTDIFF = Real interest rate differential (%); RER = Real Exchange Rate (Index, 2010=100); INF = Domestic inflation rate (%). Asterisk, "***" indicates significance at 1% level.

In addition, the table shows that the average value of the real interest rate differential (RINTDIFF) of Nigeria in the six decades period is 10.50 percent. Its minimum value of 0.19 percent was achieved in 1981 while its maximum value of 28.15 percent was recorded in 1993. Unlike the real GDP, the RINTDIFF is normally distributed as explained by the statistically insignificant coefficient of the J-B statistic for RINTDIFF. Similarly, RER is normally distributed. Its mean value is above 100 basis points, suggesting that Nigeria's goods valued less the foreign goods on the average during the six decades period, although the depreciation was largely stimulated by currency devaluation (see Figure 2.30 in section 2.2.3.2). Its highest level of depreciation of 279.68 basis points was observed in 1992 when the official exchange rate was devalued from ₦9.91/US$ to ₦17.3/US$ between 1991 and 1992, while its highest level of appreciation of 47.30 basis points was observed in 1984, leading to NER devaluation in 1985-86.

Lastly, the inflation rate of Nigeria over the six decades period ranged between -3.80 percent observed in 1967 and 54.72 percent observed in 1995. The average inflation in the period is double-digit of 14.07 percent. Nigeria's inflation rate is positively skewed and has fat tail (leptokurtic), suggesting that it is not normally distributed. This assertion was confirmed by the Jarque-Bera statistic for INF, which shows that the null hypothesis of normality for inflation rate series can be rejected at 1% level of statistical significance.

## 4.2 Results of Unit Root Tests

Unit root test is an important preliminary test when conducting time series analysis. Knowing the stationarity property of the variables for the analysis helps researchers, in the choice of appropriate empirical model and/or the description of variables in the model, to circumvent the problem of spurious regression. For ease of analysis, all the variables have been log transformed, except in interest rate differential which may possibly turn negative. LOED is the log of oil export dependence; YGAP is the log difference between the real GDP and its potential; RINTDIFF is the difference between real interest rate of Nigeria (that is, nominal interest rate of, minus inflation rate of, Nigeria) and the real interest rate of the United States (that is, nominal interest rate of, minus inflation rate of, the US); INF is the log of the current CPING minus the log of the immediate past values of CPING; E2 is the log of the Bureau De Change (BDC) exchange rate; Q is the log of the BDC exchange rate plus the log of consumer price index of the United States (CPIUS) minus the log of CPING; LIMP is the log of total imports; DRES is the log of the current external reserves minus log of its immediate past value; and E1 is the log of Nigeria's official exchange rate.

**Table 4. 3: Results of Unit root tests**

| Variables | Specification | ADF | DFGLS | PP | Remark |
|---|---|---|---|---|---|
| LOED | None | 0.2501 | - | 0.8634 | I(0) |
| | Constant | -7.5898$^{a}$ | 0.0257 | -20.3334$^{a}$ | |
| | Constant & Trend | -5.9038$^{a}$ | -0.8524 | -17.2659$^{a}$ | |
| YGAP | None | -4.2449$^{a}$ | - | -4.2369$^{a}$ | I(0) |
| | Constant | -4.2078$^{a}$ | -4.0956$^{a}$ | -4.1990$^{a}$ | |
| | Constant & Trend | -4.1715$^{a}$ | -4.1832$^{a}$ | -4.1621$^{a}$ | |
| RINTDIFF | None | -0.6736 | - | -0.6382 | I(0) |
| | Constant | -1.9735 | -1.5632 | -2.0070 | |
| | Constant & Trend | -3.2243$^{c}$ | -3.3134$^{a}$ | -2.6437 | |
| INF | None | -2.1516$^{b}$ | - | -2.0166$^{b}$ | I(0) |
| | Constant | -4.0839$^{a}$ | -3.3533$^{a}$ | -3.4515$^{b}$ | |
| | Constant & Trend | -4.0597$^{b}$ | -3.5841$^{a}$ | -3.4346$^{c}$ | |
| E2 | None | 0.8076 | - | 1.2433 | I(1) |
| | Constant | -0.3166 | 0.2209 | -0.0816 | |
| | Constant & Trend | -1.8866 | -1.5354 | -1.8048 | |
| Q | None | -0.2445 | - | -0.2622 | I(0) |
| | Constant | -2.7083$^{c}$ | -2.6811$^{a}$ | -2.3152 | |
| | Constant & Trend | -2.9116 | -2.8133$^{a}$ | -2.4907 | |
| LIMP | None | 3.1638 | - | 2.4300 | I(0) |
| | Constant | 0.0590 | 2.0047$^{b}$ | 0.0474 | |
| | Constant & Trend | -2.3967 | -1.8701$^{c}$ | -2.5400 | |
| DRES | None | -6.5205$^{a}$ | - | -6.4516$^{a}$ | I(0) |
| | Constant | -6.3611$^{a}$ | -6.4355$^{a}$ | -6.5563$^{a}$ | |
| | Constant & Trend | -6.3006$^{a}$ | -6.6059$^{a}$ | -6.4806$^{a}$ | |
| E1 | None | 2.2712 | - | 1.5419 | I(1) |
| | Constant | 0.3785 | 0.7214 | 0.1601 | |
| | Constant & Trend | -1.8869 | -1.2252 | -1.9891 | |
| E2-E1 | None | -2.0062$^{b}$ | - | -2.2643$^{b}$ | I(0) |
| | Constant | -2.2432 | -2.1816$^{b}$ | -2.5287 | |
| | Constant & Trend | -2.2530 | -2.2994$^{c}$ | -2.5628 | |

Source: Computed by the author

Note: The superscripts a, b and c indicate statistical significance respectively at 1%, 5% and 10% levels. Also, I(0) indicates that the variable is stationary in its level form, while I(1) indicates that the variable is stationary after first difference. The variable is considered stationary if the null hypothesis of unit root is rejected for the series when the unit root test is conducted with constant and trend, with constant only, or with none of the constant and trend.

For robustness purpose, three variants of unit root tests are considered. These are the Augmented Dickey-Fuller (ADF), the Phillip-Perron and the Dickey-Fuller Generalized Least Square unit root tests. The results of the unit root tests are presented in Table 4.3. Summarily, the result shows that all the endogenous variables are stationary. Thus, in the proposed 7-equation SVARX model, E2 is the only non-stationary endogenous variable, as E1 is one of the exogenous variables in that model. Therefore, there is no basis for consideration of cointegration test, Structural Vector Error Correction (SVEC) model, or analysis of permanent effect of shocks. In other words, all shocks originating from the SVARX model are transient, short to medium term, which is consistent with the assumption of the Mundell-Fleming-Dornbusch model.

## 4.3 Oil Export Dependence and Exchange Rate Behaviour in Nigeria

### 4.3.1 Main Analysis

The results from the SVARX model can be divided into three. The first is the contemporaneous effect, which explained the immediate effect of different economic shocks on the endogenous variables. The second is the exogenous effect, which explained the effect of exogenous variables on the endogenous variables in the model. The third is the dynamic effect, which explained the effect of different economic shocks on the endogenous variables over the short to medium term horizons. This effect is explained by impulse response functions (IRF) and forecast error variance decomposition (FEVD).

Table 4.4 presents the contemporaneous and exogenous effects from the SVARX model. The results show that oil export dependence (OED) shock has significant positive contemporaneous effect on real output and inflation rate in Nigeria. In other words, lower (higher) oil export dependence caused instantaneous reduction (increase) in real output and inflation in Nigeria. This result tends to contradict the theoretical expectation on the real output effect of lower OED due to export diversification, which explains that lower OED will cause real output to increase. Thus, this result indicates the dominance of oil export in OED, as the reduction in OED over the sampled period appears to be caused by a lower oil export rather than a higher non-oil export. This may explain why lower OED will cause real output to reduce contemporaneously.

On the contemporaneous effect of oil export dependence on exchange rates in Nigeria, the results show that oil export dependence shocks have negative but insignificant contemporaneous effect on nominal (-0.0651) and real exchange rates (-0.0087). This suggests that lower (higher) oil export dependence do not have significant immediate effect on nominal and real exchange rates. In other words, achieving lower oil export dependence do not have significant immediate effect on nominal and real exchange rates. By implication, the exchange rate benefits of export diversification efforts should not be expected in the year of its initiation.

Furthermore, the results show that shocks to other factors in the system such as output shocks, demand shocks, monetary shocks, forex shocks do not have significant contemporaneous impact on nominal exchange rate. This suggests that economic shocks do not have immediate impact of the Nigeria's nominal exchange rate. This tends to represent the nature of the Nigeria's exchange rate system, where the monetary authorities resist the effect of shocks on the currency, at least in the short term. Meanwhile, there is evidence of significant positive contemporaneous effects of output shocks and forex shocks, and significant negative contemporaneous effect of demand shocks and exchange rate policy shock on real exchange rate in Nigeria. This suggests that contemporaneous adjustment to real exchange rate can be caused by sudden changes in output level, forex exchange, inflation level and exchange rate policy such as currency devaluation. As oil export dependence shock has contemporaneous effect on real output and inflation rate, it suggests that oil export dependence can have contemporaneous influence on real exchange rate indirectly through real output and inflation rate. Evidence from the comparison of the contemporaneous responses of the nominal and real exchange rates to changes in macroeconomic factors including oil export dependence support the hypothesis of this study that real exchange rate is more responsive than nominal exchange rate under managed floating exchange rate system.

As regards the exogenous factors, import was found to have negative significant effect on NER. This implies that higher import reduced the gap between parallel market and official exchange rate in the long run. This can be explained by the low level of technology in Nigeria, which necessitates imports, particularly of machinery and equipment, to enhance economic diversification and better trade position. Official exchange rate was found to have significant negative impact on nominal exchange rate and significant positive impact on real exchange rate. This implies that currency devaluation (higher official exchange rate) will tend to enhance NER stability by reducing the gap between the parallel market and official exchange rates, and cause real exchange rate depreciation. This may explain why monetary authorities often refer to currency devaluation as a way to bridge the gap between the parallel and official exchange rates, and moderate real exchange rate behaviour at the same time. However, the trends analysis conducted suggests that the closer gap between the parallel and official exchange rates and the real exchange rate depreciation generated through currency devaluation are usually not sustainable. This suggests that alternative to currency devaluation, particularly real sector innovation such as higher production, higher investment or higher exports should be used to achieve sustainable stable real and nominal exchange rates.

Furthermore, non-oil export was found to have negative but insignificant effect on oil export dependence. This suggests that, although higher non-oil export has the tendency to reduce level of oil export dependence, it does not reduce it significantly in the period under consideration. This implies that lower oil export dependence in Nigeria over this period was dominated by lower oil export (external factor) rather than higher non-oil export. In other words, non-oil export has been insufficient to herald a significant reduction in the country's level of oil export dependence. This result further explains why lower oil export dependence caused contemporaneous reduction in real output rather that an increase as may be expected when lower OED was effectively caused by higher non-oil export. This suggests that more export diversification efforts would be required to generate high level of non-oil export that would contribute significantly towards reducing the country's level of export dependence and prompt higher output.

**Table 4. 4: Contemporaneous and Exogenous effects - Full sample (1960 - 2019)**

| Variables | Contemporaneous effects | | | | | | | Exogenous effects | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | $\varepsilon^1_{oed}$ | $\varepsilon^2_{yg}$ | $\varepsilon^3_{inf}$ | $\varepsilon^4_{rintdiff}$ | $\varepsilon^5_{\Delta R}$ | $\varepsilon^6_{e_2-e_1}$ | $\varepsilon^7_{rer}$ | $m$ | $e_1$ | $nox$ |
| $oed$ | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0379 |
| $y-\bar{y}$ | 0.1741** | 1 | 0 | 0 | 0 | 0 | 0 | 2.50E-06 | 0 | 0.0465 |
| $p-p_{t-1}$ | 0.1932*** | -0.1436 | 1 | 0 | 0 | 0 | 0 | 5.37E-07 | 0 | 0 |
| $r-r^*$ | -0.1376 | 6.3667** | -3.8831 | 1 | 0 | 0 | 0 | 0 | 3.9517*** | 0 |
| $\Delta R$ | 0 | 2.5043** | -0.6685 | 0.00835 | 1 | 0.8592 | 0 | -4.72E-05 | 0 | 0.0309 |
| $e_2-e_1$ | -0.0651 | 0.1052 | 0.3930 | -0.00434 | -0.0754 | 1 | 0 | -4.03E-05*** | -0.4817*** | 0.1345*** |
| $q$ | -0.0087 | 0.0372* | -0.9156*** | 0.00091 | 0.0130*** | -0.0443*** | 1 | 3.07E-06 | 0.9830*** | -0.0111* |

Source: Computed by the Author

Note: Under the contemporaneous effects, shock 1 ($\varepsilon^1_{oed}$ ) represents oil export dependence shock, shock 2 ($\varepsilon^2_{yg}$) is the real output/aggregate supply shock, shock 3 ($\varepsilon^3_{inf}$) is the inflation/aggregate demand shock, shock 4 ($\varepsilon^4_{rintdiff}$) is the interest rate/monetary policy shock, shock 5 ($\varepsilon^5_{\Delta R}$) is the external reserves shock, shock 6 is the nominal exchange rate shock, while shock 7 is the real exchange rate shock. Under the exogenous effects, $m$ is import, $e_1$ is the official exchange rate, and $nox$ is non-oil export. Asterisks ***,**, and * indicates 1%, 5%, and 10% level of statistical significant. The detailed results for contemporaneous effects are presented in Table A6 (in Appendix), while the estimated parameters for the exogenous variables are presented in Table A7 (in Appendix). The sign of the contemporaneous coefficients is multiplied by -1 to recover the contemporaneous coefficients from A matrix.

Figure 4.1 and Table 4.5 are impulse response graphs and table for explaining the dynamic effect of oil export dependence shocks on the macroeconomic fundamentals of Nigeria including the nominal and real exchange rates. The figure shows positive effect of OED on real output in the short horizon (h2=0.0121) to medium horizons (h4=0.0023). It shows positive effect on OED on inflation rate in the short (h2=0.0283) to medium term horizons (h=0.0110), positive effect on NER (h2=0.0067, h4=0.0294), and negative effect on real exchange rate (h2=-0.0487; h4=-0.0738). Meanwhile, using the rule of thumb that a coefficient is statistically significant at 5% if the standard error of that coefficient is lower than half of the coefficient, Table 4.4 on the impulse response functions shows that the dynamic effects of OED on real output and NER are not statistically significant. However, it shows significant positive effect on inflation rate and significant negative effect on RER. This suggests that lower OED had no impact on NER but caused lower inflation and RER depreciation over the short to medium term in Nigeria. This suggests that lower level of oil export dependence in Nigeria would cause reduction in inflation rate and promote trade competitiveness of the country. Higher trade competitiveness will imply that RER is self-stabilised, which will tend to be a sustainable measure of stabilising RER rather than official devaluation of currency, which will have the consequence of destabilizing NER.

The results of the forecast error variance decomposition are presented in Table 4.6. The results show that OED is largely determined outside the system, as the real output and external reserves that explained the large variation in OED only explain less than 5% of the variations in OED after 4-year horizon. This is not surprising, as its definition shows that it is largely determined by the external (oil market dynamics) and exogenous (commitment to export diversification) factors. Meanwhile, OED explained the largest variation in RER, ranging from 17.6% of the total variation in RER in the short-term horizon (h2=17.63%) to 26.68% in the medium-term horizon (h4=26.68%). This was followed by inflation rate, for which OED explained 11.2% of its total variation in the short-term horizon (h2=11.2%) and 17.90% in the medium-term horizon (h4=17.90%). For NER, OED only explains 0.13% of its total variation in the short-term period (h2=0.13%) and 1.86% in the medium-term period (h4=1.86%). This corroborates the results from the impulse response functions.

