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Aims and Scope

The *Economic and Financial Review (EFR)* is a quarterly publication of the Research Department of the Central Bank of Nigeria. The Review contains articles on research undertaken at the Bank, in particular, and Nigeria, in general, mainly on policy issues both at the macroeconomic and sectoral levels in the hope that the research would improve and enhance policy choices. Its main thrust is to promote studies and disseminate research findings, which could facilitate achievement of these objectives. Comments on or objective critiques of published articles are also featured in the review.

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Notes to Contributors

Information on manuscript submission is provided on the last and inside back cover of the Review.

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Money Demand in the Conduct of Monetary Policy in Nigeria

Nakorji, M. and Asuzu, O. C.*

Abstract

This paper examined the behaviour of money demand in the conduct of monetary policy using quarterly data from 2010Q1 to 2018Q2. The ARDL methodology was adopted given the outcome of the unit root test. The results revealed that exchange rate, financial innovation, and growth rate of real GDP have positive short-run impacts on real money demand, while treasury bill rate and lags of growth rate of real GDP influenced it negatively. Furthermore, the estimates revealed evidence of long-run relationship among the variables, which was significant only with respect to the financial innovation variable. The model passed all the diagnostic tests – specification, serial correlation, heteroskedasticity, and structural stability. Exchange rate depreciation exhibited a perceived wealth effect in the short-run given the negative relationship between exchange rate and real money balances. Also, the upward trend in financial innovation led to an upward movement in the holdings of real money balances in Nigeria. One of the implications of these results for policy makers is that an increase in treasury bill rate would cause Nigerians to hold more money for transactionary reasons rather than substitute the naira for other currencies. This would increase the potential of attracting currency outside banks into the coffers of the financial institutions. As a result, a sizeable volume of funds will remain within the influence of monetary authorities and could improve effective implementation of monetary policy.

Keywords: Money Demand, Exchange Rate, Currency Substitution, ARDL approach

JEL Classification Numbers: E41, E52, F31

I. Introduction

Central banks are charged with the responsibility of ensuring the stability of the general price level through monetary policy. This is achieved by ensuring sustainable levels of money supply and indirectly, money demand. In a bid to ensure the stability of prices, central banks employ policies, which work through the action of several tools of monetary policy. These include the use of open market operations, bank reserve requirements, and non-conventional monetary policies. Demand for money occurs in parallel with the supply of money which follows from the combined effect of income, interest rates (alternative sources of income, such as investments), rate of inflation and exchange rates in any economy. The higher the equilibrium interest rate, the more households, and businesses allocate assets into interest-bearing investments and vice versa. In open economies also, higher equilibrium interest rates in the domestic country lead to higher return on domestic assets, which in turn affect the exchange rate between both countries. The interaction between money demand and certain macro-economic variables have, however, been captured by several money demand theories such as the Classical Quantity theory of money, Keynes Liquidity Preference theory, and Baumol-Tobin Demand models.

The 'economic' relationship between individuals and the macro-economy is best captured by the money demand relationship, that is, the interaction between individuals and monetary authorities is best captured through effective monetary policy, which involves increasing or decreasing the amount of money in the banking system. The need to understand the behaviour of monetary policy has long been identified and tested variously,

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usually via modifying reserve requirements, changing short-term interest rates and/or conducting open market operations. Several studies highlight such relationships especially as propounded by Irving Fisher in the early 1900s, Keynes (1936), Mundell (1963) and as estimated even in Nigeria by Tomori as early as the 1970s. Others have also determined the stability of the money demand function in several economies including Nigeria[1]. For example, Bartholomew and Kargbo (2010) aver that a stable and anticipated money demand function is crucial for the conduct of monetary policy as it enables policy-makers to forecast money demand and determine the appropriate growth rates of money supply needed to control inflation thus, further emphasising the role of money demand and, by extension, money supply, on the conduct of monetary policy. This is usually ensured by sustaining equilibrium in the money market according to Keynes's theory of liquidity preference, which says that the equilibrium price of money is the interest rate where money supply equals money demand.

Demand for money has been defined as the amount of money people want to hold (Blanchard, 2017). It is often classified under three motives or purposes for holding money – transactionary, precautionary and speculative. However, given the increasing use of electronic-based (e-based) platforms, demand for money could be defined to mean the ability of individuals to demand for monetary instruments. People trade on e-based platforms without necessarily exchanging cash. In another argument, the influence of the global economy has a strong effect on trade and income. The more the value of exports of a particular nation, the higher its revenues and by extension, the stronger the currency, that is a currency appreciation. Being a heavily import dependent economy, the effect of exchange rate changes, alongside other variables, are influential in the effectiveness of monetary policy (Doguwa, et al., 2014). Bahmani-Oskooee (1991), Anoruo (2002), Samreth (2008), Bathalomew and Kargbo (2010), Kumar et al (2013), and Doguwa, et al. (2014), among others, have determined the stability of the money demand function in several economies including Nigeria capturing real income, interest rate, rate of inflation and in some cases, official exchange rate and financial innovation as its major determinants.

The cashless policy of the Nigerian economy has been driven by the central bank in a bid to ensure limited or minimal movement of cash as the Bank ensures that it sustains monetary policy. This it does through the use of interest rate, where an increase in the interest rate, that is, contractionary monetary policy, is expected to reduce demand for money. The question is how effective or efficient has this policy been on the macroeconomy? This study, therefore, intends to determine the existence or otherwise of a long-run relationship among money demand and its determinants and hence its effect on monetary policy, especially as it relates to wealth or currency substitution effects on the Nigerian economy. It would borrow some hindsight from an earlier study by Bartholomew and Kargbo (2010) study, which determined the existence of either wealth or currency substitution effects on the economy of Sierra Leone. This study covers the period between 2010Q1 and 2018Q2, uses M_3 as a measure of money demand and employs a reasonable series of financial innovation. The choice of 2010Q1 as the first data point is as a result of the availability of data for M_3 and the non-harmonisation of the GDP data earlier than 2010.

The remainder of the paper is organised as follows; Section 2 details review of some related literature, which covers both theoretical and empirical literature. Section 3 discusses stylised facts on demand for money and the behaviour or conduct of monetary policy in Nigeria.

[1] See Iyoha (1976), Akinlo (2006), Ball (2012), Nduka & Chukwu (2013), Bassey et al (2017), Tule et al (2018)

The econometric analysis, which entails the data and methodology used is presented in Section 4 while Section 5 concludes the paper, highlighting some policy implications and recommendations.

II. Review of Related Literature

II.1 Theories of Money Demand

Early economists proposed several theories of demand for money. These are the classical quantity theory of money demand (also called the "neo-quantity theory" or the Fisherian theory), which states that there exists a direct relationship between the quantity of money in an economy and the level of prices of goods and services sold, that is, there exists a mechanical and fixed proportional relationship between changes in the money supply and the general price level. The Liquidity Preference theory, propounded by John Maynard Keynes, ignored the role of interest rates and assumed that there exists no direct relationship between money and price level. He also argued that individual prices for specific markets adapt differently to changes in money supply.

The Baumol-Tobin model, popularly referred to as a model of cash management, emphasised the role of money as a medium of exchange. It is believed that money is a dominated asset that people hold to make purchases. Another theory is Friedman's restatement of the Quantity Theory of Money, which regarded the amount of real cash balances (M/P) as a commodity, which is demanded because it yields services to the person who holds it.

This study, however, relies on the Baumol-Tobin model of money demand. This model is an extension of the Keynes view of money demand, which includes an interest rate component. It is usually classified as a transaction theory because it emphasises the role of money as a medium of exchange. The transaction theorists believe that money is a dominated asset that people hold to make purchases. The proponents explained the cost and benefit of holding money as low rate of return and convenience of transactions, respectively. The optimum amount of assets an individual can hold depends on the interest forgone on the cash balance held and the cost of brokerage, that is, the cost of acquiring bonds and converting them into cash.

This model assumes that:

i. An individual receives income of Y at the beginning of every period;

ii. An individual spends this income at a constant rate;

iii. There are only two (2) assets – cash and bonds. Cash earns a nominal return of zero and bonds earn an interest rate (i); and

iv. Every time an individual buys/sells bonds to raise cash, a fixed brokerage fee of F is incurred.

The Baumol-Tobin money demand model is thus denoted as $M^d = \sqrt{\frac{YF}{2i}} = L(i, Y, F)$, where $Y, i, L, F \text{ and } M^d$represents income, interest rate, a function relating Y and i to money demand, fixed brokerage fee and aggregate money demand, respectively.

It concludes that:

i. The transactions demand for money is negatively related to interest rate;

ii. The transactions demand for money is positively related to income, but there are economies of scale in money holdings, that is, the demand for money rises less than proportionally with income;
iii. A lowering of the brokerage costs due to technological improvements would decrease the demand for money; and
iv. There is no money illusion in the demand for money. If the price level doubles, $Y\ and\ F$ also doubles.

Since monetary policy is usually achieved by monetary authorities through the use of modifying reserve requirements, changing short-term interest rates and/or conducting open market operations (IMF 2018), this study proxies monetary authorities by the use of interest rates. Also, the Central Bank of Nigeria uses the interest rate to carry out its control over the money supply.

II.2 Empirical Literature

Based on theory and as empirically tested by Arango and Nadiri (1981), Mannah-Blankson and Belnye (2004), Bahmani-Oskooee and Tanku (2006), Misati et al (2010), etc., money demand is said to respond to changes in the macro-economy, through monetary policy (that is, interest rates – domestic and foreign inflation and exchange rates), and technology, which help influence decisions of monetary authorities. The design of effective monetary policy is very crucial for policy-makers as it relies on the configuration of the demand for money function especially as several economies relate with each other (Samreth 2008). As a result, the choice of the determinants of the demand for money function is paramount to effective monetary policy implementation through the effect of changes in interest rates, cash reserve requirements, exchange rates, and technology (such as effects of the cashless policy).

Arango and Nadiri (1981) estimated evidence of demand for money in open economies for select industrialised countries (Canada, Germany, United Kingdom and the United States) using quarterly post-war data between 1960 and 1975. The Portfolio model was employed in the estimation. They inferred that demand for money was affected not only by changes in domestic variables such as permanent income, domestic interest rate and price expectations, but also by fluctuations in exchange rate expectations and foreign interest rates. Their study found that exchange rate expectations played an important role in portfolio decisions concerning the degree of substitution between money and foreign assets. They also noted that when these external components are omitted, the empirical results point to significant misspecification biases in the traditional demand functions for real cash balances in these industrialised nations. Also, real cash balances adjust to their desired values rapidly through the speed of adjustment of money demand, which varied among countries.