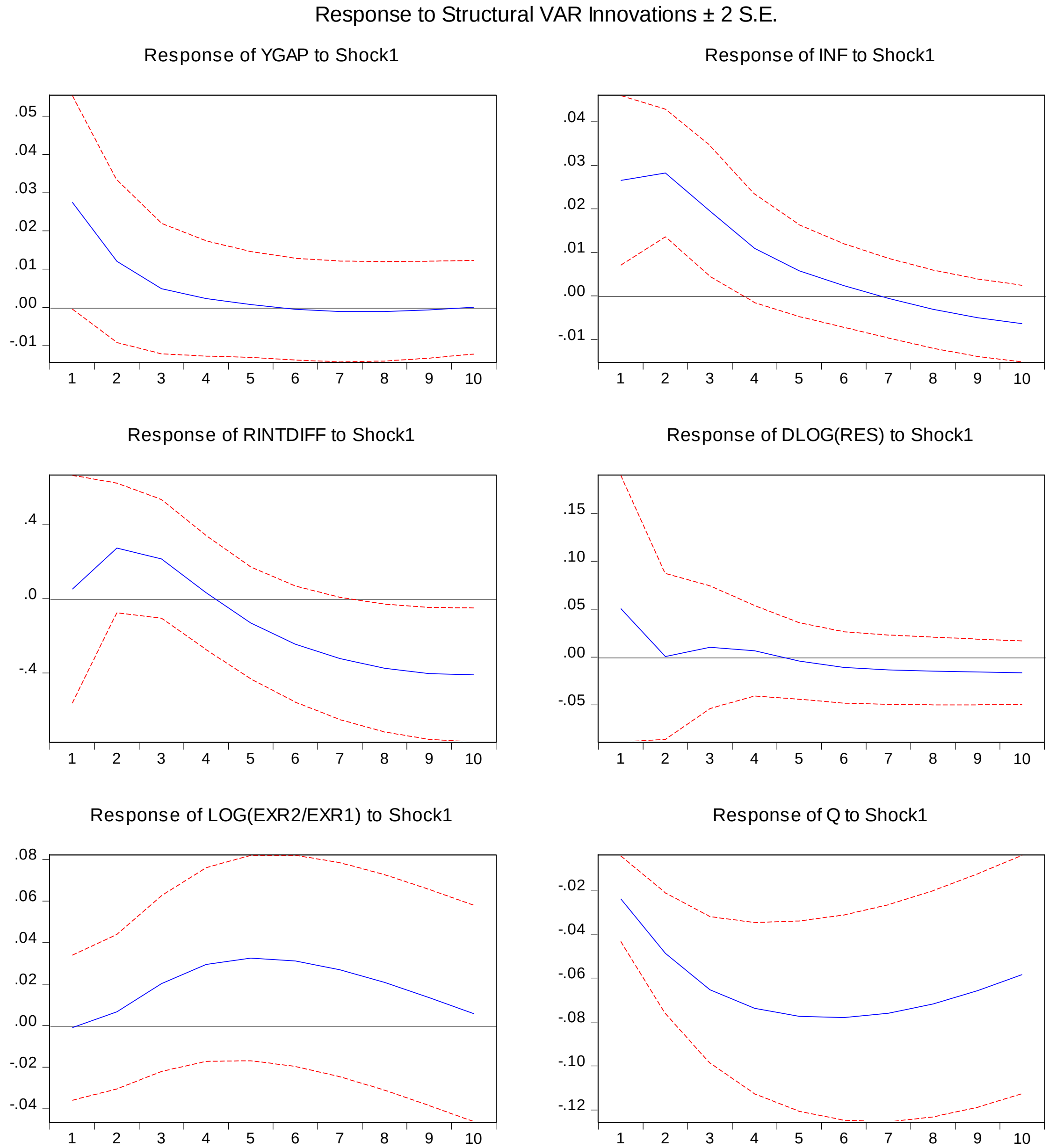



**Figure 4.1: Impulse Responses of Macroeconomic Fundamentals to OED shocks**

**Table 4. 5: The impulse responses of macroeconomic fundamentals to OED shocks**

| Period | YGAP | INF | RINTDIFF | DLOG(RES) | LOG(EXR2/EXR1) | Q |
|---|---|---|---|---|---|---|
| 1 | 0.027487 | 0.026552** | 0.050170 | 0.050663 | -0.000978 | -0.023909** |
| | (0.01395) | (0.00975) | (0.30671) | (0.06958) | (0.01745) | (0.00970) |
| 2 | 0.012063 | 0.028250** | 0.272401 | 0.000518 | 0.006709 | -0.048728** |
| | (0.01062) | (0.00732) | (0.17454) | (0.04330) | (0.01860) | (0.01369) |
| 3 | 0.004922 | 0.019490** | 0.212968 | 0.010269 | 0.020223 | -0.065360** |
| | (0.00852) | (0.00751) | (0.15957) | (0.03204) | (0.02115) | (0.01666) |
| 4 | 0.002328 | 0.010955 | 0.031594 | 0.006566 | 0.029439 | -0.073738** |
| | (0.00753) | (0.00624) | (0.15357) | (0.02359) | (0.02330) | (0.01946) |
| 5 | 0.000766 | 0.005801 | -0.131312 | -0.004182 | 0.032526 | -0.077374** |
| | (0.00691) | (0.00527) | (0.15049) | (0.01997) | (0.02470) | (0.02164) |
| 6 | -0.000446 | 0.002388 | -0.244888 | -0.010847 | 0.031152 | -0.078011** |
| | (0.00664) | (0.00480) | (0.15618) | (0.01863) | (0.02543) | (0.02334) |
| 7 | -0.001054 | -0.000535 | -0.322528 | -0.013359 | 0.026919 | -0.076035** |
| | (0.00657) | (0.00458) | (0.16445) | (0.01810) | (0.02576) | (0.02468) |
| 8 | -0.001040 | -0.003062 | -0.374397 | -0.014594 | 0.020798 | -0.071749** |
| | (0.00650) | (0.00450) | (0.17197) | (0.01768) | (0.02592) | (0.02573) |
| 9 | -0.000604 | -0.005011 | -0.403050 | -0.015636 | 0.013530 | -0.065677** |
| | (0.00634) | (0.00446) | (0.17739) | (0.01718) | (0.02600) | (0.02654) |
| 10 | 6.10E-05 | -0.006357 | -0.410335 | -0.016327 | 0.005795 | -0.058389** |
| | (0.00611) | (0.00439) | (0.18020) | (0.01656) | (0.02602) | (0.02713) |

Cholesky Ordering: LOG(OED) YGAP INF RINTDIFF DLOG(RES) LOG(EXR2/EXR1) Q
Standard Errors: Analytic

**Table 4.6: Forecast Error Variance Decomposition of the SVARX model**

Variance Decomposition of LOG(OED):

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.157853 | 100.0000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.208991 | 97.65875 | 0.197655 | 0.267483 | 0.000182 | 1.761451 | 0.114413 | 6.51E-05 |
| 3 | 0.241287 | 95.25791 | 1.323282 | 0.778722 | 0.083680 | 2.340131 | 0.215862 | 0.000413 |
| 4 | 0.262721 | 93.84793 | 2.218478 | 0.999658 | 0.234669 | 2.455752 | 0.241207 | 0.002303 |
| 5 | 0.276848 | 93.10705 | 2.742706 | 1.014168 | 0.340971 | 2.543970 | 0.245941 | 0.005195 |
| 6 | 0.286295 | 92.55277 | 3.152699 | 0.976621 | 0.403921 | 2.651840 | 0.253751 | 0.008394 |
| 7 | 0.292730 | 92.02697 | 3.553965 | 0.938358 | 0.449727 | 2.750685 | 0.268650 | 0.011642 |
| 8 | 0.297160 | 91.51911 | 3.946323 | 0.910669 | 0.490421 | 2.828896 | 0.289777 | 0.014806 |
| 9 | 0.300224 | 91.03995 | 4.310797 | 0.896517 | 0.528851 | 2.889922 | 0.316236 | 0.017731 |
| 10 | 0.302362 | 90.59391 | 4.639189 | 0.895338 | 0.565509 | 2.938127 | 0.347648 | 0.020282 |

Variance Decomposition of YGAP:

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.107996 | 6.477875 | 93.52212 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.126701 | 5.612847 | 91.05226 | 0.217287 | 0.512633 | 1.700779 | 0.899924 | 0.004271 |
| 3 | 0.130259 | 5.453200 | 88.72355 | 0.207395 | 0.495390 | 2.442569 | 2.669838 | 0.008061 |
| 4 | 0.131705 | 5.365394 | 86.90219 | 0.217490 | 0.683611 | 2.566603 | 4.254805 | 0.009908 |
| 5 | 0.132854 | 5.276331 | 85.40587 | 0.213768 | 1.062493 | 2.590082 | 5.439977 | 0.011480 |
| 6 | 0.133836 | 5.200288 | 84.17633 | 0.211324 | 1.441778 | 2.607459 | 6.349019 | 0.013804 |
| 7 | 0.134667 | 5.142409 | 83.19864 | 0.209865 | 1.781080 | 2.613146 | 7.037705 | 0.017154 |
| 8 | 0.135328 | 5.098226 | 82.45892 | 0.220648 | 2.071881 | 2.604962 | 7.523996 | 0.021369 |
| 9 | 0.135808 | 5.064198 | 81.92404 | 0.251547 | 2.301522 | 2.592072 | 7.840420 | 0.026197 |
| 10 | 0.136136 | 5.039842 | 81.54827 | 0.304759 | 2.465883 | 2.580626 | 8.029260 | 0.031365 |

Variance Decomposition of INF:

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.076573 | 12.02365 | 3.835827 | 84.14053 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 0.090866 | 18.20455 | 11.05742 | 63.49320 | 0.053992 | 3.399029 | 3.726460 | 0.065353 |
| 3 | 0.101903 | 18.13253 | 21.89075 | 50.99484 | 1.155519 | 2.707364 | 5.022692 | 0.096302 |
| 4 | 0.105769 | 17.90422 | 23.42647 | 48.02840 | 2.441405 | 3.050969 | 5.029809 | 0.118735 |
| 5 | 0.106629 | 17.91246 | 23.11531 | 47.67599 | 2.874469 | 3.306710 | 4.969469 | 0.145583 |
| 6 | 0.107108 | 17.80224 | 23.03338 | 47.73919 | 2.923776 | 3.398514 | 4.929446 | 0.173462 |
| 7 | 0.107721 | 17.60287 | 23.08513 | 47.84999 | 2.893325 | 3.452485 | 4.919317 | 0.196886 |
| 8 | 0.108535 | 17.41933 | 23.22116 | 47.82850 | 2.856711 | 3.493729 | 4.967299 | 0.213268 |
| 9 | 0.109515 | 17.31816 | 23.43217 | 47.59349 | 2.840820 | 3.510204 | 5.082224 | 0.222931 |
| 10 | 0.110576 | 17.31818 | 23.66086 | 47.18802 | 2.858702 | 3.499448 | 5.247439 | 0.227346 |

Variance Decomposition of RINTDIFF:

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 2.336128 | 0.046120 | 9.582784 | 1.363080 | 89.00802 | 0.000000 | 0.000000 | 0.000000 |
| 2 | 2.494316 | 1.233110 | 9.283764 | 1.218231 | 86.78023 | 1.308570 | 0.092586 | 0.083507 |
| 3 | 2.586085 | 1.825323 | 10.84374 | 3.211561 | 82.42642 | 1.305289 | 0.184008 | 0.203657 |
| 4 | 2.658017 | 1.741994 | 10.84047 | 6.671446 | 78.66496 | 1.564477 | 0.220680 | 0.295977 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 2.724079 | 1.890893 | 10.50841 | 9.475613 | 74.97783 | 2.071905 | 0.717097 | 0.358254 |
| 6 | 2.809640 | 2.537165 | 11.22639 | 11.35909 | 70.51273 | 2.345019 | 1.628110 | 0.391502 |
| 7 | 2.911069 | 3.590967 | 12.41948 | 12.57138 | 65.90050 | 2.426626 | 2.690607 | 0.400443 |
| 8 | 3.016504 | 4.884815 | 13.55480 | 13.25914 | 61.73902 | 2.419554 | 3.749298 | 0.393371 |
| 9 | 3.116555 | 6.248717 | 14.47170 | 13.52847 | 58.27977 | 2.369100 | 4.723791 | 0.378448 |
| 10 | 3.204891 | 7.548269 | 15.13327 | 13.51643 | 55.57444 | 2.298401 | 5.567521 | 0.361673 |

Variance Decomposition of DLOG(RES):

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.531100 | 0.909971 | 24.39225 | 0.187634 | 0.032425 | 74.47772 | 0.000000 | 0.000000 |
| 2 | 0.580569 | 0.761584 | 28.63704 | 3.032847 | 0.439913 | 66.60912 | 0.518384 | 0.001114 |
| 3 | 0.597937 | 0.747479 | 31.16406 | 3.397874 | 1.337628 | 62.85169 | 0.488706 | 0.012559 |
| 4 | 0.599777 | 0.754886 | 31.22134 | 3.450505 | 1.493046 | 62.50016 | 0.557100 | 0.022972 |
| 5 | 0.600712 | 0.757385 | 31.15467 | 3.671130 | 1.488446 | 62.32360 | 0.576449 | 0.028318 |
| 6 | 0.601644 | 0.787541 | 31.17254 | 3.791252 | 1.486094 | 62.15642 | 0.574708 | 0.031442 |
| 7 | 0.602555 | 0.834318 | 31.24102 | 3.858131 | 1.481705 | 61.97556 | 0.575487 | 0.033780 |
| 8 | 0.603343 | 0.890646 | 31.28213 | 3.916925 | 1.479954 | 61.81566 | 0.579147 | 0.035543 |
| 9 | 0.604034 | 0.955618 | 31.29424 | 3.971301 | 1.479827 | 61.67601 | 0.586276 | 0.036727 |
| 10 | 0.604660 | 1.026546 | 31.29342 | 4.014547 | 1.480913 | 61.54973 | 0.597412 | 0.037435 |

Variance Decomposition of LOG(EXR2/EXR1):

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.132891 | 0.005421 | 1.797858 | 5.276264 | 0.599203 | 0.103088 | 92.21817 | 0.000000 |
| 2 | 0.185447 | 0.133647 | 0.924728 | 6.714624 | 5.011165 | 1.046001 | 86.16836 | 0.001470 |
| 3 | 0.229173 | 0.866213 | 1.415254 | 6.866018 | 8.927738 | 2.328479 | 79.59454 | 0.001757 |
| 4 | 0.266602 | 1.859407 | 3.466983 | 5.966135 | 11.80350 | 2.814120 | 74.08139 | 0.008463 |
| 5 | 0.296677 | 2.703457 | 5.587078 | 5.029485 | 14.03306 | 2.751402 | 69.87370 | 0.021822 |
| 6 | 0.318782 | 3.296506 | 6.920324 | 4.372003 | 15.74102 | 2.562167 | 67.06648 | 0.041502 |
| 7 | 0.333905 | 3.654583 | 7.530529 | 4.002959 | 17.00911 | 2.394426 | 65.34103 | 0.067358 |
| 8 | 0.343712 | 3.815155 | 7.689375 | 3.903678 | 17.92467 | 2.272442 | 64.29625 | 0.098427 |
| 9 | 0.349838 | 3.832294 | 7.617511 | 4.056988 | 18.55255 | 2.193696 | 63.61413 | 0.132833 |
| 10 | 0.353679 | 3.776346 | 7.475490 | 4.428657 | 18.93186 | 2.150403 | 63.06908 | 0.168155 |

Variance Decomposition of Q:

| Period | S.E. | Shock1 | Shock2 | Shock3 | Shock4 | Shock5 | Shock6 | Shock7 |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.075819 | 9.944144 | 8.793008 | 76.26054 | 0.116254 | 0.659710 | 0.554721 | 3.671621 |
| 2 | 0.129271 | 17.62938 | 3.032592 | 68.54352 | 0.249317 | 4.441624 | 3.975117 | 2.128451 |
| 3 | 0.175644 | 23.39618 | 6.683437 | 55.59857 | 0.232411 | 4.805627 | 7.821015 | 1.462764 |
| 4 | 0.217776 | 26.68387 | 11.76767 | 45.29318 | 0.922541 | 3.959093 | 10.28969 | 1.083948 |
| 5 | 0.253983 | 28.89897 | 14.74387 | 38.60882 | 1.853429 | 3.235052 | 11.80559 | 0.854278 |
| 6 | 0.283903 | 30.67904 | 16.19178 | 34.09880 | 2.699909 | 2.747472 | 12.87734 | 0.705669 |
| 7 | 0.307922 | 32.17685 | 16.85708 | 30.82705 | 3.417237 | 2.411862 | 13.70377 | 0.606158 |
| 8 | 0.326558 | 33.43645 | 17.08411 | 28.39311 | 4.023142 | 2.173376 | 14.35013 | 0.539678 |
| 9 | 0.340456 | 34.48371 | 17.04064 | 26.59695 | 4.527110 | 2.006070 | 14.84884 | 0.496682 |
| 10 | 0.350390 | 35.33311 | 16.84464 | 25.30070 | 4.933120 | 1.894029 | 15.22360 | 0.470791 |

Factorization: Structural

### 4.3.2 Sensitivity and Robustness Analysis

The results of the contemporaneous and exogenous effects presented in Table 4.4 shows that non-oil export have insignificant negative effect on OED. This suggests that higher non-oil export do not reducing OED significantly in the (full-sample) period. This was explicit in the results of the FEVD, where OED was weakly explained by the endogenous variables. This also lend credence to the argument that changes in oil export dependence was dominated by changes in oil export during the period being considered. This study examined the sensitivity of the results to variation in exchange rate system, with sensitivity done with and without accounting for the role of external reserves.

Notably, the model specification and results presented as the main analysis was based on the assumption that exchange rate system is managed float. This implies that the model accounted for multiple exchange rate system and the commitment of the monetary authority to defend the gap between parallel market and official exchange rate using external reserves. In this sub-section, it was assumed that a floating exchange rate system was operated. Thus, the model was modified, such that the change in external reserves was expunged from the dependent variables while nominal exchange rate was defined as the parallel market rate. Comparing the results obtained from this floating exchange rate system model (Model 2) with the results from our main model, a managed floating exchange rate system model (Model 2) explains the empirical implication for ignoring the managed floating nature of the Nigeria's exchange rate system when analyzing the relationship between oil export dependence and exchange rate behaviour.

The results of this sensitivity analysis are presented in Tables 4.7, 4.8 and Figure 4. Overall, the sign and significance of the relationship are similar under the two exchange rate systems. This suggests that the dynamics of the Nigeria's economy would not likely change markedly due to a change in the country's exchange rate system. Table 4.7 compares the contemporaneous effects of OED shocks on the endogenous variables in the model. The results show that the contemporaneous coefficient of OED shock on nominal exchange rate is higher (in absolute term) under free floating than under managed floating system, while the coefficient of OED shock on real exchange rate is lower (in absolute term) under free floating than under managed floating system. This suggests that failure to acknowledge the managed floating nature of Nigeria's exchange rate system will cause the spontaneous impact of changes in OED on nominal exchange rate to be exaggerated, and the immediate impact of changes in OED on real exchange rate to be under-estimated. This supports the postulation of the Mundell-Fleming-Dornbusch framework, which explains that real can be more responsive to economic changes under managed floating exchange rate system, as nominal exchange rate is constrained by the monetary authority.

However, as the contemporaneous effects for both nominal and real exchange rates are not statistically significant, apparent distinction in terms of magnitude cannot be substantiated for an empirical conclusion. Hence, it can be concluded that failure to account for the managed floating nature of the Nigeria's exchange rate system do not have significant impact on the result of the contemporaneous effect of OED on the nominal and real exchange rates in Nigeria.

**Table 4.7: Contemporaneous effects, OED shocks and Exchange Rate System**

| Endogenous variables | Model 1 (with Managed Floating) | | | Model 2 (without Free Floating) | | |
|---|---|---|---|---|---|---|
| | Coeff. | z-stat | p.value | Coeff. | z-stat | p.value |
| ygap | 0.1741** | 2.0043 | 0.0450 | 0.1819** | 2.2413 | 0.0250 |
| inf | 0.1932*** | 3.1980 | 0.0014 | 0.1638*** | 2.6757 | 0.0075 |
| rintdiff | -0.1376 | -0.0669 | 0.9466 | -1.0940 | -0.5401 | 0.5891 |
| ner | -0.0651 | -0.5172 | 0.6050 | -0.0756 | -0.6201 | 0.5352 |
| rer | -0.0087 | -0.6387 | 0.5230 | -0.0027 | -0.2017 | 0.8402 |

Source: Computed by the Author

Note: Asterisks, *** and ** indicate 1% and 5% significance level, respectively.