Analysing the roles of financial factors in the behaviour of M_1 and M_2 demands in Malaysia, Ibrahim (2001) focused on the financial innovations and influence of real stock prices on the holdings of monetary assets using post-1986 data. Employing co-integration and error correction modeling to arrive at a robust money demand function, the findings of the study indicated the significance of both real income and real stock prices in influencing the behaviour of money demand in Malaysia in the short-run. The dominance of the wealth effect over the substitution effect, which emphasised the effect of increasing exchange rate depreciation on the domestic economy was established.

Samreth (2008) empirically estimated the money demand function in Cambodia having adopted nominal exchange rate, M_1, and real income, and utilised the Autoregressive Distributed Lag (ARDL) approach covering 1994M12 to 2006M12. The results indicated co-integration among variables in money demand function. In the long-run, there exists a mix of both currency substitution and wealth effects. Also employing the ARDL modeling technique, Bathalomew and Kargbo (2010) examined the impact of foreign monetary developments on demand for real broad money (RM_2) balances in Sierra Leone for the period 1983Q1 to 2008Q4. The results suggest a co-integrating relationship between real M_2 and its determinants (real GDP, domestic interest rates and inflation rate). While the long-run exhibits a currency substitution phenomenon, the short-run dynamics highlight the presence of both currency substitution and wealth effects. The indicators also reveal stability in the M_2 as an appropriate intermediate target in the conduct of the monetary aggregates targeting framework in Sierra Leone.

Silverstovs (2008) developed a money demand function for Latvia for the period 1996 to 2006 using the VAR methodology. This was based on the single co-integration vector between the real money balances, income, long-term interest rate and inflation. The results show that these variables adequately explain long-run relationships with respect to real money balances in Latvia. The decision to use a particular type or class of exchange rate, especially in economies with several exchange rates, has also been debated by several researchers. Given the existence of the parallel market for foreign exchange in less developed countries, it has been suggested that the parallel market exchange rate rather than the official rate could be used as the determinant of the demand for money Bahmani-Oskooee and Tanku (2006). Marquez (1985) examined the degree of currency substitution as a result of the relationship between domestic money holdings and foreign exchange considerations. The study concluded that individuals select the levels of foreign and domestic money that reduce the costs of borrowing related to a given level of monetary services. A slightly different study was that on post-revolutionary Iran by Bahmani and Bahmani-Oskooee (2012), which incorporated the impact of exchange rate volatility on the money demand function. The authors explained that Mundell (1963) proposed that demand for money could depend on the exchange rate in addition to income and interest rate. The study revealed that exchange rate volatility had both short- and long-run effects on the demand of 1979 – 2007 and has remained a very important determinant when it comes to the demand for money in Iran.

Bahmani-Oskooee (1991) estimated a money demand function that includes real effective exchange rate (REER) as another determinant of the demand for money using quarterly data from the UK over the 1973Q1 to 1987Q4 period. It was found that REER had a significant effect on the demand for money both in the long- and short-run. Thus, in the long-run, an increase in REER, that is, a depreciation of the British Pound, makes monetary policy less effective as a result of increasing demand for money.

Bahmani-Oskooee and Tanku (2006) explored the inclusion of the black market exchange rate in estimating the money demand function in less developed countries. This was tested by estimating the demand for money function for 25 less developed countries (LDCs) using the Bounds testing Approach to co-integration. Though the study period varied from one country to another, it generally ranged between 1957Q1 to 1998Q4. The study concluded that while in some LDCs, the black market rate enters into the formulation of the demand for money; the official rate was used as the determinant in others. The black market premium also played a role in some countries.

Misati et al (2010) examined the effect of financial innovation on monetary policy transmission in Kenya and focused on the interest rate channel through which the central bank implements monetary policy. The paper utilised the two stage least squares technique (2SLS) and monthly data covering the period 1996 to 2007. The authors found that financial innovation dampens the interest rate channel of monetary transmission mechanism and thus poses complex challenges to the conduct of monetary policy which would necessitate constant revision of policy and instruments, to enhance monetary policy effectiveness in the country.

Using annual data between 1979 and 2007 and the Bounds testing approach to co-integration, Bahmani, and Bahmani-Oskooee (2012) suggested that exchange rate volatility could serve as an important determinant of the demand for money. They showed that exchange rate volatility has both short- and long-run effects on the demand for real M_2 monetary aggregates in Iran.

Proxied by the volume of cash cards transactions, that is Automated Teller Machines (ATMs), credit cards and money transfer cards, Mannah-Blankson and Belnye (2004) estimated the impact of financial innovation on the demand for real money balances. The co-integration and error correction model was utilised for data covering 1992M2 to 2000M4. The study revealed that the long-run demand for real money balances in Ghana was driven by income, inflation, exchange rate and financial innovation. It concluded that financial innovation, when tested on a variety of measures of real money balances, such as M_1 and M_2, yielded positive and negative impacts, respectively.