Furthermore, the dynamic effect of OED shock on the selected macroeconomic variables including exchange rates was compared under the two exchange rate system assumptions using the impulse response functions (in Figure 4.2) and forecast error variance decomposition (in Table 4.8). In Figure 4.2, the first column enlists the endogenous variables. The second column (Model 1) presents the IRF of the responses of the respective endogenous variable to OED shock under the assumption of managed floating exchange rate system. The third column (Model 2) presents the IRF of the responses of the respective endogenous variable to OED shock under the assumption of free floating exchange rate system, while the fourth column compares the results of the two. The unbroken line indicates the response under the assumption of managed floating system, while the broken line indicates the response under the assumption of free floating system.

Summarily, the figure shows that the effect of OED on nominal exchange rate is exaggerated in the short horizon (h=1), but under-estimated afterwards. Meanwhile, this may not be substantiated as the responses were not statistically significant under both exchange rate system assumptions. This is suggesting that Nigeria's nominal exchange rate will behave in its unique way irrespective of whether free floating or managed floating exchange rate system is operated. However, the effect of OED on real exchange rate, which is statistically significant under both exchange rate systems, is under-estimated from short to long horizon. This suggests that ignoring the managed floating features of the Nigeria's exchange rate system caused the effect of OED on real exchange rate to be underestimated over the short to long period. Failure to acknowledge the full effect of OED on real exchange rate implies non-realization of the full effect of the diversification efforts of government and/or the monetary authority, which may cause misrepresentation of policy effects. Further results show that the effect of OED on real output as well as inflation and real interest rate are also under-estimated without accounting for nature of the Nigeria's exchange rate system.

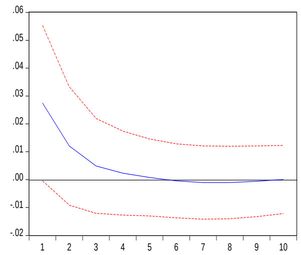
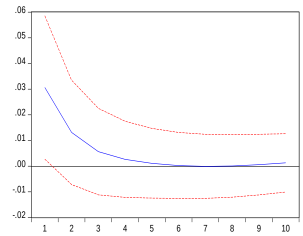
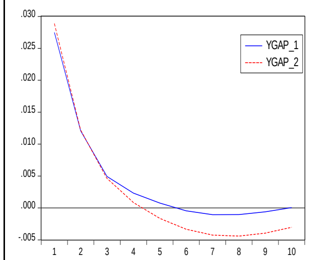
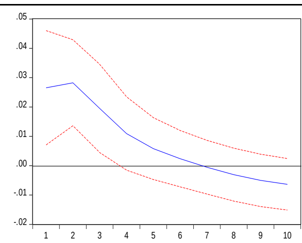
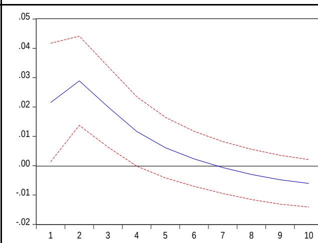
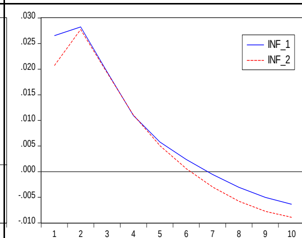
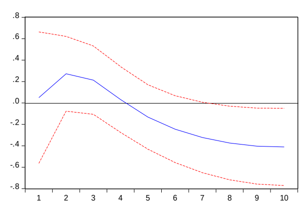
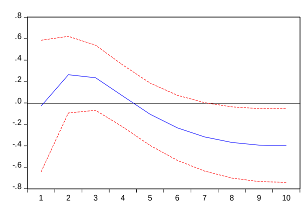
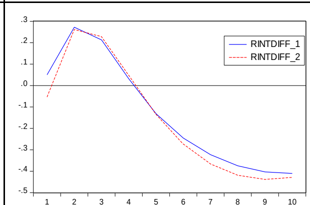
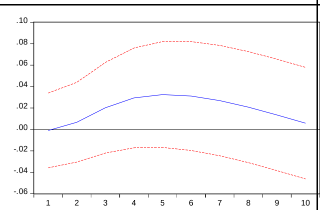
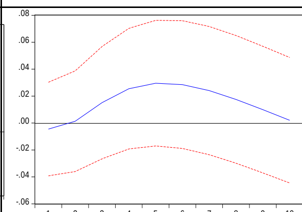
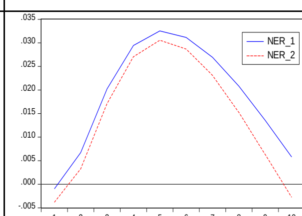
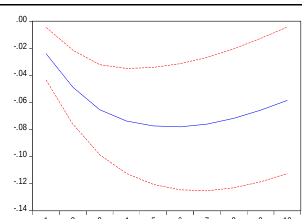
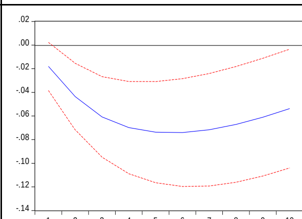
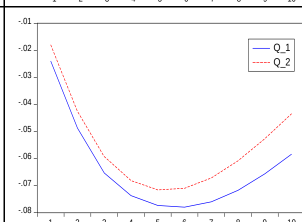
| **Endog. variables** | **Model 1** | **Model 2** | **Model 2 vs Model 1** |
| --- | --- | --- | --- |
| ygap |  |  |  |
| inf |  |  |  |
| rintdiff |  |  |  |
| ner |  |  |  |
| rer |  |  |  |

**Figure 4. 2: Impulse Response Function (IRF), OED shocks and Exchange rate system**

The FEVD results (Table 4.8) confirmed the IRF results as it also concluded that failure to acknowledge the managed floating nature of the Nigeria's exchange rate system will cause the effect of OED shock on real exchange rate to be under-estimated in the short to long term. Furthermore, FEVD confirmed the IRF results on inflation rate, as variation in inflation rate due to OED shock is understated under the assumption of free floating exchange rate system[14].

[14] Note: Asides from the motive of keeping it simple, which makes the discussion to be primarily focused on the effects of OED on exchange rates and less on other macroeconomic variables, the dynamic effects of OED shocks on other factors such as real output, interest rate differential and external reserves are not statistically significant, hence, discussing them is not important.

**Table 4.8: Variance Decomposition, OED shocks and Exchange rate system**

| | Period | Model 1 | Model 2 | Deviation from Model 2 |
|---|---|---|---|---|
| ygap | 1 | 6.4779 | 7.3151 | 0.8372 |
| | 2 | 5.6128 | 6.7430 | 1.1301 |
| | 4 | 5.3654 | 6.3976 | 1.0322 |
| | 8 | 5.2003 | 6.2219 | 1.0216 |
| | 10 | 5.0982 | 6.2454 | 1.1472 |
| Inf | 1 | 12.0237 | 7.06198 | -4.9617 |
| | 2 | 18.2046 | 14.33935 | -3.8652 |
| | 4 | 17.9042 | 16.35774 | -1.5465 |
| | 8 | 17.8022 | 15.64971 | -2.1525 |
| | 10 | 17.4193 | 15.07330 | -2.3460 |
| rintdiff | 1 | 0.0461 | 0.05226 | 0.0061 |
| | 2 | 1.2331 | 1.14818 | -0.0849 |
| | 4 | 1.7420 | 1.80696 | 0.0650 |
| | 8 | 2.5372 | 2.65991 | 0.1227 |
| | 10 | 4.8848 | 5.44150 | 0.5567 |
| Ner | 1 | 0.0054 | 0.0818 | 0.0764 |
| | 2 | 0.1336 | 0.0729 | -0.0607 |
| | 4 | 1.8594 | 1.5711 | -0.2883 |
| | 8 | 3.2965 | 3.1236 | -0.1729 |
| | 10 | 3.8152 | 3.5155 | -0.2996 |
| Rer | 1 | 9.9441 | 5.200791 | -4.7434 |
| | 2 | 17.6294 | 12.41974 | -5.2096 |
| | 4 | 26.6839 | 22.56523 | -4.1186 |
| | 8 | 30.6790 | 28.37886 | -2.3002 |
| | 10 | 33.4365 | 32.04706 | -1.3894 |

Source: Computed by the Author

## 4.4 Sectoral Non-Oil Exports and Oil Export Dependence-Exchange Rate Relationship

### 4.4.1 Main Analysis

To examine the effect of export diversification by sector, and by implication, the exchange rate stabilizing potential of different non-oil sector, on the oil export dependence-exchange rate relationship in Nigeria, non-oil export was decomposed into three main non-oil export sectors; agricultural sector, manufacturing sector, and solid mineral sector. To effectively analysis export diversification efforts, the analysis was commenced from the first year that export diversification effort was introduced in Nigeria, 1976, till 2019. The results for the contemporaneous and the exogenous effects of the non-oil sectoral SVARX model are presented in Table 4.9. The table shows that the effect of OED shock on real output, nominal and real exchange remained unchanged. Meanwhile, it established that the significance of non-oil export in the explanation of changes in OED over this period was related to the increased in the export of manufactured goods. Export diversification into agricultural sector appears to behave differently from diversification into other two sectors. This is apparent as the results for the contemporaneous effects show that agricultural export to performs better than the other two sectors in generating higher real output real output, while the other two sectors increased foreign reserves significantly, unlike the agricultural sector. Thus, the monetary authorities will be willing to diversify into solid minerals and manufacturing sectors if it is committed to maintaining exchange rate stability, and will be willing to diversify into agricultural sector if it is committed to getting higher output.

## Table 4.9: Sectoral Contemporaneous and Exogenous effects

| Variables | Contemporaneous effects | | | | | | | Exogenous effects | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\varepsilon^1_{oed}$ | $\varepsilon^2_{yg}$ | $\varepsilon^3_{inf}$ | $\varepsilon^4_{rintdiff}$ | $\varepsilon^5_{\Delta R}$ | $\varepsilon^6_{e_2-e_1}$ | $\varepsilon^7_{rer}$ | $m$ | $e_1$ | $agrfx$ | $mfgx$ | $slmx$ |
| $oed$ | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -0.0030 | -0.0073* | 0.0014 |
| $y-\bar{y}$ | 0.9784** | 1 | 0 | 0 | 0 | 0 | 0 | 0.0347 | 0 | 0.0391*** | 0.0019 | -0.0108 |
| $p-p_{t-1}$ | 0.206 | -0.7681*** | 1 | | 0 | 0 | 0 | 0.0061 | 0 | 0 | 0 | 0 |
| $r-r^*$ | 24.3273 | 11.3943 | -4.8806 | 1 | 0 | 0 | 0 | 0 | 5.2469*** | 0 | 0 | 0 |
| $\Delta R$ | 0 | 0.2963 | 1.5649 | 0.0385 | 1 | -3.0041 | 0 | -0.4701*** | 0 | -0.1749*** | 0.2460*** | 0.1455* |
| $e_2-e_1$ | -2.4377 | -0.1261 | -0.011 | -0.0200 | 0.5010 | 1 | 0 | 0.1586* | -0.5063*** | 0.0387 | 0.0021 | -0.0873** |
| $q$ | 0.0689 | 0.0710* | -0.9397*** | 0.0011 | 0.0095 | -0.0365** | 1 | 0.0012 | 0.9827*** | -0.0041 | -0.0020 | 0.0086** |

Source: Computed by the Author

Note: Under the contemporaneous effects, shock 1 ($\varepsilon^1_{oed}$ ) represents oil export dependence shock, shock 2 ($\varepsilon^2_{yg}$) is the real output/aggregate supply shock, shock 3 ($\varepsilon^3_{inf}$) is the inflation/aggregate demand shock, shock 4 ($\varepsilon^4_{rintdiff}$) is the interest rate/monetary policy shock, shock 5 ($\varepsilon^5_{\Delta R}$) is the external reserves shock, shock 6 is the nominal exchange rate shock, while shock 7 is the real exchange rate shock. Under the exogenous effects, $m$ is import, $e_1$ is the official exchange rate, and $nox$ is non-oil export. Asterisks ***,**, and * indicates 1%, 5%, and 10% level of statistical significant. The detailed results for contemporaneous effects are presented in Table A8 (in Appendix), while the estimated parameters for the exogenous variables are presented in Table A9 (in Appendix). The sign of the contemporaneous coefficients are multiplied by -1 to recover the contemporaneous coefficients from A matrix.

### 4.4.2 Simulation of Export Diversification Policy Options

The model for sectoral analysis was used to simulate export diversification options. This is based on the assumption presented in Table 4.10. The baseline shows the level of OED of Nigeria from 2017 to 2019 and then assumed that the components of OED follow their natural path. With this scenario, it suggests that oil export dependence of Nigeria will reduce to 86.67% in 2021 and 85.29% in 2023. For the scenario analysis, this study rely on the pronouncement of the Federal Government of Nigeria to engage in export diversification policy such that level of OED reduced by 7.5% from 92.5 in 2017 to 85% in 2019 as stipulated in the Economic Recovery and Growth Plan (ERGP) of Nigeria between 2017 and 2019. This is invariably a plan to reduce level of OED by 7.5 percent in two years. To forecast OED for four (4) years, we assumed 15% reduction from its value of 83.89% in 2019 to 68.89% in 2023. Under the first scenario, it was assumed that extensive diversification was made in the agricultural sector such that export of agricultural products increased to generate the required level of OED, which export growth in other sectors follows their natural path. Similar assumption was made in respect of export of manufactured goods under the second scenario and in respect of the export of solid minerals under the third scenario. The graphical representation of the in-sample simulation of the model for sectoral export diversification is presented in Figure 4.3. Overall, the forecast of the dependent variables in the model tracked the actual considerably, suggesting that the model is good for forecast analysis.

**Table 4.10: Alternative Scenarios for export diversification**

| Period | Baseline | | | | |
|---|---|---|---|---|---|
| | **OED** | **OX** | **AGRFX** | **MFGX** | **SLMX** |
| 2017 | 92.32 | 12913.24 | 288.57 | 247.25 | 19.24 |
| 2018 | 92.38 | 17282.25 | 395.99 | 647.33 | 57.85 |
| 2019 | 83.89 | 16702.73 | 380.73 | 2139.81 | 59.91 |
| 2020 | 87.68 | 21254.45 | 484.83 | 2421.25 | 81.28 |
| 2021 | 86.67 | 24248.53 | 553.45 | 3077.87 | 98.57 |
| 2022 | 85.90 | 27242.60 | 622.07 | 3734.48 | 115.87 |
| 2023 | 85.29 | 30236.68 | 690.69 | 4391.10 | 133.17 |
| | **Scenario 1 (Higher Agricultural export)** | | | | |
| | **OED** | **OX** | **AGRFX** | **MFGX** | **SLMX** |
| 2017 | 92.32 | 12913.24 | 288.57 | 247.25 | 19.24 |
| 2018 | 92.38 | 17282.25 | 395.99 | 647.33 | 57.85 |
| 2019 | 83.89 | 16702.73 | 380.73 | 2139.81 | 59.91 |
| 2020 | 80.39 | 21254.45 | 2681.46 | 2421.25 | 81.28 |
| 2021 | 76.89 | 24248.53 | 4110.76 | 3077.87 | 98.57 |
| 2022 | 72.89 | 27242.60 | 6280.85 | 3734.48 | 115.87 |
| 2023 | 68.89 | 30236.68 | 9128.87 | 4391.10 | 133.17 |
| | **Scenario 2 (High Manufacturing export)** | | | | |
| | **OED** | **OX** | **AGRFX** | **MFGX** | **SLMX** |
| 2017 | 92.32 | 12913.24 | 288.57 | 247.25 | 19.24 |
| 2018 | 92.38 | 17282.25 | 395.99 | 647.33 | 57.85 |
| 2019 | 83.89 | 16702.73 | 380.73 | 2139.81 | 59.91 |
| 2020 | 80.39 | 21254.45 | 484.83 | 4617.89 | 81.28 |
| 2021 | 76.89 | 24248.53 | 553.45 | 6635.18 | 98.57 |
| 2022 | 72.89 | 27242.60 | 622.07 | 9393.26 | 115.87 |
| 2023 | 68.89 | 30236.68 | 690.69 | 12829.28 | 133.17 |
| | **Scenario 3 (High Solid Mineral export)** | | | | |
| | **OED** | **OX** | **AGRFX** | **MFGX** | **SLMX** |
| 2017 | 92.32 | 12913.24 | 288.57 | 247.25 | 19.24 |
| 2018 | 92.38 | 17282.25 | 395.99 | 647.33 | 57.85 |
| 2019 | 83.89 | 16702.73 | 380.73 | 2139.81 | 59.91 |
| 2020 | 80.39 | 21254.45 | 484.83 | 2421.25 | 2277.91 |
| 2021 | 76.89 | 24248.53 | 553.45 | 3077.87 | 3655.89 |
| 2022 | 72.89 | 27242.60 | 622.07 | 3734.48 | 5774.65 |
| 2023 | 68.89 | 30236.68 | 690.69 | 4391.10 | 8571.35 |

Source: Computed by the author

Note: OED is expressed in percentage while other variables are expressed in billion Naira.


**Figure 4.3: In-sample simulation of sectoral export diversification model**

Figure 4.4 presents the out-of-sample forecast for the simulation analysis. The figure shows that higher export agricultural goods will not help in reducing Nigeria's level of OED. Higher export in the solid mineral sector appears to be the best for government when willing to reduce Nigeria's level of OED. However, the simulation result shows that it will require some resilience as this sector can potentially increase level of OED in the initial period of diversification. In terms of real output, agricultural sector appears to have better potential to generate higher output than other sectors, particularly over the short to medium term period. In terms of external reserves, export of manufactured goods tends to have long term potential to generate higher external reserves for the country, although export of solid minerals performs better than other two sectors in the short to medium term period. Contrarily, higher export of agricultural products has potential to deplete foreign reserves in the medium to long term period.