The search for the major determinants of demand for money in Nigeria, popularly referred to as the TATTOO DEBATE, has been a recurring phenomenon since the early 1970s. This was propagated by Tomori (1972) who found interest rate and real income to be major determinants of demand for money in Nigeria. The debate by other researchers such as Ajayi (1974), Ojo (1974) and Teriba (1974) centred on the significance of income in the money demand function in Nigeria, the stability of the function and the choice of appropriate definition of money demand in Nigeria. Teriba (1974) reported that though short-term interest rates have a negative effect on money demand, they remain insignificant in changes in money demand. In the search for other factors that could affect real money balances in Nigeria, Essien et al (1996) as cited in Bitrus (2011), contended that the return on the holdings of foreign assets would be influenced by the expectations of exchange rate movements and so efforts should be made to explain the influence of exchange rate or exchange rate premium on the holdings of domestic currency vis-à-vis holdings of foreign currency or other forms of durable assets.

Anoruo (2002) explored the stability of the M_2 money demand function in Nigeria in the SAP period. The M_2 money demand function in Nigeria was stable for the study period. The study revealed that M_2 was a viable policy tool that could be used to stimulate economic activity in Nigeria with economic activity proxied by real industrial production. Ighodaro and Ihaza (2008) considered the stability of the broad money demand function in Nigeria using data from 1970 to 2004. Applying the Johansen co-integration and VAR methodology, they concluded that broad money demand in Nigeria was stable. The variance decomposition showed that a high proportion of broad money and its determinants (income, inflation rate, and interest rate) are explained by their own innovations. The impulse response function revealed that one standard deviation shock on broad money induces more broad money. The study also revealed that income Granger causes inflation and interest rate.

Odulana and Okunrinboye (2008) analysed the effect of financial innovations that occurred post-1986 on the demand for money in Nigeria using the Engle and Granger two-step co-integration technique. The study revealed that a positive and negative relationship exists between income and real money balances and interest rate and real money balances, respectively. It was also established that financial innovations introduced into the financial system have not significantly affected the demand for money in Nigeria. Matthew et al. (2010) in modeling the impact of financial innovations (that occurred in Nigeria after the Structural Adjustment Programme of 1986) on the demand for money in Nigeria concluded that financial innovation has had no significant impact on the demand for money in Nigeria and the Structural Adjustment Programme (SAP) era financial liberalisation policies have had no indirect impact on the demand for money as well. Bitrus (2011) using annual time series over a 26 year period, investigated the demand for money function in Nigeria in relation to changes in both narrow and broad money, income, interest rate, exchange rate and the stock market. The study established the existence of a stable demand for money function in Nigeria during the sample period. It also concluded that income was the most significant cause of changes in demand for money. According to him, stock market variables could improve the performance of money demand function in Nigeria. In addition, exchange rate depreciation was quite low and insignificant with respect to narrow money (M_1) but significant in the case of broad money (M_2) highlighting that "excessive" speculation in the foreign exchange market was quite low amongst the general populace.

Nduka (2014) examined the long-run demand for real broad money function and its stability in Nigeria between 1970 and 2012. It employed the ADF and PP tests for unit root and the Godfrey-Hanson co-integration test to capture endogenous structural breaks in the co-integrating vectors of Nigerian long-run money demand function, as well as, CUSUM and CUSUMSQ tests for structural stability. The results provide evidence of a regime shift in the demand for real broad money in 2005. It also confirms the existence of long-run relationship between real broad money demand, real income, real domestic interest rate, real exchange rate, the rate of inflation and foreign interest rate. Though the result of CUSUMSQ reveals that the demand for money is stable, it has undergone some temporary periods of instability.

Doguwa et al (2014) examined the issues of structural breaks, co-integration and the stability of the money demand function in Nigeria from 1991Q1 to 2013Q4. The variables of interest were money demand, price level, interest rate, national income, movements in BDC exchange rates and spreads (exchange rate premium). They found the demand for money function for Nigeria pre- and post-global financial crisis period to be stable. The study also revealed that the BDC exchange rate was more robust than other rates in explaining developments in the foreign exchange market. Kumar et al., (2013) carried out an empirical investigation into the demand for real narrow money (M_1) in Nigeria, using annual data, over the period 1960 – 2008 in an attempt to identify whether the CBN was right to adopt the new monetary policy framework. The study utilised real money, real income, nominal rate of interest, real exchange rate and inflation rate. The results suggest that the canonical specification was well determined and concluded that Nigeria could effectively use the supply of money as an instrument of monetary policy.

Tule and Oduh (2017) investigated the implications of financial innovations on Nigeria's monetary policy. The study utilised trend analysis, error correction modeling and a structural model estimated with General Method of Moments over January 2009 to February 2015.

Financial innovation was proxied by the development in e-based platforms over the period. Though financial innovation increases the output gap as it raises the cost of implementing monetary policy, it improves the interest rate channel of monetary policy transmission and the efficiency of the financial system. The papers reviewed incorporated income, inflation, interest rate, exchange rate, exchange rate premium, stock prices and financial innovation as the determinants of the money demand function having ascertained the stability or otherwise of the function. They also revealed diverse findings, which included diverse effects of exchange rate depreciation, currency substitution and wealth effects on the money demand function in various economies, among others.

III. Trends in Money Demand and its Key Determinants

The primary goals of monetary policy include price (inflation, interest and exchange rates) stability, maximum employment, and economic growth and development. Either goal attainment is acceptable as long as it operates to make price stability the primary goal in the long-run. In order to achieve these goals, central banks around the world use various tools, acceptable policy (operating) instruments and intermediate targets. The most popular tools are open market operations, discount policy, and reserve requirements. Others are non-conventional tools such as quantitative easing, credit easing, forward guidance, negative interest rate, signaling, and development finance initiatives. The most common intermediate targets of monetary policy include monetary aggregates (M_1, M_2, M_3, etc.) and short- and long-term interest rates. Others include changes in money supply, inflation rate, and exchange rate.

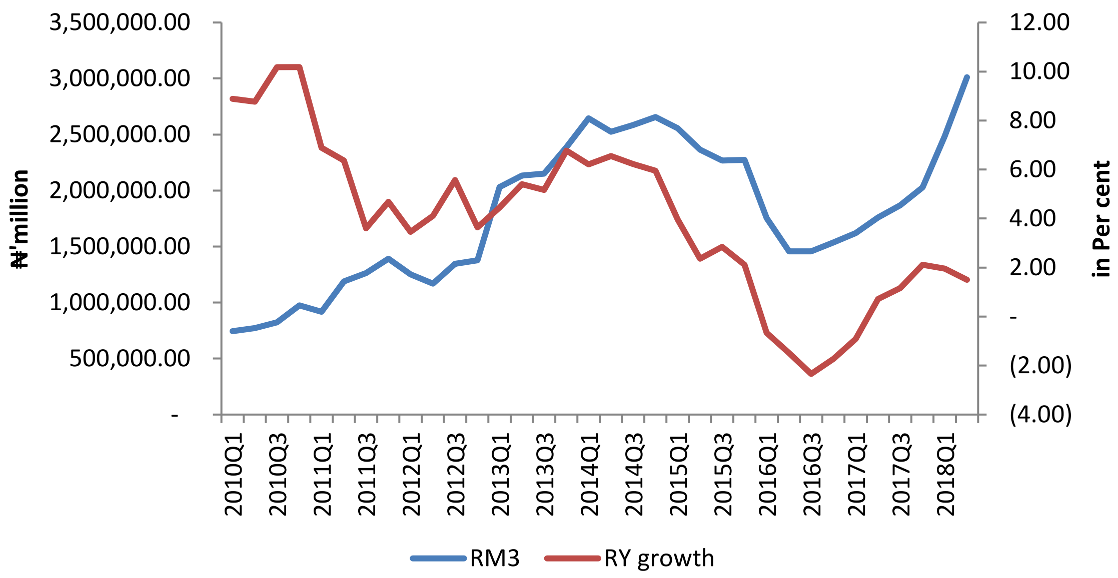
In Nigeria, the conduct of monetary policy is left to the central bank with the objectives of ensuring monetary and price stability, maintaining external reserves to safeguard the international value of the legal tender currency, issuing legal tender currency, promoting a sound financial system and acting as banker thus providing economic and financial advice to the Federal Government. The success of monetary policy relies on the monetary policy framework in use. These could be either monetary targeting or inflation targeting. The implementation of these targets work via operating targets, intermediate targets and finally ultimate objectives. In monetary targeting frameworks, the intermediate target remains broad money, reserve money being the operating target and inflation and output stabilisation are the final targets. For effective monetary policy under a monetary targeting framework, the stability of the money demand function is a necessary condition Goldfeld (1973). Several variables that have been used in the money demand function and their movements over time are discussed below.

III.I Real Money Demand

Real money demand is used to capture the transactions motive. In July 2018, Nigeria migrated to the use of a more broad definition of the demand for money – M_3. The M_3 in Nigeria represents M_2 plus CBN bills held by the non-bank public. Examples of a non-Bank public are pension companies. CBN bills are mainly sold to commercial banks, who buy from CBN and sell to others banks. The higher the level of transaction, the greater the demand for real money balances. The quantity theory of money demand posits a one-for-one relationship between money demand and income. Real money demand is also affected by growth in gross domestic income (GDP) as rising GDP would cause consumers to spend more. Where the central bank targets price stability, an increase in real money balance would cause it to operate monetary policy tightening.

Real money demand in Nigeria increased over time, rising consistently from ₦0.43 billion in 2010Q1 to ₦2.66 billion in 2014Q4. It declined slightly to ₦1.46 billion in 2016Q3, its lowest point but increased in the following quarter to ₦1.54 billion. It improved consistently recording ₦3.01 billion 2018Q2. Despite the relative stability in the demand for real money balances, real growth rate fluctuated remarkably over time with the economy falling into a recession in 2016Q2 and sustaining this until 2017Q1. This trend contradicts economic theory of a positive relationship between GDP and real money demand; in a recession, GDP growth and real money demand are expected to decline but an increase is observed in real money demand at the expense of economic activity between 2017Q3 and 2018Q2 (Figure 1).