In terms of the response of NER, higher export of agricultural export appears to put pressure on NER to depreciate, as it tends to widens the gap between the parallel market and the official exchange rate, contrary to the effect of diversification into manufacturing and solid mineral sectors, which tends to close the gap between the parallel market and the official exchange rate. In terms of the RER, export diversification into agricultural sector tends to cause RER appreciation in the short to medium term period, while higher export of solid minerals and manufactured goods tends to cause RER depreciation.

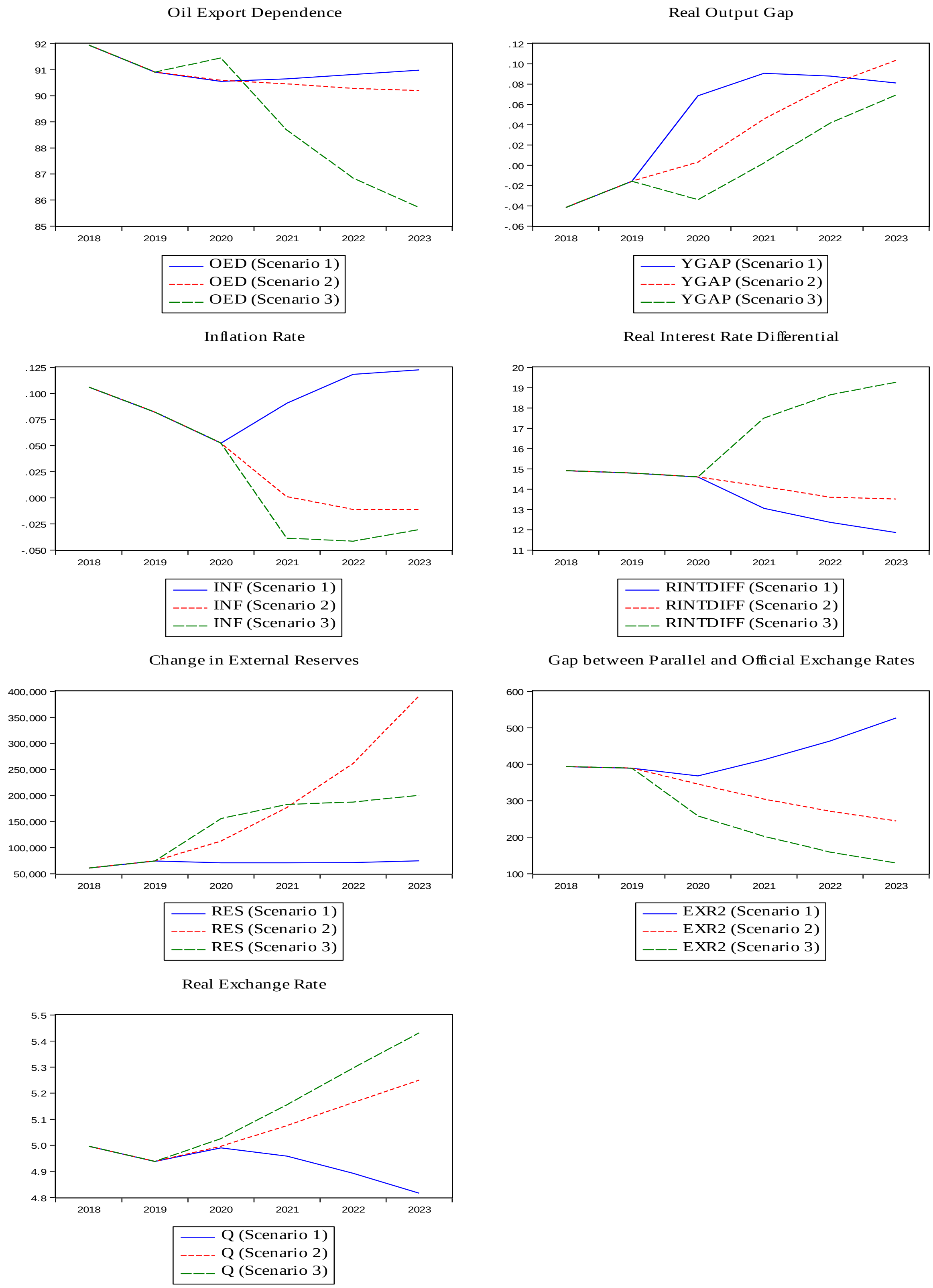



**Figure 4.4: The out-of-sample forecast for the simulation analysis**

# CHAPTER FIVE

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

## 5.0 Overview

This section discusses summary of findings, conclusions from the study and recommendations. It also highlights the contributions of this study to the literature. Lastly, it states the limitations of the study and made suggestions for future research.

## 5.1 Summary

The behaviour of Nigeria's exchange rates had been tied to the vagaries of oil export's proceeds. Despite export diversification efforts to reduce Nigeria's level of oil export dependence (OED), the country's nominal and real exchange rates remain unstable. Nigeria's OED rose from an average of 19.13% in the 1960s to 97.35% in the 1990s, before dropping to 83.89% in 2019. The nominal exchange rate (NER) depreciated from ₦0.71/US$ in the 1960s to ₦306.92/US$ in 2019, while the real exchange rate (RER) of 137 basis points (bpts) in the 1960s appreciated to 97.24bpts in the 1980s, and became 134.52bpts in 2019 following intermittent currency devaluations. Alley (2018) found that export diversification or lower oil export dependence would make Nigeria's NER to appreciate. This and some other relevant studies modelled the relationship between oil export dependence and the behaviour of the Nigeria's nominal exchange rate by relying implicitly on the assumption that Nigeria operates a free floating exchange rate regime, as single exchange rate was used and the role of external reserves was ignored in their models.

In reality, however, Nigeria has started operating multiple/dual exchange rate system with parallel and official exchange, and using her external reserves to constrain free flow of the official exchange rate of Nigeria (that was used by some of these studies) for more than three decades (including the periods covered by the studies). Failure to account for the fundamental property of an economic system may cause misleading results. Earlier studies also paid little attention to variation in the exchange rate stabilising potential of different non-oil sectors, by focusing only on aggregate non-oil export. Therefore, this study investigates the effect of oil export dependence on the behaviour of Nigeria's exchange rates, while acknowledging the managed floating exchange rate system and the varied exchange rate stabilising potential of different non-oil sectors in the country.

The study adopted Mundell-Fleming-Dornbusch (MFD) model which assumes variation in domestic prices and foreign prices (to allow distinction between real and nominal exchange rates) rather than the popular Mundell-Fleming (MF) model, which assumes equality between domestic and foreign prices (thus assuming equality between nominal and real exchange rate). As the MFD model was originally designed under the free floating and fixed exchange rate arrangement, this study augmented the MFD with the managed floating model by Lai et al. (1985) to analyse the effect of oil export dependence on the behaviour of Nigeria's exchange rates.

The study employed Structural Vector Autoregressive model with block exogeneity (SVARX) to capture both external (oil export) and exogenous (non-oil export) components of OED. This method dealt with endogeneity problem and allowed simultaneous effect of oil export dependence on nominal and real exchange rates as well as other relevant macroeconomic indicators suggested by the augmented MFD such as the real output, real interest rate differential, inflation rate and external reserves. External reserves were acknowledged as the instrument that defined the potential of the monetary authorities to remain committed to maintaining a gap between official and the parallel market exchange rates under managed floating exchange rate regime. The variables included OED (oil export percentage of total merchandise export), NER (domestic price per unit of foreign currency), and RER (foreign price relative to domestic price of a common basket of goods). The data were obtained from the Central Bank of Nigeria Statistical Bulletin.

The study conducted the main and additional analyses using contemporaneous matrix and exogenous effects, impulse responses functions (IRF) and forecast error variance decomposition (FEVD) from the SVARX model. While the main analysis dealt with the effect of oil export dependence shocks on macroeconomic indicators including the nominal and real exchange rates under the full sample period (1960 - 2019), additional analysis focused on the period since Nigeria first initiated export diversification policy, thus covered 1976 – 2019. This allowed for the analysis of the sensitivity of the results from the main analysis to changes in the commitment of government to export diversification. Additional sensitivity analysis was conducted to examine the implication of confusing Nigeria's managed floating exchange rate system for free floating exchange rate system. A simulation analysis was also conducted on the estimated parameters from the non-oil sector-based SVARX model to examine the exchange rates stabilising potential three main non-oil sectors (agricultural, manufacturing, and solid minerals) on OED and exchange rates. All estimates were validated at $\alpha \leq 0.05$.

Under the main analysis with aggregate non-oil export, the results of the contemporaneous effect showed that oil export dependence shock had an insignificant negative effect on NER (-0.0651) and RER (-0.0087). The dynamic effect using impulse response function showed that OED had insignificant effect on NER (h2=0.0067, h4=0.0294), but a significant negative effect on RER (h2=-0.0487, h4=-0.0737). This implied that a lower OED (which may be caused by external factor [such as negative oil price shock or disruption in oil production] or through by exogenous factor [such as increase in the commitment of government to export diversification]) had no immediate impact on NER and RER. However, it caused RER to depreciate in the short to medium and long term. As this effect countered the resilient appreciating trend of the RER, it suggests that lower OED had immediate and short to long-term stabilising effect on RER.

In other words, RER can be self-stabilised without being officially stabilized by the monetary authority through currency intervention. The higher trade competitiveness as indicated by RER depreciation appeared to be stimulated by the lower inflation rate effect of low in OED, as the result shows that OED shock also had significant positive contemporaneous (0.1741) and dynamic effects on inflation rate. However, further results show that OED shock also had significant positive contemporaneous effect on real output (0.1741). This suggests that lower OED would cause instantaneous reduction in real output, which imply a slow economic growth. Evidence from the FEVD, showed that OED explained the largest variation in RER, ranging from 17.6% of the total variation in RER in the short-term horizon (h2=17.63%) to 26.68% in the medium-term horizon (h4=26.68%). This was followed by inflation rate, for which OED explained 11.2% of its total variation in the short-term horizon (h2=11.2%) and 17.90% in the medium-term horizon (h4=17.90%). For NER, OED only explains 0.13% of its total variation in the short-term period (h2=0.13%) and 1.86% in the medium-term period (h4=1.86%). Hence, the results from the FEVD corroborated the results from the IRF. The exogenous factor, non-oil export, was found to have negative but insignificant effect on oil export dependence. This suggests that, although higher non-oil export has tendency to reduce level of oil export dependence, it does not reduce it significantly in the period under consideration. This implies that lower oil export dependence in Nigeria over this period was dominated by lower oil export (external factor) rather than higher non-oil export.

On the sensitivity of the results to improper definition of the Nigeria's exchange rate system, the results showed that Nigeria's nominal exchange rate will behave in its unique way irrespective of whether free floating or managed floating exchange rate system is assumed. However, the effect of OED on real exchange rate was found to be under-estimated from short to long horizon by the assumption of the free floating exchange rate system. This suggests that ignoring the managed floating features of the Nigeria's exchange rate system caused the effect of OED on real exchange rate to be underestimated over the short to long period. Further results showed that the effect of OED on inflation was also under-estimated without accounting for nature of the Nigeria's exchange rate system.

On the analysis of the variation in the exchange rate stabilising effect of different non-oil sectors, the results from the model simulation showed that higher export of manufactured goods and solid minerals reduced the level of OED, increased external reserves, and stabilized real and nominal exchange rates better than higher export of agricultural goods. Whereas, a higher export of agricultural goods caused RER appreciation, unlike the other sectors.

Summarily, this study presents four main findings. The first three findings relate to the first objective of this study, which is to examine the effect of oil export dependence on Nigeria's (Nominal and Real) exchange rates, while the fourth finding emanates from analysing the second objective of this study, which is to investigate the exchange rate stabilising potentials of different non-oil sectors in Nigeria. These findings are highlighted below.

1. Nominal exchange rate did not respond significantly to changes in level of oil export dependence when managed floating nature of the Nigeria exchange rate system is considered. Hence, earlier finding (as in Alley, 2018) that export diversification caused NER to appreciate appears a misleading result.
2. Lower oil export dependence caused lower inflation and real exchange rate depreciation in Nigeria. This suggests that pursuing an export diversification policy will help the monetary authority in achieving its price stability objective. This will also help the economy to achieve a self-motivated high level of trade competitiveness, and avoid exchange rate misalignment and the eventual frequent official devaluation to currency to achieve moderate level of trade competitiveness.
3. Misrepresentation of Nigeria's exchange rate system as floating system rather than as a managed floating system will cause the effect of oil export dependence on real exchange rate to be under-estimated. Under estimation of the OED effects, may be responsible for low commitment of government to export diversification in Nigeria.
4. Export diversification to solid minerals and manufacturing sectors would better help in achieving stable nominal and real exchanges in Nigeria compared with export diversification to agricultural sector.

## 5.2 Conclusion

Based on the results discussed above, this study has some notable conclusions. First, this study concluded that nominal exchange rate did not respond significantly to changes in level of oil export dependence when managed floating nature of the Nigeria exchange rate system is considered. Hence, earlier finding that export diversification caused NER to appreciate appears a misleading result. Evidence from this study revealed that nominal exchange rate behaviour is hardly explained by the Nigeria's macroeconomic dynamics, but it is significantly influenced by changes in the official exchange rate. This suggests that political economy factors may play important role in explaining nominal exchange rate behaviour in Nigeria.

Second, this study concluded that lower oil export dependence caused lower inflation and real exchange rate depreciation in Nigeria. This suggests that pursuing an export diversification policy will help the monetary authority in achieving its price stability objective. This will also help the economy to achieve a self-motivated high level of trade competitiveness, and avoid exchange rate misalignment and the eventual frequent official devaluation to currency to achieve moderate level of trade competitiveness.

Third, this study concluded that misrepresentation of Nigeria's exchange rate system as floating system rather than as a managed floating system caused the effect of oil export dependence on real exchange rate to be under-estimated. Under estimation of the OED effects, may be responsible for low commitment of government to export diversification in Nigeria.

Fourth and lastly, this study concluded that, export diversification to solid minerals and manufacturing sectors would better help in achieving stable nominal and real exchanges in Nigeria compared with export diversification to agricultural sector.

## 5.3 Recommendations

This study revealed that lower oil export dependence had no significant effect on nominal exchange rate but enhanced real exchange rate stabilisation. As the real exchange rate stabilisation produced lower inflation and higher trade competitiveness, it is recommended that government should continue on its economic and trade policies towards reducing Nigeria's level of oil export dependence.

Another finding of this study is that non-oil export or commitment to export diversification of Nigeria is insufficient to herald a significant reduction in the country's level of oil export dependence. Therefore, higher commitment to export diversification is recommended.

This study also finds that export diversification to solid minerals and manufacturing sectors would better help in achieving stable nominal and real exchanges in Nigeria compared with export diversification to agricultural sector. While Nigerian government and the monetary authorities have focused on agricultural sector for its export diversification strategy this study revealed that this effort of government is good to generate higher output, but not good for maintenance of stable exchange rate. Hence, unless monetary authority prioritizes output growth over exchange rate stability, its effort to promote export diversification should be directed towards solid minerals and manufacturing sectors in order to achieve nominal and real exchange rates stability.

## 5.4 Contributions to Knowledge

The innovation of this study is to investigate the effect of oil export dependence on exchange rate behaviour under managed floating or intermediate exchange rate arrangement. Pursuing this makes the study to fill important knowledge gaps in the theoretical, methodological and empirical literature on oil export dependence – exchange rate relationship. Specifically, some specific contributions of this study to knowledge are as follows:

1. It analysed the effect of oil export dependence on Nigeria's nominal and real exchange rates while taking cognizance of the managed floating exchange rate regime system adopted by the country, where official and parallel market exchange rates exist and external reserves play important role in exchange rate management. The results obtained suggests that extant literature ignoring this characteristic tends to underestimate the OED effects on real exchange rate.
2. It employed dynamic system approach with maximum likelihood estimator in the Structural Vector Autoregressive with block exogeneity (SVARX) model in deal with the relationship between oil export dependence and exchange rate behaviour. This solved the problem of endogeneity and allows simultaneous examination of the effect of oil export dependence on nominal and real exchange rates, as well as real output as may be required under the application of managed floating exchange rate regime. Extant literature ignoring this channel of transmission as stipulated by this tends to generate incomplete results.
3. It analysed the theoretical relationship between oil export dependence and exchange behaviour by re-defining OED and modifying the IS equation of the Mundell-Fleming-Dornbusch model.
4. It disaggregated non-oil export in the analysis of oil export dependence –exchange rate relationship. This provided evidence-based result on the relative effectiveness

of different sectors in stabilising nominal and real exchange rates in Nigeria. Extant literature considered only aggregate non-oil export, hence, could not provide recommendation on which of the non-sector should be accorded with diversification efforts if the objective is to stabilise exchange rates.

## 5.5 Limitations and Suggestions for Future Research

This study is not without some limitations. The first limitation has to do with data issues. Exchange rate is a high frequency data, which can be obtained monthly, daily or even at intraday interval. However, this was aggregated to annual data in this study to align the variable with some other macroeconomic variables in the model that are only available on a lower frequency basis such as monthly, quarterly or annually. For example, the data for oil export and non-oil export for Nigeria, which defined Nigeria's level of oil export dependence (oil export as percentage of total merchandise export) are only available on annual basis from 1960 to 2019. The analysis, notwithstanding, would have been possible with Generalized Autoregressive Conditional Heteroscedasticity (GARCH) - Mixed Data Sampling (MIDAS) Technique, which can accommodate high frequency dependent variable and low frequency independent variable. However, the method is a single equation method, which has been argued in this study to provide limited explanation on the effect of oil export dependence on exchange rates and having potential problem of endogeneity. Hence, the study is constrained to using annual data for the analysis.

Also, this study revealed that nominal exchange rate is not significantly influenced by any of the other six endogenous variables, but is significantly influenced by exogenous changes in official exchange rate. This suggests that the gap between the parallel and official nominal exchange rates may be due to political economic factors, which are not captured in this study due to the theoretical framework adopted, which is basically the mainstream economic thinking.

Future studies may consider adopting the theoretical and the methodology frameworks introduced in this study to analyse the effect of oil export dependence and exchange rate behaviour in an oil dependent country like Nigeria, where managed floating exchange rate system is being operated. To revisit the case of Nigeria, future studies are enjoined to consider one or two political economy factors. Measures of central bank independence would be of utmost relevance.

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**Appendix**

**Table A1: Classification of Nigerian Non-oil exports**

| |
|---|
| **Arms and Ammunition** |
| Arms and ammunition; parts and accessories thereof |
| Explosives; pyrotechnic products; matches; pyrophoric alloys; certain combustible preparations |
| Aircraft, spacecraft, and parts thereof |
| |
| **Agricultural products and edible materials** |
| Cocoa and cocoa preparations |
| Oil seeds and oleaginous fruits; miscellaneous grains, seeds and fruit; industrial or medicinal ... |
| Tobacco and manufactured tobacco substitutes |
| Edible fruit and nuts; peel of citrus fruit or melons |
| Fish and crustaceans, molluscs and other aquatic invertebrates |
| Beverages, spirits and vinegar |
| Miscellaneous edible preparations |
| Animal or vegetable fats and oils and their cleavage products; prepared edible fats; animal ... |
| Coffee, tea, maté and spices |
| Dairy produce; birds' eggs; natural honey; edible products of animal origin, not elsewhere ... |
| Cotton |
| Preparations of vegetables, fruit, nuts or other parts of plants |
| Edible vegetables and certain roots and tubers |
| Sugars and sugar confectionery |
| Pharmaceutical products |
| Man-made staple fibres |
| Cereals |
| Wool, fine or coarse animal hair; horsehair yarn and woven fabric |
| Cork and articles of cork |
| Furskins and artificial fur; manufactures thereof |
| Natural or cultured pearls, precious or semi-precious stones, precious metals, metals clad ... |
| Vegetable plaiting materials; vegetable products not elsewhere specified or included |
| Commodities not elsewhere specified |
| |
| **Cosmetics and Washing Materials** |
| Soap, organic surface-active agents, washing preparations, lubricating preparations, artificial ... |
| Essential oils and resinoids; perfumery, cosmetic or toilet preparations |

| |
|---|
| Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring ... |
| |
| **Furniture, Wears and Textile materials** |
| Raw hides and skins (other than furskins) and leather |
| Rubber and articles thereof |
| Prepared feathers and down and articles made of feathers or of down; artificial flowers; articles ... |
| Other made-up textile articles; sets; worn clothing and worn textile articles; rags |
| Live trees and other plants; bulbs, roots and the like; cut flowers and ornamental foliage |
| Glass and glassware |
| Footwear, gaiters and the like; parts of such articles |
| Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; ... |
| Carpets and other textile floor coverings |
| Man-made filaments; strip and the like of man-made textile materials |
| Other vegetable textile fibres; paper yarn and woven fabrics of paper yarn |
| Wadding, felt and nonwovens; special yarns; twine, cordage, ropes and cables and articles thereof |
| Articles of leather; saddlery and harness; travel goods, handbags and similar containers; articles ... |
| Special woven fabrics; tufted textile fabrics; lace; tapestries; trimmings; embroidery |
| Impregnated, coated, covered or laminated textile fabrics; textile articles of a kind suitable ... |
| Knitted or crocheted fabrics |
| Articles of apparel and clothing accessories, knitted or crocheted |
| Articles of apparel and clothing accessories, not knitted or crocheted |
| Headgear and parts thereof |
| Umbrellas, sun umbrellas, walking sticks, seat-sticks, whips, riding-crops and parts thereof |
| Clocks and watches and parts thereof |
| |
| **Live animals and Agricultural input materials** |
| Fertilisers |
| Residues and waste from the food industries; prepared animal fodder |
| Preparations of cereals, flour, starch or milk; pastrycooks' products |
| Lac; gums, resins and other vegetable saps and extracts |
| Products of animal origin, not elsewhere specified or included |
| Preparations of meat, of fish or of crustaceans, molluscs or other aquatic invertebrates |
| Albuminoidal substances; modified starches; glues; enzymes |
| Pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or ... |

| |
|---|
| Meat and edible meat offal |
| Live animals |
| |
| **Manufacturing products and Transport materials** |
| Ships, boats and floating structures |
| Plastics and articles thereof |
| Miscellaneous chemical products |
| Machinery, mechanical appliances, nuclear reactors, boilers; parts thereof |
| Electrical machinery and equipment and parts thereof; sound recorders and reproducers, television ... |
| Miscellaneous manufactured articles |
| Paper and paperboard; articles of paper pulp, of paper or of paperboard |
| Products of the milling industry; malt; starches; inulin; wheat gluten |
| Optical, photographic, cinematographic, measuring, checking, precision, medical or surgical ... |
| Vehicles other than railway or tramway rolling stock, and parts and accessories thereof |
| Organic chemicals |
| Photographic or cinematographic goods |
| Other base metals; cermets; articles thereof |
| Manufactures of straw, of esparto or of other plaiting materials; basketware and wickerwork |
| Printed books, newspapers, pictures and other products of the printing industry; manuscripts, ... |
| Tools, implements, cutlery, spoons and forks, of base metal; parts thereof of base metal |
| Railway or tramway locomotives, rolling stock and parts thereof; railway or tramway track fixtures ... |
| Toys, games and sports requisites; parts and accessories thereof |
| Musical instruments; parts and accessories of such articles |
| Works of art, collectors' pieces and antiques |
| |
| **Non-oil mineral resources** |
| Salt; sulphur; earths and stone; plastering materials, lime and cement |
| Wood and articles of wood; wood charcoal |
| Aluminium and articles thereof |
| Lead and articles thereof |
| Iron and steel |
| Ores, slag and ash |
| Articles of iron or steel |
| Copper and articles thereof |
| Inorganic chemicals; organic or inorganic compounds of precious metals, of rare-earth metals, ... |

| |
|---|
| Tin and articles thereof |
| Miscellaneous articles of base metal |
| Zinc and articles thereof |
| Articles of stone, plaster, cement, asbestos, mica or similar materials |
| Ceramic products |
| Silk |
| Nickel and articles thereof |

**Table A2: Level of oil export dependence**

Let the level of oil export dependence (OED) of the oil exporting country be defined as the ratio of her oil export (OX) to total export (X), that is;

$$OED = \frac{OX}{OX + NOX} \qquad \text{(A1)}$$

Divide both numerator and denominator of RHS by $OX$

$$OED = \frac{1}{1 + \frac{NOX}{OX}} \qquad \text{(A2)}$$

If the values of oil export (OX) increases faster than the value of non-oil export (NOX), the denominator falls and level of oil export dependence increases. On the other hand, if than the value of NOX increases faster than the value of oil export the denominator increases and level of oil export dependence falls. This suggests that using increase in non-oil export to explain export diversification in oil dependent countries (as in Alley (2018)) in not complete.

From equation A2, the following can be deduced;

when $NOX = 0$; $OED = 1$

when $OX = NOX$; $OED = 0.5$

when $OX > NOX$; $OED > 0.5$

when $OX < NOX$; $OED < 0.5$

For oil exporting country; $OED \neq 0$

Summarily, the range of level of oil export dependence can be defined as:
$0 < OED \leq 1$.

## Table A3: Data Presentation

| | OED | CGDP | BRM | RES | EXR1 | EXR2 | CPING | CPIUS | OX | NOX | TX |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1960 | 2.60 | 6.79 | 0.28 | 343.00 | 0.71 | 0.71 | 0.07 | 13.56 | 0.01 | 0.33 | 0.34 |
| 1961 | 6.65 | 7.18 | 0.30 | 307.07 | 0.71 | 0.71 | 0.07 | 13.71 | 0.02 | 0.32 | 0.35 |
| 1962 | 10.21 | 7.90 | 0.33 | 289.02 | 0.71 | 0.71 | 0.07 | 13.87 | 0.03 | 0.30 | 0.34 |
| 1963 | 10.66 | 8.38 | 0.36 | 210.03 | 0.71 | 0.71 | 0.07 | 14.04 | 0.04 | 0.34 | 0.38 |
| 1964 | 14.93 | 8.80 | 0.43 | 228.05 | 0.71 | 0.71 | 0.07 | 14.22 | 0.06 | 0.37 | 0.43 |
| 1965 | 25.37 | 9.46 | 0.47 | 239.05 | 0.71 | 0.71 | 0.08 | 14.45 | 0.14 | 0.40 | 0.54 |
| 1966 | 32.37 | 10.26 | 0.52 | 215.35 | 0.71 | 0.71 | 0.08 | 14.89 | 0.18 | 0.38 | 0.57 |
| 1967 | 29.81 | 8.37 | 0.45 | 112.36 | 0.71 | 0.71 | 0.08 | 15.30 | 0.14 | 0.34 | 0.49 |
| 1968 | 17.53 | 8.08 | 0.52 | 121.19 | 0.71 | 0.71 | 0.08 | 15.95 | 0.07 | 0.35 | 0.42 |
| 1969 | 41.18 | 10.79 | 0.66 | 132.46 | 0.71 | 0.71 | 0.09 | 16.82 | 0.26 | 0.37 | 0.64 |
| 1970 | 57.54 | 16.06 | 0.98 | 223.50 | 0.71 | 0.71 | 0.10 | 17.81 | 0.51 | 0.38 | 0.89 |
| 1971 | 73.68 | 20.23 | 1.04 | 431.94 | 0.71 | 0.71 | 0.12 | 18.57 | 0.95 | 0.34 | 1.29 |
| 1972 | 82.01 | 21.86 | 1.20 | 390.71 | 0.66 | 0.66 | 0.12 | 19.18 | 1.18 | 0.26 | 1.43 |
| 1973 | 83.11 | 26.25 | 1.37 | 622.85 | 0.66 | 0.66 | 0.13 | 20.36 | 1.89 | 0.38 | 2.28 |
| 1974 | 92.60 | 57.25 | 2.59 | 5708.97 | 0.63 | 0.63 | 0.14 | 22.61 | 5.37 | 0.43 | 5.79 |
| 1975 | 92.64 | 65.32 | 4.04 | 5665.69 | 0.62 | 0.62 | 0.19 | 24.68 | 4.56 | 0.36 | 4.93 |
| 1976 | 93.64 | 81.07 | 5.71 | 5256.78 | 0.63 | 0.63 | 0.24 | 26.10 | 6.32 | 0.43 | 6.75 |
| 1977 | 92.69 | 95.87 | 7.68 | 4335.99 | 0.64 | 0.64 | 0.27 | 27.79 | 7.07 | 0.56 | 7.63 |
| 1978 | 89.07 | 105.05 | 7.52 | 2028.81 | 0.64 | 0.64 | 0.33 | 29.92 | 5.40 | 0.66 | 6.06 |
| 1979 | 93.82 | 127.66 | 9.85 | 5899.64 | 0.60 | 0.60 | 0.37 | 33.28 | 10.17 | 0.67 | 10.84 |
| 1980 | 96.09 | 150.95 | 14.39 | 10639.79 | 0.55 | 0.55 | 0.41 | 37.79 | 13.63 | 0.55 | 14.19 |
| 1981 | 96.89 | 144.83 | 15.24 | 4168.45 | 0.62 | 0.62 | 0.49 | 41.70 | 10.68 | 0.34 | 11.02 |
| 1982 | 97.52 | 154.98 | 16.69 | 1926.43 | 0.67 | 0.67 | 0.53 | 44.25 | 8.00 | 0.20 | 8.21 |
| 1983 | 95.98 | 163.00 | 19.03 | 1251.99 | 0.72 | 0.72 | 0.66 | 45.68 | 7.20 | 0.30 | 7.50 |
| 1984 | 97.28 | 170.38 | 21.24 | 1674.11 | 0.77 | 0.77 | 0.77 | 47.64 | 8.84 | 0.25 | 9.09 |
| 1985 | 95.76 | 192.27 | 23.15 | 1891.87 | 0.89 | 0.89 | 0.83 | 49.33 | 11.22 | 0.50 | 11.72 |
| 1986 | 93.81 | 202.44 | 23.61 | 1349.90 | 1.75 | 1.75 | 0.88 | 50.27 | 8.37 | 0.55 | 8.92 |
| 1987 | 92.91 | 249.44 | 28.90 | 1497.83 | 4.02 | 4.02 | 0.98 | 52.11 | 28.21 | 2.15 | 30.36 |
| 1988 | 91.16 | 320.33 | 38.41 | 932.99 | 4.54 | 4.54 | 1.51 | 54.23 | 28.44 | 2.76 | 31.19 |
| 1989 | 94.90 | 419.20 | 43.37 | 2041.08 | 7.36 | 7.36 | 2.27 | 56.85 | 55.02 | 2.95 | 57.97 |
| 1990 | 97.03 | 499.68 | 57.55 | 4128.79 | 8.04 | 8.04 | 2.44 | 59.92 | 106.63 | 3.26 | 109.89 |
| 1991 | 96.15 | 596.04 | 79.07 | 4678.02 | 9.91 | 13.51 | 2.75 | 62.46 | 116.86 | 4.68 | 121.54 |
| 1992 | 97.94 | 909.80 | 129.09 | 1196.05 | 17.30 | 20.58 | 3.98 | 64.35 | 201.38 | 4.23 | 205.61 |
| 1993 | 97.72 | 1259.07 | 198.48 | 1640.44 | 22.07 | 36.65 | 6.26 | 66.25 | 213.78 | 4.99 | 218.77 |
| 1994 | 97.40 | 1762.81 | 266.94 | 1649.17 | 22.00 | 60.50 | 9.82 | 67.98 | 200.71 | 5.35 | 206.06 |
| 1995 | 97.57 | 2895.20 | 318.76 | 1709.11 | 21.90 | 84.15 | 16.98 | 69.88 | 927.57 | 23.10 | 950.66 |
| 1996 | 98.22 | 3779.13 | 370.33 | 4329.39 | 21.88 | 83.88 | 21.95 | 71.93 | 1286.22 | 23.33 | 1309.54 |
| 1997 | 97.65 | 4111.64 | 429.73 | 7781.25 | 21.89 | 85.77 | 23.82 | 73.61 | 1212.50 | 29.16 | 1241.66 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1998 | 95.47 | 4588.99 | 525.64 | 7298.55 | 21.89 | 88.52 | 26.20 | 74.76 | 717.79 | 34.07 | 751.86 |
| 1999 | 98.36 | 5307.36 | 699.73 | 5649.73 | 92.34 | 100.10 | 27.93 | 76.39 | 1169.48 | 19.49 | 1188.97 |
| 2000 | 98.72 | 6897.48 | 1036.08 | 10099.45 | 101.70 | 111.83 | 29.87 | 78.97 | 1920.90 | 24.82 | 1945.72 |
| 2001 | 98.50 | 8134.14 | 1309.36 | 10646.60 | 111.23 | 132.83 | 35.51 | 81.20 | 1839.95 | 28.01 | 1867.95 |
| 2002 | 94.57 | 11332.25 | 1555.80 | 7566.81 | 120.58 | 137.79 | 40.08 | 82.49 | 1649.45 | 94.73 | 1744.18 |
| 2003 | 96.93 | 13301.56 | 1766.01 | 7415.09 | 129.22 | 141.99 | 45.70 | 84.36 | 2993.11 | 94.78 | 3087.89 |
| 2004 | 97.54 | 17321.30 | 2131.17 | 17256.54 | 132.89 | 140.85 | 52.56 | 86.62 | 4489.47 | 113.31 | 4602.78 |
| 2005 | 98.54 | 22269.98 | 2612.89 | 28632.05 | 131.27 | 142.56 | 61.95 | 89.56 | 7140.58 | 105.96 | 7246.53 |
| 2006 | 98.18 | 28662.47 | 3562.70 | 42735.47 | 128.65 | 137.10 | 67.05 | 92.45 | 7191.09 | 133.59 | 7324.68 |
| 2007 | 97.60 | 32995.38 | 6689.37 | 51907.03 | 125.81 | 127.41 | 70.66 | 95.09 | 8110.50 | 199.26 | 8309.76 |
| 2008 | 94.94 | 39157.88 | 9513.85 | 53599.28 | 118.55 | 120.71 | 78.84 | 98.74 | 9861.83 | 525.86 | 10387.69 |
| 2009 | 94.18 | 44285.56 | 10928.02 | 45509.82 | 148.90 | 161.64 | 87.94 | 98.39 | 8105.46 | 500.86 | 8606.32 |
| 2010 | 94.08 | 54612.26 | 11662.91 | 35884.93 | 150.30 | 153.06 | 100.00 | 100.00 | 11300.52 | 710.95 | 12011.48 |
| 2011 | 94.00 | 62980.40 | 14192.09 | 36263.65 | 153.86 | 159.31 | 110.84 | 103.16 | 14323.15 | 913.51 | 15236.67 |
| 2012 | 94.19 | 71713.94 | 18035.94 | 47548.40 | 157.50 | 160.86 | 124.38 | 105.29 | 14259.99 | 879.34 | 15139.33 |
| 2013 | 92.59 | 80092.56 | 20615.45 | 46254.76 | 157.31 | 162.45 | 134.92 | 106.83 | 14131.84 | 1130.17 | 15262.01 |
| 2014 | 92.64 | 89043.62 | 20451.73 | 37497.23 | 158.55 | 171.45 | 145.80 | 108.57 | 12006.97 | 953.53 | 12960.49 |
| 2015 | 92.53 | 94144.96 | 21288.24 | 29011.45 | 192.44 | 222.72 | 158.94 | 108.70 | 8184.48 | 660.68 | 8845.16 |
| 2016 | 92.57 | 101489.49 | 28083.91 | 28020.20 | 253.49 | 372.86 | 183.85 | 110.07 | 8178.82 | 656.79 | 8835.61 |
| 2017 | 92.32 | 113711.63 | 28473.66 | 40499.22 | 305.79 | 395.42 | 214.23 | 112.41 | 12913.24 | 1074.90 | 13988.14 |
| 2018 | 92.38 | 127736.83 | 32739.62 | 42838.87 | 306.08 | 361.52 | 240.14 | 115.16 | 17282.25 | 1425.71 | 18707.96 |
| 2019 | 83.89 | 144210.49 | 34776.38 | 38335.89 | 306.92 | 359.53 | 267.51 | 117.24 | 16702.73 | 3207.02 | 19909.75 |