Figure 1: Real Money Demand and Real GDP Growth

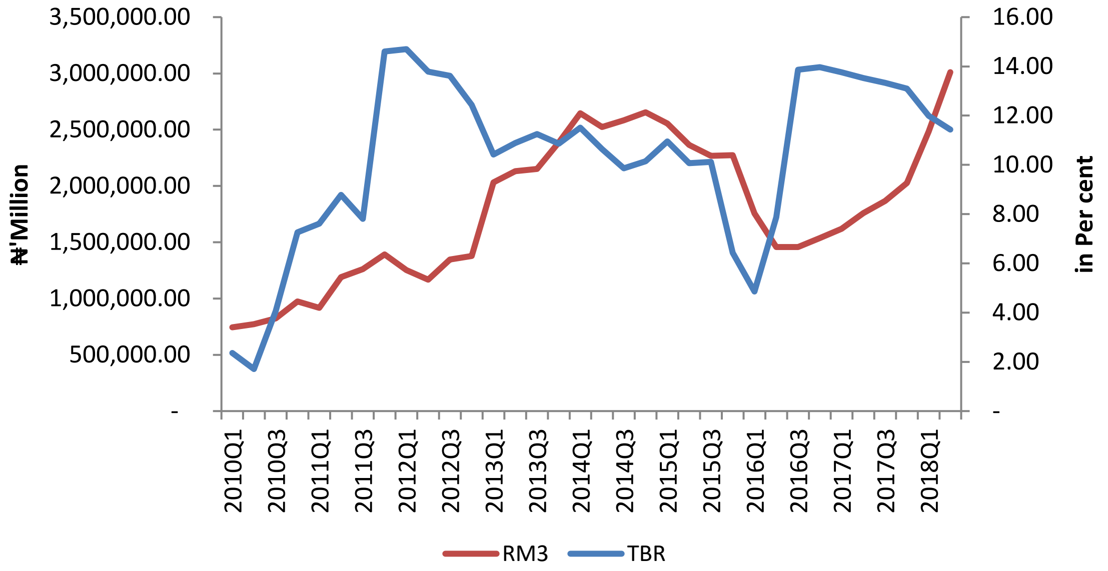


Source: CBN 2018

III.2 Interest Rate

The rate of interest on risk free bonds is seen to be a major proxy for monetary policy as it gives monetary authorities an idea of customer perception and of the performance of the monetary authorities to ensure price stability. The opportunity cost of holding money considers the rate of return on assets alternative to money and expected rate of return. Interest rate is expected to be negatively related to all monetary aggregates (Sichei and Kamau, 2012). Hence, the higher the return on alternative assets, the lower the incentive to hold money, *ceteris paribus*, and the more effective monetary policy would be, as the monetary authorities would have a more effective hold on the macroeconomy. Interest rate, in this paper, was measured by the rate on the 91-day Treasury bills (TBR) issued by the Nigerian government. From Figure 2, the rate on investments increased between 2010Q2 and 2011Q2 but declined gradually until 2014Q3. The rates, however, averaged 9.5 per cent between 2014Q4 and 2015Q4 before declining to a low of 4.9 per cent in 2016Q1. Interest rates on the 91-day Treasury bill, however, stabilised at an average of 11.7 per cent as at 2018Q2. A slight negative relationship can be observed between the 91-day Treasury bill and real money balances as shown below except between 2013Q1 – 2014Q1 and 2015Q1 – 2016Q2. This could be attributed to the activities surrounding the presidential and national elections held in 2015 that saw to the decrease in capital flows and increased currency depreciation.

Figure 2: Interest Rate (91-day Treasury bill rate)

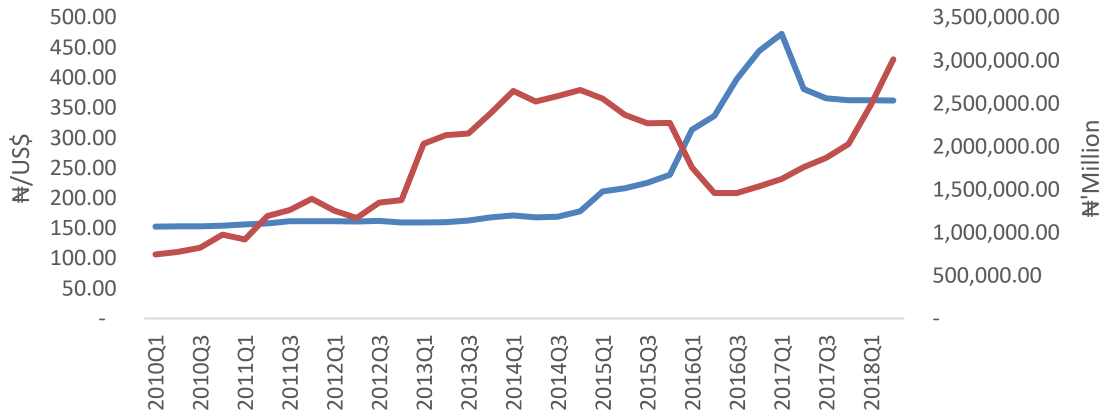


Source: CBN 2018

III.3 Exchange Rates

Generally, there are two (2) competing theories on the impact of exchange rate depreciation on the holdings of the domestic currency. On the one hand, depreciation of the domestic currency increases the wealth of the people and demand for domestic currency increases. On the other hand, people substitute foreign currency for domestic currency to hedge against depreciation and therefore hold less domestic currency (Bartholomew and Kargbo, 2010).