Note: This data is downloadable from Mendeley Data repository. See: https://data.mendeley.com/datasets/8hkc6pnb3k/1. Cite as: OLOKO, Tirimisiyu (2021), "Data for: Oil export dependence and Exchange rate behaviour in Nigeria ", Mendeley Data, V1, doi: 10.17632/8hkc6pnb3k.1

**Table A4: Description and Transformation of Variables**

```
genr oed=100*(ox/(ox+nox))     '   Oil export dependence - conventional definition
genr loed  = log(oed)          '   Log transforming OED
genr rgdp = cgdp/cping         '   Computation of real GDP
genr lrgdp = log(rgdp)         '   Log transforming the real GDP
lrgdp.hpf yf                   '   Generating potential real GDP using Hodrick-
                               Prescott

genr ygap = lrgdp - yf         '   Generating real GDP gap using Hodrick-Prescott
   genr rng=ldrng-inf          '   Computing Nigeria real interest rate
   genr rus=ldrus-infus        '   Computing the US real interest rate
genr rintdiff= rng-rus         '   Generating real interest rate differential
genr dres=100*dlog(res)        '   Generating change in external reserves
genr rmb = log(brm/cping)      '   Generating real money balances
genr limp = log(m)             '   Log transforming total import
genr p = log(cping)            '   Log transforming Nigeria (domestic) price level
genr p_star = log(cpius)       '   Log transforming the US (foreign) price level
genr e1 = log(exr1)            '   Log transforming official nominal exchange rate
genr e2 = log(exr2)            '   Log transforming BDC nominal exchange rate
genr q = e1 + p_star - p       '   Generating Nigeria's real exchange rate
genr inf = (p - p(-1))         '   Generating month-on-month inflation rate
genr exr_gap = e2-e1           '   Computing gap between official and BDC
                               exchange rate
```

**Table A6: Detailed Results of Contemporaneous Effects from SVARX model**

Structural VAR Estimates
Date: 09/06/21 Time: 14:14
Sample (adjusted): 1962 2019
Included observations: 58 after adjustments
Restrictions: @VEC(E3) = "0, NA, NA, 0, NA, NA, NA", @VEC(E5) = "0, 0, 0, NA, 0, NA, NA", @VEC(E7) = "NA, NA,
0, 0, NA, NA, NA"
Iterated GLS convergence achieved after 5 iterations
Estimation method: Maximum likelihood via Newton-Raphson (analytic derivatives)
Convergence achieved after 20 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

A =

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| C(1) | 1 | 0 | 0 | 0 | 0 | 0 |
| C(2) | C(6) | 1 | 0 | 0 | 0 | 0 |
| C(3) | C(7) | C(11) | 1 | 0 | 0 | 0 |
| 0 | C(8) | C(12) | C(15) | 1 | C(20) | 0 |
| C(4) | C(9) | C(13) | C(16) | C(18) | 1 | 0 |
| C(5) | C(10) | C(14) | C(17) | C(19) | C(21) | 1 |

B =

| | | | | | | |
|---|---|---|---|---|---|---|
| C(22) | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | C(23) | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | C(24) | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | C(25) | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | C(26) | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | C(27) | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | C(28) |

| | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | -0.174129 | 0.086876 | -2.004348 | 0.0450 |
| C(2) | -0.193210 | 0.060416 | -3.197977 | 0.0014 |
| C(3) | 0.137648 | 2.056131 | 0.066945 | 0.9466 |
| C(4) | 0.065058 | 0.125781 | 0.517231 | 0.6050 |
| C(5) | 0.008678 | 0.013587 | 0.638697 | 0.5230 |
| C(6) | 0.143595 | 0.088308 | 1.626077 | 0.1039 |
| C(7) | -6.366713 | 2.833424 | -2.247003 | 0.0246 |
| C(8) | -2.504300 | 0.972799 | -2.574325 | 0.0100 |
| C(9) | -0.105228 | 1.362682 | -0.077221 | 0.9384 |
| C(10) | -0.037231 | 0.021972 | -1.694482 | 0.0902 |
| C(11) | 3.883095 | 4.120202 | 0.942453 | 0.3460 |
| C(12) | 0.668527 | 2.801402 | 0.238640 | 0.8114 |
| C(13) | -0.393044 | 0.301200 | -1.304927 | 0.1919 |
| C(14) | 0.915614 | 0.028085 | 32.60096 | 0.0000 |
| C(15) | -0.008350 | 0.043916 | -0.190126 | 0.8492 |
| C(16) | 0.004340 | 0.008176 | 0.530839 | 0.5955 |
| C(17) | -0.000910 | 0.000868 | -1.047678 | 0.2948 |
| C(18) | 0.075391 | 0.554523 | 0.135957 | 0.8919 |
| C(19) | -0.013024 | 0.004164 | -3.127489 | 0.0018 |
| C(20) | -0.859239 | 7.250254 | -0.118512 | 0.9057 |
| C(21) | 0.044250 | 0.014948 | 2.960209 | 0.0031 |
| C(22) | 0.157853 | 0.014656 | 10.77033 | 0.0000 |
| C(23) | 0.104440 | 0.009697 | 10.77033 | 0.0000 |
| C(24) | 0.070239 | 0.006522 | 10.77033 | 0.0000 |

| | | | | | | |
|---|---|---|---|---|---|---|
| C(25) | 2.203998 | 0.204636 | 10.77033 | 0.0000 | | |
| C(26) | 0.474842 | 0.247716 | 1.916879 | 0.0553 | | |
| C(27) | 0.131161 | 0.059942 | 2.188128 | 0.0287 | | |
| C(28) | 0.014528 | 0.001349 | 10.77033 | 0.0000 | | |
| Log likelihood | 180.3098 | | | | | |
| Estimated A matrix: | | | | | | |
| 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -0.174129 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -0.193210 | 0.143595 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.137648 | -6.366713 | 3.883095 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | -2.504300 | 0.668527 | -0.008350 | 1.000000 | -0.859239 | 0.000000 |
| 0.065058 | -0.105228 | -0.393044 | 0.004340 | 0.075391 | 1.000000 | 0.000000 |
| 0.008678 | -0.037231 | 0.915614 | -0.000910 | -0.013024 | 0.044250 | 1.000000 |
| Estimated B matrix: | | | | | | |
| 0.157853 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.104440 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.070239 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 2.203998 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.474842 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.131161 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.014528 |

**Table A7: Estimated Parameters for endogenous variables (in VAR) and the exogenous variables**

Vector Autoregression Estimates (with restrictions)
Date: 09/06/21 Time: 14:21
Sample (adjusted): 1962 2019
Included observations: 58 after adjustments
Restrictions: @VEC(E3) = "0, NA, NA, 0, NA, NA, NA", @VEC(E5) = "0, 0, 0, NA, 0, NA, NA", @VEC(E7) = "NA, NA, 0, 0, NA, NA, NA"
Iterated GLS convergence achieved after 5 iterations
Standard errors in ( ) & t-statistics in [ ]

| | LOG(OED) | YGAP | INF | RINTDIFF | DLOG(RES) | LOG(EXR2/EXR1) | Q |
|---|---|---|---|---|---|---|---|
| LOG(OED(-1)) | 0.829136 | -0.012712 | 0.094693 | 1.532019 | 0.002471 | -0.002665 | -0.077024 |
| | (0.04906) | (0.03359) | (0.02319) | (0.71311) | (0.16548) | (0.04202) | (0.02302) |
| | [ 16.9009] | [-0.37848] | [ 4.08381] | [ 2.14835] | [ 0.01493] | [-0.06342] | [-3.34665] |
| YGAP(-1) | -0.217812 | 0.453876 | 0.383967 | 1.400885 | -1.947212 | 0.103410 | -0.382878 |
| | (0.17168) | (0.11756) | (0.08312) | (2.53172) | (0.57833) | (0.14471) | (0.08232) |
| | [-1.26869] | [ 3.86088] | [ 4.61935] | [ 0.55333] | [-3.36697] | [ 0.71459] | [-4.65131] |
| INF(-1) | 0.185468 | -0.070135 | 0.324674 | 4.866506 | 1.675031 | 0.167496 | -0.329311 |
| | (0.20756) | (0.14209) | (0.10073) | (3.16202) | (0.69885) | (0.18012) | (0.09988) |
| | [ 0.89355] | [-0.49359] | [ 3.22334] | [ 1.53905] | [ 2.39684] | [ 0.92992] | [-3.29716] |
| RINTDIFF(-1) | -0.000380 | 0.003576 | -0.000309 | 0.334824 | -0.019698 | 0.022656 | 0.000767 |
| | (0.00795) | (0.00545) | (0.00383) | (0.11618) | (0.02682) | (0.00671) | (0.00379) |
| | [-0.04785] | [ 0.65624] | [-0.08069] | [ 2.88186] | [-0.73438] | [ 3.37639] | [ 0.20232] |
| DLOG(RES(-1)) | 0.060152 | 0.035916 | -0.037353 | -0.681611 | 0.257352 | -0.031255 | 0.045287 |
| | (0.03761) | (0.02577) | (0.01823) | (0.57146) | (0.12676) | (0.03267) | (0.01808) |
| | [ 1.59953] | [ 1.39382] | [-2.04849] | [-1.19275] | [ 2.03024] | [-0.95677] | [ 2.50440] |
| LOG(EXR2(-1)/EXR1(-1)) | -0.055907 | -0.096707 | 0.144525 | 0.814272 | -0.321645 | 0.903158 | -0.160427 |
| | (0.08225) | (0.05629) | (0.03950) | (1.24099) | (0.27701) | (0.07179) | (0.03921) |
| | [-0.67971] | [-1.71806] | [ 3.65863] | [ 0.65615] | [-1.16115] | [ 12.5803] | [-4.09185] |
| Q(-1) | -0.011604 | -0.056995 | 0.159893 | 4.961442 | 0.133395 | -0.048934 | 0.827779 |
| | (0.08819) | (0.06045) | (0.04142) | (1.25528) | (0.29808) | (0.07452) | (0.04110) |
| | [-0.13158] | [-0.94280] | [ 3.86032] | [ 3.95246] | [ 0.44751] | [-0.65663] | [ 20.1405] |
| C | 0.811847 | 0.299823 | -1.053091 | -25.34105 | -0.619994 | 0.087490 | 1.085045 |
| | (0.53261) | (0.36494) | (0.24961) | (7.56357) | (1.79947) | (0.45001) | (0.24772) |
| | [ 1.52429] | [ 0.82156] | [-4.21895] | [-3.35041] | [-0.34454] | [ 0.19442] | [ 4.38011] |
| M(-1) | -4.38E-06 | -9.99E-06 | 1.63E-05 | -0.000169 | 2.39E-05 | 6.80E-05 | -2.07E-05 |
| | (1.3E-05) | (1.6E-05) | (1.1E-05) | (0.00019) | (8.3E-05) | (2.1E-05) | (1.1E-05) |
| | [-0.33857] | [-0.61802] | [ 1.44211] | [-0.88561] | [ 0.28661] | [ 3.23995] | [-1.84175] |
| M | 0.000000 | 2.50E-06 | 5.37E-07 | 0.000000 | -4.72E-05 | -4.03E-05 | 3.07E-06 |
| | --- | (1.2E-05) | (8.2E-06) | --- | (6.3E-05) | (1.6E-05) | (8.2E-06) |
| | | [ 0.20824] | [ 0.06534] | | [-0.74857] | [-2.52514] | [ 0.37605] |
| D(E1(-1)) | 0.026915 | 0.043628 | -0.015603 | 0.795576 | -0.033656 | 0.087957 | 0.015017 |
| | (0.08877) | (0.06088) | (0.04316) | (1.33571) | (0.29950) | (0.07619) | (0.04277) |
| | [ 0.30319] | [ 0.71660] | [-0.36150] | [ 0.59562] | [-0.11237] | [ 1.15445] | [ 0.35111] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D(E1) | 0.000000 | 0.000000 | 0.000000 | 3.951656 | 0.000000 | -0.481703 | 0.982954 |
| | --- | --- | --- | (1.17838) | --- | (0.06909) | (0.00851) |
| | | | | [ 3.35346] | | [-6.97170] | [ 115.442] |
| LOG(NOX(-1)) | 0.045106 | -0.037540 | -0.041768 | 0.571075 | 0.030268 | -0.190615 | 0.047946 |
| | (0.05018) | (0.03585) | (0.01052) | (0.32087) | (0.18134) | (0.04495) | (0.01193) |
| | [ 0.89895] | [-1.04720] | [-3.97156] | [ 1.77980] | [ 0.16691] | [-4.24083] | [ 4.01772] |
| LOG(NOX) | -0.037932 | 0.046497 | 0.000000 | 0.000000 | 0.030937 | 0.134539 | -0.011123 |
| | (0.04712) | (0.03402) | --- | --- | (0.17311) | (0.04285) | (0.00608) |
| | [-0.80507] | [ 1.36656] | | | [ 0.17872] | [ 3.13971] | [-1.82901] |
| R-squared | 0.940055 | 0.365748 | 0.691294 | 0.892537 | 0.253622 | 0.898163 | 0.982123 |
| Sum sq. resids | 1.096379 | 0.513181 | 0.257992 | 240.1296 | 12.41095 | 0.777044 | 0.252933 |
| Mean dependent | 4.322919 | -0.001263 | 0.142052 | 10.61778 | 0.083225 | 0.166416 | 4.820247 |
| S.D. dependent | 0.566455 | 0.119143 | 0.121086 | 6.261181 | 0.540114 | 0.365874 | 0.498210 |
| Determinant resid covariance | | 4.70E-12 | | | | | |
| Log likelihood | | 236.3892 | | | | | |
| Akaike information criterion | | -5.047903 | | | | | |
| Schwarz criterion | | -1.850664 | | | | | |
| Number of coefficients | | 90 | | | | | |
| Number of restrictions | | 8 | | | | | |

**Table A8: Detailed Results of Contemporaneous Effects from SVARX model (Sectoral Model)**

Structural VAR Estimates
Date: 09/06/21 Time: 14:57
Sample: 1976 2019
Included observations: 44
Restrictions: @VEC(E3) = "0, NA, NA, 0, NA, NA, NA", @VEC(E5) = "0, 0, 0, NA, 0, NA, NA", @VEC(E7) = "NA, NA,
0, 0, NA, NA, NA", @VEC(E9) = "NA, NA, 0, 0, NA, NA, NA", @VEC(E11) = "NA, NA, 0, 0, NA, NA, NA"
Iterated GLS convergence achieved after 15 iterations
Estimation method: Maximum likelihood via Newton-Raphson (analytic derivatives)
Convergence achieved after 44 iterations
Structural VAR is just-identified

Model: Ae = Bu where E[uu']=I

A =

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| C(1) | 1 | 0 | 0 | 0 | 0 | 0 |
| C(2) | C(6) | 1 | 0 | 0 | 0 | 0 |
| C(3) | C(7) | C(11) | 1 | 0 | 0 | 0 |
| 0 | C(8) | C(12) | C(15) | 1 | C(20) | 0 |
| C(4) | C(9) | C(13) | C(16) | C(18) | 1 | 0 |
| C(5) | C(10) | C(14) | C(17) | C(19) | C(21) | 1 |

B =

| | | | | | | |
|---|---|---|---|---|---|---|
| C(22) | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | C(23) | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | C(24) | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | C(25) | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | C(26) | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | C(27) | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | C(28) |

| | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| C(1) | -0.978377 | 0.422096 | -2.317901 | 0.0205 |
| C(2) | -0.206015 | 0.388266 | -0.530603 | 0.5957 |
| C(3) | -24.32728 | 15.78758 | -1.540912 | 0.1233 |
| C(4) | 2.437664 | 1.773499 | 1.374495 | 0.1693 |
| C(5) | -0.068944 | 0.097113 | -0.709930 | 0.4777 |
| C(6) | 0.768093 | 0.130910 | 5.867341 | 0.0000 |
| C(7) | -11.39428 | 7.084011 | -1.608450 | 0.1077 |
| C(8) | -0.296309 | 2.032075 | -0.145816 | 0.8841 |
| C(9) | 0.126127 | 0.601727 | 0.209609 | 0.8340 |
| C(10) | -0.070966 | 0.042097 | -1.685787 | 0.0918 |
| C(11) | 4.880576 | 6.110520 | 0.798717 | 0.4245 |
| C(12) | -1.564918 | 2.127262 | -0.735649 | 0.4619 |
| C(13) | 0.011026 | 0.562951 | 0.019587 | 0.9844 |
| C(14) | 0.939740 | 0.035849 | 26.21413 | 0.0000 |
| C(15) | -0.038523 | 0.042470 | -0.907075 | 0.3644 |
| C(16) | 0.019873 | 0.020106 | 0.988441 | 0.3229 |
| C(17) | -0.001061 | 0.000904 | -1.174389 | 0.2402 |
| C(18) | -0.501021 | 0.406871 | -1.231401 | 0.2182 |
| C(19) | -0.009454 | 0.006204 | -1.523877 | 0.1275 |
| C(20) | 3.004081 | 4.664279 | 0.644061 | 0.5195 |
| C(21) | 0.036488 | 0.014212 | 2.567373 | 0.0102 |
| C(22) | 0.024251 | 0.002585 | 9.380833 | 0.0000 |
| C(23) | 0.067898 | 0.007238 | 9.380833 | 0.0000 |
| C(24) | 0.058960 | 0.006285 | 9.380832 | 0.0000 |

| | | | | |
|---|---|---|---|---|
| C(25) | 2.389796 | 0.254753 | 9.380830 | 0.0000 |
| C(26) | 0.669214 | 0.628342 | 1.065047 | 0.2869 |
| C(27) | 0.193974 | 0.096875 | 2.002316 | 0.0453 |
| C(28) | 0.013791 | 0.001470 | 9.380833 | 0.0000 |

| | |
|---|---|
| Log likelihood | 249.9173 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Estimated A matrix: | | | | | | |
| 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -0.978377 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -0.206015 | 0.768093 | 1.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| -24.32728 | -11.39428 | 4.880576 | 1.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | -0.296309 | -1.564918 | -0.038523 | 1.000000 | 3.004081 | 0.000000 |
| 2.437664 | 0.126127 | 0.011026 | 0.019873 | -0.501021 | 1.000000 | 0.000000 |
| -0.068944 | -0.070966 | 0.939740 | -0.001061 | -0.009454 | 0.036488 | 1.000000 |
| Estimated B matrix: | | | | | | |
| 0.024251 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.067898 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.058960 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 2.389796 | 0.000000 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.669214 | 0.000000 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.193974 | 0.000000 |
| 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.013791 |