Figure 3: BDC Exchange Rate



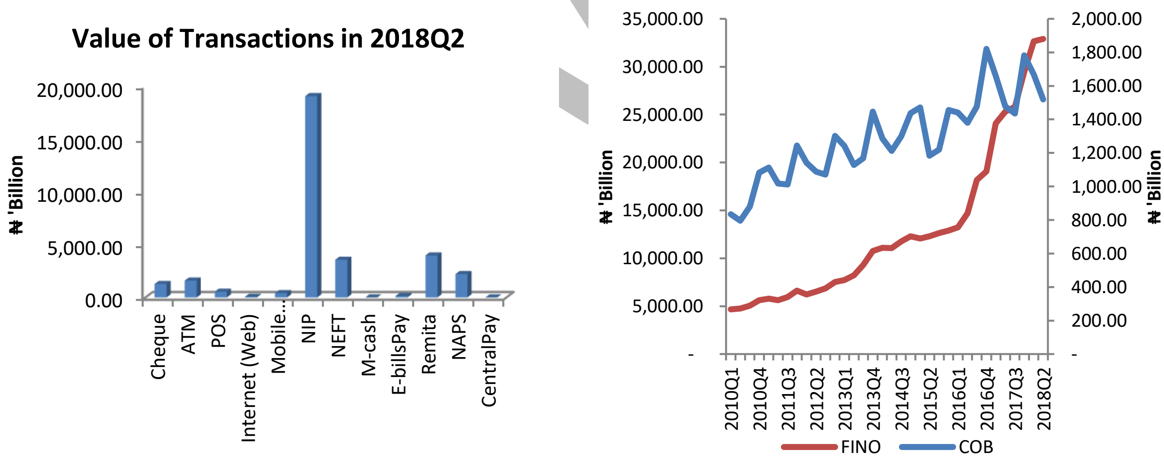
Source: CBN 2018

The inclusion of exchange rate in the determination of the money demand function in Nigeria is supported by the heavy dependence of the Nigerian economy on imports. Virtually all consumables in Nigeria are imported from all over the world, with the US, UK, China, India, EU, and a few West African countries, topping the list as major trading partners. Thus, the effect of changes in the exchange rate of the naira on the Nigerian economy and in relation to monetary policy is of the essence. The average exchange rate of the naira to the US dollar was relatively stable at the BDC segment of the foreign exchange market between 2010Q1 and 2014Q4. However, due to the demand pressure in the Nigerian foreign exchange market, the rates depreciated from ₦177.91/US$ in 2014Q4 to ₦210.70/US$ in 2015Q1 and further to ₦336.49/US$ in 2016Q2. The declining trend was further heightened by the decline in foreign exchange inflow following the decline in the international price of crude oil. This trend continued, recording ₦397.24/US$ in 2016Q3 as the Bank, in June 2016, moved to a more flexible exchange rate system and further to ₦444.22/US$ in 2016Q4. To further stabilise the market, the Bank introduced the Investors and Exporters window in April 2017, which led to the appreciation of the exchange rate by 23.9 per cent, from ₦472.49/US$ in 2017Q1 to ₦381.21/US$ in 2017Q2 and a further appreciation to ₦361.92/US$ in 2018Q2.

III.4 Financial Innovation

Financial innovation refers to the development of financial instruments as well as new financial technologies, institutions and markets. It includes institutional, product and process innovation. With regards to monetary policy, financial innovation refers to all e-based platforms in the Nigerian financial system following the implementation of the cashless policy. This includes the use of automated teller machines (ATMs), point of sale devices (POS), internet banking services, mobile payments, cheques truncation, NIBSS[2] Instant Payment (NIP) and NIBSS Electronic Funds Transfer (NEFT), Mobile cash, Electronic bills, Remita, NIBSS Automated Payment Services (NAPS) and Central Pay. The value of financial innovation increased over time between 2010Q1 to 2018Q2 as shown in Figure 4B. These financial innovations were driven by NIP, Remita, and NEFT.

Figure 4: Growth of the Value of Financial Innovations in the Nigerian Banking Industry



Source: CBN 2018

In theory, increase in financial innovation is expected to cause a decline in cash holding and an increase in the transactionary motive for using money. This is because individuals are then encouraged to make more transfers rather than carry cash. The figure below shows that currency outside banks increased over time despite the rise in financial innovation. This could be attributed to the strong informal sector that has been expanding and the surge in corrupt activities that were predominantly carried out with cash so as not to leave any trail.

[2] NIBSS stands for Nigerian Inter-bank Settlement System

However, the rate of growth in financial innovation was higher than currency outside banks by 5.2 per cent during the period under study.

The level of money demand is expected to increase as nominal output increases and decrease as the nominal interest rate increases. As money demand also envelopes bank deposits, financial innovations would cause demand deposits use to rise causing a positive relation between money demand and financial innovations. This would accordingly enhance the effectiveness of monetary policy.