**Table A9: Estimated Parameters for endogenous variables (in VAR) and the exogenous variables (Sectoral Model)**

Vector Autoregression Estimates (with restrictions)
Date: 09/06/21 Time: 14:57
Sample: 1976 2019
Included observations: 44
Restrictions: @VEC(E3) = "0, NA, NA, 0, NA, NA, NA", @VEC(E5) = "0, 0, 0, NA, 0, NA, NA", @VEC(E7) = "NA, NA, 0, 0, NA, NA, NA",
@VEC(E9) = "NA, NA, 0, 0, NA, NA, NA", @VEC(E11) = "NA, NA, 0, 0, NA, NA, NA"
Iterated GLS convergence achieved after 15 iterations
Standard errors in ( ) & t-statistics in [ ]

| | LOG(OED) | YGAP | INF | RINTDIFF | DLOG(RES) | LOG(EXR2/EXR1) | Q |
|---|---|---|---|---|---|---|---|
| LOG(OED(-1)) | 0.586465 | 0.292395 | -0.610000 | 11.71215 | -1.358137 | 1.855208 | 0.247858 |
| | (0.18591) | (0.53979) | (0.56639) | (19.9438) | (2.99209) | (1.28174) | (0.59015) |
| | [ 3.15451] | [ 0.54168] | [-1.07699] | [ 0.58726] | [-0.45391] | [ 1.44742] | [ 0.41999] |
| YGAP(-1) | -0.011274 | 0.372890 | 0.546097 | -4.825267 | -1.548954 | 0.227965 | -0.492344 |
| | (0.04815) | (0.14089) | (0.15300) | (5.44377) | (0.76307) | (0.32636) | (0.15896) |
| | [-0.23413] | [ 2.64662] | [ 3.56936] | [-0.88638] | [-2.02989] | [ 0.69850] | [-3.09723] |
| INF(-1) | 0.037601 | -0.133948 | 0.281931 | 3.844632 | 2.226138 | 0.278135 | -0.271218 |
| | (0.03619) | (0.10721) | (0.11311) | (4.23056) | (0.59482) | (0.28243) | (0.11830) |
| | [ 1.03893] | [-1.24935] | [ 2.49261] | [ 0.90878] | [ 3.74255] | [ 0.98481] | [-2.29265] |
| RINTDIFF(-1) | 0.000214 | 0.003925 | -0.002236 | 0.310697 | 0.009234 | 0.013958 | 0.003627 |
| | (0.00135) | (0.00385) | (0.00406) | (0.13682) | (0.02141) | (0.00900) | (0.00422) |
| | [ 0.15859] | [ 1.01828] | [-0.55049] | [ 2.27077] | [ 0.43133] | [ 1.55098] | [ 0.85959] |
| DLOG(RES(-1)) | -0.000197 | 0.005797 | -0.029437 | -1.214745 | 0.069221 | 0.008283 | 0.035778 |
| | (0.00826) | (0.02367) | (0.02508) | (0.89354) | (0.13060) | (0.05533) | (0.02608) |
| | [-0.02390] | [ 0.24492] | [-1.17389] | [-1.35947] | [ 0.53003] | [ 0.14971] | [ 1.37166] |
| LOG(EXR2(-1)/EXR1(-1)) | -0.006948 | -0.089745 | 0.168115 | 3.018729 | -0.651952 | 0.747088 | -0.173243 |
| | (0.01577) | (0.04430) | (0.04389) | (1.49665) | (0.25579) | (0.10846) | (0.04581) |
| | [-0.44068] | [-2.02599] | [ 3.83027] | [ 2.01699] | [-2.54880] | [ 6.88845] | [-3.78175] |
| Q(-1) | 0.002338 | -0.045654 | 0.186597 | 6.969673 | -0.509251 | -0.021520 | 0.783114 |
| | (0.01673) | (0.05057) | (0.05598) | (1.68544) | (0.27709) | (0.11976) | (0.05769) |
| | [ 0.13977] | [-0.90282] | [ 3.33337] | [ 4.13522] | [-1.83784] | [-0.17969] | [ 13.5743] |
| C | 1.828181 | -0.980939 | 1.914922 | -71.93461 | 8.702897 | -9.053509 | -0.062515 |
| | (0.81009) | (2.36526) | (2.49963) | (87.9661) | (13.0507) | (5.56791) | (2.60244) |
| | [ 2.25675] | [-0.41473] | [ 0.76608] | [-0.81775] | [ 0.66685] | [-1.62601] | [-0.02402] |
| LOG(M(-1)) | 0.004293 | -0.074094 | 0.012273 | -0.991974 | 0.355652 | -0.094899 | -0.022988 |
| | (0.00903) | (0.03501) | (0.03953) | (0.95945) | (0.19473) | (0.08343) | (0.04038) |
| | [ 0.47524] | [-2.11620] | [ 0.31045] | [-1.03389] | [ 1.82643] | [-1.13744] | [-0.56935] |
| LOG(M) | 0.000000 | 0.034727 | 0.006112 | 0.000000 | -0.470107 | 0.158610 | 0.001243 |
| | --- | (0.03381) | (0.03464) | --- | (0.20660) | (0.09052) | (0.03518) |
| | | [ 1.02701] | [ 0.17646] | | [-2.27542] | [ 1.75223] | [ 0.03534] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D(E1(-1)) | -0.016696 | 0.035937 | -0.036602 | 1.181029 | 0.125592 | 0.037136 | 0.051721 |
| | (0.01780) | (0.05350) | (0.05921) | (1.98975) | (0.28825) | (0.12547) | (0.06133) |
| | [-0.93817] | [ 0.67170] | [-0.61822] | [ 0.59356] | [ 0.43570] | [ 0.29597] | [ 0.84336] |
| D(E1) | 0.000000 | 0.000000 | 0.000000 | 4.661601 | 0.000000 | -0.486634 | 0.982865 |
| | --- | --- | --- | (1.30661) | --- | (0.09338) | (0.00955) |
| | | | | [ 3.56772] | | [-5.21156] | [ 102.876] |
| LOG(SLMX(-1)) | -0.010078 | -0.001333 | 0.004838 | 1.307502 | -0.264384 | 0.020357 | -0.009566 |
| | (0.00477) | (0.01412) | (0.01527) | (0.54089) | (0.07671) | (0.03351) | (0.01588) |
| | [-2.11281] | [-0.09447] | [ 0.31688] | [ 2.41732] | [-3.44657] | [ 0.60748] | [-0.60239] |
| LOG(SLMX) | 0.001425 | -0.010770 | 0.000000 | 0.000000 | 0.145451 | -0.087277 | 0.008576 |
| | (0.00542) | (0.01229) | --- | --- | (0.08753) | (0.03969) | (0.00401) |
| | [ 0.26276] | [-0.87634] | | | [ 1.66178] | [-2.19888] | [ 2.13800] |
| LOG(MFGX(-1)) | 0.007613 | 0.022109 | -0.035939 | 0.303694 | -0.010968 | -0.073600 | 0.040859 |
| | (0.00519) | (0.01492) | (0.01579) | (0.54986) | (0.08224) | (0.03444) | (0.01643) |
| | [ 1.46634] | [ 1.48150] | [-2.27571] | [ 0.55231] | [-0.13336] | [-2.13684] | [ 2.48733] |
| LOG(MFGX) | -0.007258 | 0.001879 | 0.000000 | 0.000000 | 0.246007 | 0.002104 | -0.001999 |
| | (0.00437) | (0.01086) | --- | --- | (0.07738) | (0.03374) | (0.00339) |
| | [-1.66261] | [ 0.17302] | | | [ 3.17927] | [ 0.06237] | [-0.58895] |
| LOG(AGRFX(-1)) | 0.005209 | -0.019679 | 0.004086 | -0.737861 | 0.145029 | 0.071361 | -0.011217 |
| | (0.00571) | (0.01649) | (0.01708) | (0.57391) | (0.09292) | (0.04042) | (0.01778) |
| | [ 0.91187] | [-1.19364] | [ 0.23917] | [-1.28568] | [ 1.56072] | [ 1.76533] | [-0.63089] |
| LOG(AGRFX) | -0.003011 | 0.039058 | 0.000000 | 0.000000 | -0.174921 | 0.038672 | -0.004068 |
| | (0.00414) | (0.00922) | --- | --- | (0.06570) | (0.03172) | (0.00321) |
| | [-0.72715] | [ 4.23791] | | | [-2.66244] | [ 1.21927] | [-1.26692] |
| R-squared | 0.646647 | 0.569881 | 0.743842 | 0.874874 | 0.638308 | 0.907760 | 0.987076 |
| Sum sq. resids | 0.015290 | 0.134501 | 0.165648 | 200.3675 | 3.812508 | 0.656670 | 0.177888 |
| Mean dependent | 4.554814 | 0.002602 | 0.164640 | 12.45677 | 0.043454 | 0.219367 | 4.826965 |
| S.D. dependent | 0.031723 | 0.085277 | 0.122632 | 6.102471 | 0.495110 | 0.406893 | 0.565764 |

| | |
|---|---|
| Determinant resid covariance | 2.75E-14 |
| Log likelihood | 330.9357 |
| Akaike information criterion | -9.860713 |
| Schwarz criterion | -5.238040 |
| Number of coefficients | 114 |
| Number of restrictions | 12 |

## Table A10: Baseline Model

LOG(OED) = 0.5864647138 * LOG(OED(-1)) - 0.0112739030123 * YGAP(-1) + 0.0376008719724 * INF(-1) + 0.000214177983852 * RINTDIFF(-1) - 0.000197298613485 * DLOG(RES(-1)) - 0.00694781880091 * LOG(EXR2(-1) / EXR1(-1)) + 0.00233778005457 * Q(-1) + 1.82818119636 + 0.00429298630449 * LOG(M(-1)) + 0 * LOG(M) - 0.0166955587735 * D(E1(-1)) + 0 * D(E1) - 0.0100782242752 * LOG(SLMX(-1)) + 0.00142545982636 * LOG(SLMX) + 0.00761302848393 * LOG(MFGX(-1)) - 0.00725826109929 * LOG(MFGX) + 0.00520902873212 * LOG(AGRFX(-1)) - 0.00301133653103 * LOG(AGRFX)

YGAP = 0.292395121454 * LOG(OED(-1)) + 0.372889993047 * YGAP(-1) - 0.133947548855 * INF(-1) + 0.00392468795323 * RINTDIFF(-1) + 0.0057973521769 * DLOG(RES(-1)) - 0.0897451217728 * LOG(EXR2(-1) / EXR1(-1)) - 0.0456539241715 * Q(-1) - 0.980939083394 - 0.0740936809383 * LOG(M(-1)) + 0.034726521763 * LOG(M) + 0.0359373980677 * D(E1(-1)) + 0 * D(E1) - 0.00133349681667 * LOG(SLMX(-1)) - 0.0107697714542 * LOG(SLMX) + 0.022109140969 * LOG(MFGX(-1)) + 0.00187856618721 * LOG(MFGX) - 0.0196789014981 * LOG(AGRFX(-1)) + 0.0390582877532 * LOG(AGRFX)

INF = - 0.610000122795 * LOG(OED(-1)) + 0.54609668125 * YGAP(-1) + 0.28193144893 * INF(-1) - 0.00223565763844 * RINTDIFF(-1) - 0.029437309234 * DLOG(RES(-1)) + 0.168115159514 * LOG(EXR2(-1) / EXR1(-1)) + 0.186597354669 * Q(-1) + 1.91492231359 + 0.012272804702 * LOG(M(-1)) + 0.00611239590375 * LOG(M) - 0.0366017121534 * D(E1(-1)) + 0 * D(E1) + 0.00483809747335 * LOG(SLMX(-1)) + 0 * LOG(SLMX) - 0.0359387744562 * LOG(MFGX(-1)) + 0 * LOG(MFGX) + 0.00408558854995 * LOG(AGRFX(-1)) + 0 * LOG(AGRFX)

RINTDIFF = 11.7121468001 * LOG(OED(-1)) - 4.8252670704 * YGAP(-1) + 3.84463206085 * INF(-1) + 0.310697050837 * RINTDIFF(-1) - 1.21474510788 * DLOG(RES(-1)) + 3.01872892323 * LOG(EXR2(-1) / EXR1(-1)) + 6.96967339516 * Q(-1) - 71.9346120031 - 0.991973967672 * LOG(M(-1)) + 0 * LOG(M) + 1.18102870764 * D(E1(-1)) + 4.6616007467 * D(E1) + 1.3075020765 * LOG(SLMX(-1)) + 0 * LOG(SLMX) + 0.303694013379 * LOG(MFGX(-1)) + 0 * LOG(MFGX) - 0.737860915011 * LOG(AGRFX(-1)) + 0 * LOG(AGRFX)

DLOG(RES) = - 1.35813739803 * LOG(OED(-1)) - 1.54895373198 * YGAP(-1) + 2.2261380571 * INF(-1) + 0.00923414982956 * RINTDIFF(-1) + 0.0692208524721 * DLOG(RES(-1)) - 0.651952121587 * LOG(EXR2(-1) / EXR1(-1)) - 0.509250552321 * Q(-1) + 8.70289700729 + 0.355652167024 * LOG(M(-1)) - 0.470107481321 * LOG(M) + 0.12559190091 * D(E1(-1)) + 0 * D(E1) - 0.264384324662 * LOG(SLMX(-1)) + 0.145450637389 * LOG(SLMX) - 0.010967516091 * LOG(MFGX(-1)) + 0.246007072076 * LOG(MFGX) + 0.145028536176 * LOG(AGRFX(-1)) - 0.174920874589 * LOG(AGRFX)

LOG(EXR2 / EXR1) = 1.85520848603 * LOG(OED(-1)) + 0.227964582569 * YGAP(-1) + 0.278135291679 * INF(-1) + 0.0139577662935 * RINTDIFF(-1) + 0.00828286294028 * DLOG(RES(-1)) + 0.747087538845 * LOG(EXR2(-1) / EXR1(-1)) - 0.0215196847364 * Q(-1) - 9.05350886965 - 0.0948988997699 * LOG(M(-1)) + 0.158609600975 * LOG(M) + 0.0371364248538 * D(E1(-1)) - 0.486634224686 * D(E1) + 0.0203570482621 * LOG(SLMX(-1)) - 0.0872770781976 * LOG(SLMX) - 0.0736003627476 * LOG(MFGX(-1)) + 0.00210427375578 * LOG(MFGX) + 0.0713609858854 * LOG(AGRFX(-1)) + 0.0386716834417 * LOG(AGRFX)

Q = 0.247857825087 * LOG(OED(-1)) - 0.492344250047 * YGAP(-1) - 0.271218210185 * INF(-1) + 0.00362718692088 * RINTDIFF(-1) + 0.0357782552569 * DLOG(RES(-1)) - 0.173243332983 * LOG(EXR2(-1) / EXR1(-1)) + 0.783113527696 * Q(-1) - 0.0625149545465 - 0.022987748118 * LOG(M(-1)) + 0.00124346337952 * LOG(M) + 0.0517211117217 * D(E1(-1)) + 0.982865288979 * D(E1) - 0.00956643004627 * LOG(SLMX(-1)) + 0.00857552212817 * LOG(SLMX) + 0.0408590496323 * LOG(MFGX(-1)) - 0.00199936349759 * LOG(MFGX) - 0.0112168207759 * LOG(AGRFX(-1)) - 0.00406789956497 * LOG(AGRFX)

**Table A11: Model for Scenario 1 (Higher Agricultural products export)**

LOG(OED) = 0.5864647138 * LOG(OED(-1)) - 0.0112739030123 * YGAP(-1) + 0.0376008719724 * INF(-1) + 0.000214177983852 * RINTDIFF(-1) - 0.000197298613485 * DLOG(RES(-1)) - 0.00694781880091 * LOG(EXR2(-1) / EXR1(-1)) + 0.00233778005457 * Q(-1) + 1.82818119636 + 0.00429298630449 * LOG(M(-1)) + 0 * LOG(M) - 0.0166955587735 * D(E1(-1)) + 0 * D(E1) - 0.0100782242752 * LOG(SLMX_SC1(-1)) + 0.00142545982636 * LOG(SLMX_SC1) + 0.00761302848393 * LOG(MFGX_SC1(-1)) - 0.00725826109929 * LOG(MFGX_SC1) + 0.00520902873212 * LOG(AGRFX_SC1(-1)) - 0.00301133653103 * LOG(AGRFX_SC1)

YGAP = 0.292395121454 * LOG(OED(-1)) + 0.372889993047 * YGAP(-1) - 0.133947548855 * INF(-1) + 0.00392468795323 * RINTDIFF(-1) + 0.0057973521769 * DLOG(RES(-1)) - 0.0897451217728 * LOG(EXR2(-1) / EXR1(-1)) - 0.0456539241715 * Q(-1) - 0.980939083394 - 0.0740936809383 * LOG(M(-1)) + 0.034726521763 * LOG(M) + 0.0359373980677 * D(E1(-1)) + 0 * D(E1) - 0.00133349681667 * LOG(SLMX_SC1(-1)) - 0.0107697714542 * LOG(SLMX_SC1) + 0.022109140969 * LOG(MFGX_SC1(-1)) + 0.00187856618721 * LOG(MFGX_SC1) - 0.0196789014981 * LOG(AGRFX_SC1(-1)) + 0.0390582877532 * LOG(AGRFX_SC1)

INF = - 0.610000122795 * LOG(OED(-1)) + 0.54609668125 * YGAP(-1) + 0.28193144893 * INF(-1) - 0.00223565763844 * RINTDIFF(-1) - 0.029437309234 * DLOG(RES(-1)) + 0.168115159514 * LOG(EXR2(-1) / EXR1(-1)) + 0.186597354669 * Q(-1) + 1.91492231359 + 0.012272804702 * LOG(M(-1)) + 0.00611239590375 * LOG(M) - 0.0366017121534 * D(E1(-1)) + 0 * D(E1) + 0.00483809747335 * LOG(SLMX_SC1(-1)) + 0 * LOG(SLMX_SC1) - 0.0359387744562 * LOG(MFGX_SC1(-1)) + 0 * LOG(MFGX_SC1) + 0.00408558854995 * LOG(AGRFX_SC1(-1)) + 0 * LOG(AGRFX_SC1)

RINTDIFF = 11.7121468001 * LOG(OED(-1)) - 4.8252670704 * YGAP(-1) + 3.84463206085 * INF(-1) + 0.310697050837 * RINTDIFF(-1) - 1.21474510788 * DLOG(RES(-1)) + 3.01872892323 * LOG(EXR2(-1) / EXR1(-1)) + 6.96967339516 * Q(-1) - 71.9346120031 - 0.991973967672 * LOG(M(-1)) + 0 * LOG(M) + 1.18102870764 * D(E1(-1)) + 4.6616007467 * D(E1) + 1.3075020765 * LOG(SLMX_SC1(-1)) + 0 * LOG(SLMX_SC1) + 0.303694013379 * LOG(MFGX_SC1(-1)) + 0 * LOG(MFGX_SC1) - 0.737860915011 * LOG(AGRFX_SC1(-1)) + 0 * LOG(AGRFX_SC1)

DLOG(RES) = - 1.35813739803 * LOG(OED(-1)) - 1.54895373198 * YGAP(-1) + 2.2261380571 * INF(-1) + 0.00923414982956 * RINTDIFF(-1) + 0.0692208524721 * DLOG(RES(-1)) - 0.651952121587 * LOG(EXR2(-1) / EXR1(-1)) - 0.509250552321 * Q(-1) + 8.70289700729 + 0.355652167024 * LOG(M(-1)) - 0.470107481321 * LOG(M) + 0.12559190091 * D(E1(-1)) + 0 * D(E1) - 0.264384324662 * LOG(SLMX_SC1(-1)) + 0.145450637389 * LOG(SLMX_SC1) - 0.010967516091 * LOG(MFGX_SC1(-1)) + 0.246007072076 * LOG(MFGX_SC1) + 0.145028536176 * LOG(AGRFX_SC1(-1)) - 0.174920874589 * LOG(AGRFX_SC1)

LOG(EXR2 / EXR1) = 1.85520848603 * LOG(OED(-1)) + 0.227964582569 * YGAP(-1) + 0.278135291679 * INF(-1) + 0.0139577662935 * RINTDIFF(-1) + 0.00828286294028 * DLOG(RES(-1)) + 0.747087538845 * LOG(EXR2(-1) / EXR1(-1)) - 0.0215196847364 * Q(-1) - 9.05350886965 - 0.0948988997699 * LOG(M(-1)) + 0.158609600975 * LOG(M) + 0.0371364248538 * D(E1(-1)) - 0.486634224686 * D(E1) + 0.0203570482621 * LOG(SLMX_SC1(-1)) - 0.0872770781976 * LOG(SLMX_SC1) - 0.0736003627476 * LOG(MFGX_SC1(-1)) + 0.00210427375578 * LOG(MFGX_SC1) + 0.0713609858854 * LOG(AGRFX_SC1(-1)) + 0.0386716834417 * LOG(AGRFX_SC1)

Q = 0.247857825087 * LOG(OED(-1)) - 0.492344250047 * YGAP(-1) - 0.271218210185 * INF(-1) + 0.00362718692088 * RINTDIFF(-1) + 0.0357782552569 * DLOG(RES(-1)) - 0.173243332983 * LOG(EXR2(-1) / EXR1(-1)) + 0.783113527696 * Q(-1) - 0.0625149545465 - 0.022987748118 * LOG(M(-1)) + 0.00124346337952 * LOG(M) + 0.0517211117217 * D(E1(-1)) + 0.982865288979 * D(E1) - 0.00956643004627 * LOG(SLMX_SC1(-1)) + 0.00857552212817 * LOG(SLMX_SC1) + 0.0408590496323 * LOG(MFGX_SC1(-1)) - 0.00199936349759 * LOG(MFGX_SC1) - 0.0112168207759 * LOG(AGRFX_SC1(-1)) - 0.00406789956497 * LOG(AGRFX_SC1)

**Table A12: Model for Scenario 2 (High Manufacturing export)**

LOG(OED) = 0.5864647138 * LOG(OED(-1)) - 0.0112739030123 * YGAP(-1) + 0.0376008719724 * INF(-1) + 0.000214177983852 * RINTDIFF(-1) - 0.000197298613485 * DLOG(RES(-1)) - 0.00694781880091 * LOG(EXR2(-1) / EXR1(-1)) + 0.00233778005457 * Q(-1) + 1.82818119636 + 0.00429298630449 * LOG(M(-1)) + 0 * LOG(M) - 0.0166955587735 * D(E1(-1)) + 0 * D(E1) - 0.0100782242752 * LOG(SLMX_SC2(-1)) + 0.00142545982636 * LOG(SLMX_SC2) + 0.00761302848393 * LOG(MFGX_SC2(-1)) - 0.00725826109929 * LOG(MFGX_SC2) + 0.00520902873212 * LOG(AGRFX_SC2(-1)) - 0.00301133653103 * LOG(AGRFX_SC2)

YGAP = 0.292395121454 * LOG(OED(-1)) + 0.372889993047 * YGAP(-1) - 0.133947548855 * INF(-1) + 0.00392468795323 * RINTDIFF(-1) + 0.0057973521769 * DLOG(RES(-1)) - 0.0897451217728 * LOG(EXR2(-1) / EXR1(-1)) - 0.0456539241715 * Q(-1) - 0.980939083394 - 0.0740936809383 * LOG(M(-1)) + 0.034726521763 * LOG(M) + 0.0359373980677 * D(E1(-1)) + 0 * D(E1) - 0.00133349681667 * LOG(SLMX_SC2(-1)) - 0.0107697714542 * LOG(SLMX_SC2) + 0.022109140969 * LOG(MFGX_SC2(-1)) + 0.00187856618721 * LOG(MFGX_SC2) - 0.0196789014981 * LOG(AGRFX_SC2(-1)) + 0.0390582877532 * LOG(AGRFX_SC2)

INF = - 0.610000122795 * LOG(OED(-1)) + 0.54609668125 * YGAP(-1) + 0.28193144893 * INF(-1) - 0.00223565763844 * RINTDIFF(-1) - 0.029437309234 * DLOG(RES(-1)) + 0.168115159514 * LOG(EXR2(-1) / EXR1(-1)) + 0.186597354669 * Q(-1) + 1.91492231359 + 0.012272804702 * LOG(M(-1)) + 0.00611239590375 * LOG(M) - 0.0366017121534 * D(E1(-1)) + 0 * D(E1) + 0.00483809747335 * LOG(SLMX_SC2(-1)) + 0 * LOG(SLMX_SC2) - 0.0359387744562 * LOG(MFGX_SC2(-1)) + 0 * LOG(MFGX_SC2) + 0.00408558854995 * LOG(AGRFX_SC2(-1)) + 0 * LOG(AGRFX_SC2)

RINTDIFF = 11.7121468001 * LOG(OED(-1)) - 4.8252670704 * YGAP(-1) + 3.84463206085 * INF(-1) + 0.310697050837 * RINTDIFF(-1) - 1.21474510788 * DLOG(RES(-1)) + 3.01872892323 * LOG(EXR2(-1) / EXR1(-1)) + 6.96967339516 * Q(-1) - 71.9346120031 - 0.991973967672 * LOG(M(-1)) + 0 * LOG(M) + 1.18102870764 * D(E1(-1)) + 4.6616007467 * D(E1) + 1.3075020765 * LOG(SLMX_SC2(-1)) + 0 * LOG(SLMX_SC2) + 0.303694013379 * LOG(MFGX_SC2(-1)) + 0 * LOG(MFGX_SC2) - 0.737860915011 * LOG(AGRFX_SC2(-1)) + 0 * LOG(AGRFX_SC2)

DLOG(RES) = - 1.35813739803 * LOG(OED(-1)) - 1.54895373198 * YGAP(-1) + 2.2261380571 * INF(-1) + 0.00923414982956 * RINTDIFF(-1) + 0.0692208524721 * DLOG(RES(-1)) - 0.651952121587 * LOG(EXR2(-1) / EXR1(-1)) - 0.509250552321 * Q(-1) + 8.70289700729 + 0.355652167024 * LOG(M(-1)) - 0.470107481321 * LOG(M) + 0.12559190091 * D(E1(-1)) + 0 * D(E1) - 0.264384324662 * LOG(SLMX_SC2(-1)) + 0.145450637389 * LOG(SLMX_SC2) - 0.010967516091 * LOG(MFGX_SC2(-1)) + 0.246007072076 * LOG(MFGX_SC2) + 0.145028536176 * LOG(AGRFX_SC2(-1)) - 0.174920874589 * LOG(AGRFX_SC2)

LOG(EXR2 / EXR1) = 1.85520848603 * LOG(OED(-1)) + 0.227964582569 * YGAP(-1) + 0.278135291679 * INF(-1) + 0.0139577662935 * RINTDIFF(-1) + 0.00828286294028 * DLOG(RES(-1)) + 0.747087538845 * LOG(EXR2(-1) / EXR1(-1)) - 0.0215196847364 * Q(-1) - 9.05350886965 - 0.0948988997699 * LOG(M(-1)) + 0.158609600975 * LOG(M) + 0.0371364248538 * D(E1(-1)) - 0.486634224686 * D(E1) + 0.0203570482621 * LOG(SLMX_SC2(-1)) - 0.0872770781976 * LOG(SLMX_SC2) - 0.0736003627476 * LOG(MFGX_SC2(-1)) + 0.00210427375578 * LOG(MFGX_SC2) + 0.0713609858854 * LOG(AGRFX_SC2(-1)) + 0.0386716834417 * LOG(AGRFX_SC2)

Q = 0.247857825087 * LOG(OED(-1)) - 0.492344250047 * YGAP(-1) - 0.271218210185 * INF(-1) + 0.00362718692088 * RINTDIFF(-1) + 0.0357782552569 * DLOG(RES(-1)) - 0.173243332983 * LOG(EXR2(-1) / EXR1(-1)) + 0.783113527696 * Q(-1) - 0.0625149545465 - 0.022987748118 * LOG(M(-1)) + 0.00124346337952 * LOG(M) + 0.0517211117217 * D(E1(-1)) + 0.982865288979 * D(E1) - 0.00956643004627 * LOG(SLMX_SC2(-1)) + 0.00857552212817 * LOG(SLMX_SC2) + 0.0408590496323 * LOG(MFGX_SC2(-1)) - 0.00199936349759 * LOG(MFGX_SC2) - 0.0112168207759 * LOG(AGRFX_SC2(-1)) - 0.00406789956497 * LOG(AGRFX_SC2)

**Table A13: Model for Scenario 3 (Higher Solid Minerals export)**

LOG(OED) = 0.5864647138 * LOG(OED(-1)) - 0.0112739030123 * YGAP(-1) + 0.0376008719724 * INF(-1) + 0.000214177983852 * RINTDIFF(-1) - 0.000197298613485 * DLOG(RES(-1)) - 0.00694781880091 * LOG(EXR2(-1) / EXR1(-1)) + 0.00233778005457 * Q(-1) + 1.82818119636 + 0.00429298630449 * LOG(M(-1)) + 0 * LOG(M) - 0.0166955587735 * D(E1(-1)) + 0 * D(E1) - 0.0100782242752 * LOG(SLMX_SC3(-1)) + 0.00142545982636 * LOG(SLMX_SC3) + 0.00761302848393 * LOG(MFGX_SC3(-1)) - 0.00725826109929 * LOG(MFGX_SC3) + 0.00520902873212 * LOG(AGRFX_SC3(-1)) - 0.00301133653103 * LOG(AGRFX_SC3)

YGAP = 0.292395121454 * LOG(OED(-1)) + 0.372889993047 * YGAP(-1) - 0.133947548855 * INF(-1) + 0.00392468795323 * RINTDIFF(-1) + 0.0057973521769 * DLOG(RES(-1)) - 0.0897451217728 * LOG(EXR2(-1) / EXR1(-1)) - 0.0456539241715 * Q(-1) - 0.980939083394 - 0.0740936809383 * LOG(M(-1)) + 0.034726521763 * LOG(M) + 0.0359373980677 * D(E1(-1)) + 0 * D(E1) - 0.00133349681667 * LOG(SLMX_SC3(-1)) - 0.0107697714542 * LOG(SLMX_SC3) + 0.022109140969 * LOG(MFGX_SC3(-1)) + 0.00187856618721 * LOG(MFGX_SC3) - 0.0196789014981 * LOG(AGRFX_SC3(-1)) + 0.0390582877532 * LOG(AGRFX_SC3)

INF = - 0.610000122795 * LOG(OED(-1)) + 0.54609668125 * YGAP(-1) + 0.28193144893 * INF(-1) - 0.00223565763844 * RINTDIFF(-1) - 0.029437309234 * DLOG(RES(-1)) + 0.168115159514 * LOG(EXR2(-1) / EXR1(-1)) + 0.186597354669 * Q(-1) + 1.91492231359 + 0.012272804702 * LOG(M(-1)) + 0.00611239590375 * LOG(M) - 0.0366017121534 * D(E1(-1)) + 0 * D(E1) + 0.00483809747335 * LOG(SLMX_SC3(-1)) + 0 * LOG(SLMX_SC3) - 0.0359387744562 * LOG(MFGX_SC3(-1)) + 0 * LOG(MFGX_SC3) + 0.00408558854995 * LOG(AGRFX_SC3(-1)) + 0 * LOG(AGRFX_SC3)

RINTDIFF = 11.7121468001 * LOG(OED(-1)) - 4.8252670704 * YGAP(-1) + 3.84463206085 * INF(-1) + 0.310697050837 * RINTDIFF(-1) - 1.21474510788 * DLOG(RES(-1)) + 3.01872892323 * LOG(EXR2(-1) / EXR1(-1)) + 6.96967339516 * Q(-1) - 71.9346120031 - 0.991973967672 * LOG(M(-1)) + 0 * LOG(M) + 1.18102870764 * D(E1(-1)) + 4.6616007467 * D(E1) + 1.3075020765 * LOG(SLMX_SC3(-1)) + 0 * LOG(SLMX_SC3) + 0.303694013379 * LOG(MFGX_SC3(-1)) + 0 * LOG(MFGX_SC3) - 0.737860915011 * LOG(AGRFX_SC3(-1)) + 0 * LOG(AGRFX_SC3)

DLOG(RES) = - 1.35813739803 * LOG(OED(-1)) - 1.54895373198 * YGAP(-1) + 2.2261380571 * INF(-1) + 0.00923414982956 * RINTDIFF(-1) + 0.0692208524721 * DLOG(RES(-1)) - 0.651952121587 * LOG(EXR2(-1) / EXR1(-1)) - 0.509250552321 * Q(-1) + 8.70289700729 + 0.355652167024 * LOG(M(-1)) - 0.470107481321 * LOG(M) + 0.12559190091 * D(E1(-1)) + 0 * D(E1) - 0.264384324662 * LOG(SLMX_SC3(-1)) + 0.145450637389 * LOG(SLMX_SC3) - 0.010967516091 * LOG(MFGX_SC3(-1)) + 0.246007072076 * LOG(MFGX_SC3) + 0.145028536176 * LOG(AGRFX_SC3(-1)) - 0.174920874589 * LOG(AGRFX_SC3)

LOG(EXR2 / EXR1) = 1.85520848603 * LOG(OED(-1)) + 0.227964582569 * YGAP(-1) + 0.278135291679 * INF(-1) + 0.0139577662935 * RINTDIFF(-1) + 0.00828286294028 * DLOG(RES(-1)) + 0.747087538845 * LOG(EXR2(-1) / EXR1(-1)) - 0.0215196847364 * Q(-1) - 9.05350886965 - 0.0948988997699 * LOG(M(-1)) + 0.158609600975 * LOG(M) + 0.0371364248538 * D(E1(-1)) - 0.486634224686 * D(E1) + 0.0203570482621 * LOG(SLMX_SC3(-1)) - 0.0872770781976 * LOG(SLMX_SC3) - 0.0736003627476 * LOG(MFGX_SC3(-1)) + 0.00210427375578 * LOG(MFGX_SC3) + 0.0713609858854 * LOG(AGRFX_SC3(-1)) + 0.0386716834417 * LOG(AGRFX_SC3)

Q = 0.247857825087 * LOG(OED(-1)) - 0.492344250047 * YGAP(-1) - 0.271218210185 * INF(-1) + 0.00362718692088 * RINTDIFF(-1) + 0.0357782552569 * DLOG(RES(-1)) - 0.173243332983 * LOG(EXR2(-1) / EXR1(-1)) + 0.783113527696 * Q(-1) - 0.0625149545465 - 0.022987748118 * LOG(M(-1)) + 0.00124346337952 * LOG(M) + 0.0517211117217 * D(E1(-1)) + 0.982865288979 * D(E1) - 0.00956643004627 * LOG(SLMX_SC3(-1)) + 0.00857552212817 * LOG(SLMX_SC3) + 0.0408590496323 * LOG(MFGX_SC3(-1)) - 0.00199936349759 * LOG(MFGX_SC3) - 0.0112168207759 * LOG(AGRFX_SC3(-1)) - 0.00406789956497 * LOG(AGRFX_SC3)