IV. Econometric Analysis

IV.1 Data and Variables

The study utilised quarterly data from 2010Q1 to 2018Q2. The set of variables include real broad money balances (RM_3), growth rate of real GDP (RYGROWTH), domestic interest rate, which was proxied by 91-day Treasury bill rate (TBR), exchange rate (EXRT) and financial innovation (FINO). FINO was measured as the sum of the values of transactions carried out via ATMs, POS, internet banking services, mobile payments, cheques truncation, NIP, NEFT, mobile cash, electronic bills, remita, NAPS and central pay between the period under review. Real money balance is computed by deflating the broad money by CPI, that is, M_{3t}/P_t. The TBR was used as a proxy for interest rate as it represents the best measure of the opportunity cost of holding money, that is, return on risk free assets. EXRT is the rate of foreign exchange transacted at the BDC segment of the market.

The foreign exchange rate measure was inserted mainly to account for the effect of currency substitution. The choice of the BDC exchange rate over the rate at the interbank segment of the foreign exchange market was as emphasised by an earlier study (Doguwa, 2014), which revealed that the BDC exchange rate was more robust than other rates in explaining developments in the Nigerian foreign exchange market. Here, financial innovation was captured as the sum of the values of all e-based platforms in the Nigerian financial system.

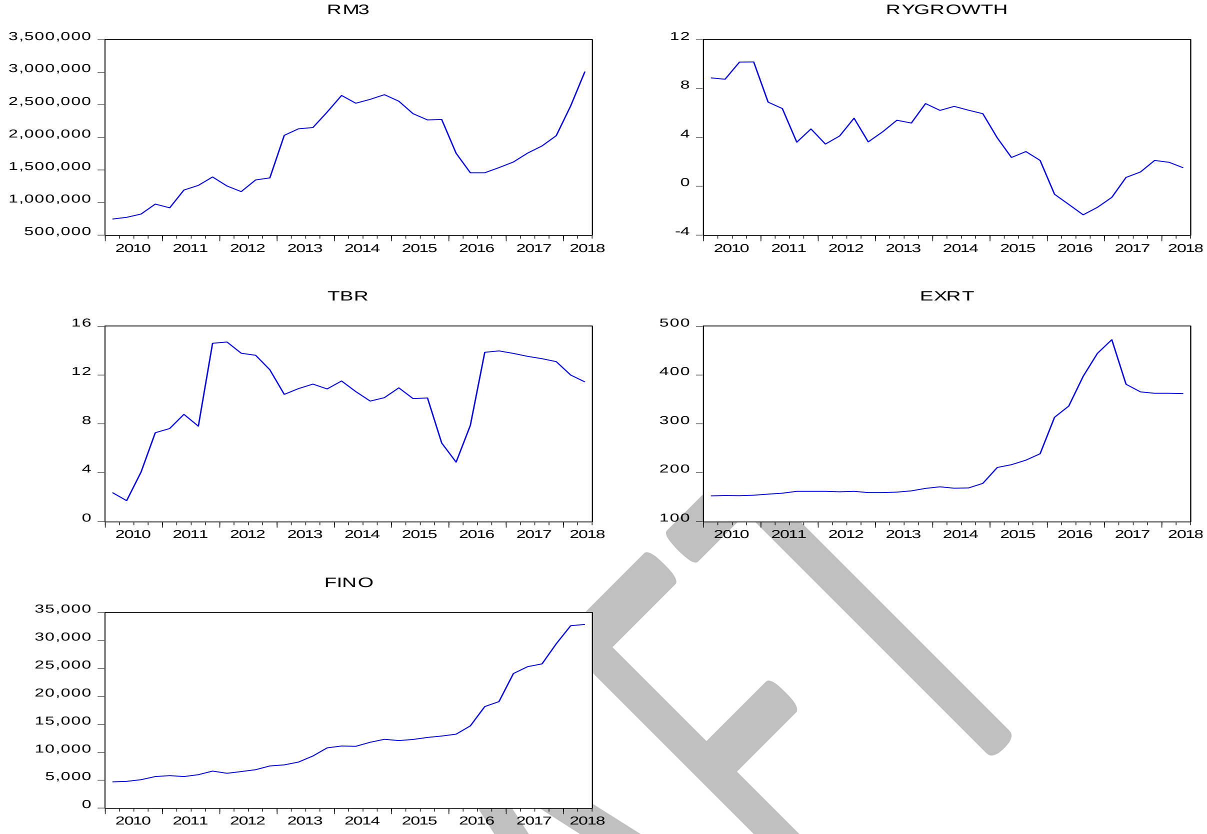
All data employed in the analysis were sourced from the statistical database of the Central Bank of Nigeria. The unavailability of the RGDP quarterly series and M_3 series prior to 2010Q1 as a result of the GDP rebasing that took place that year and the recent move to the new definition of money demand, respectively, limited the scope of the study.

IV.2 Pre-Estimation Analysis

IV.2.1 Graphical Representation

The graphical representation of the data in level form is shown in figure 5. As shown in the graphs, all the variables except TBR tend to exhibit a trend. It shows that real broad money, exchange rate, and variable capturing financial innovations exhibit a pattern of linear distinct upward and deterministic trend, while real GDP growth exhibits a downward trend. Some element of volatility is exhibited in the series. Though EXRT remained relatively stable prior to 2015, it depreciated significantly between 2015 and 2016 and began to appreciate in 2017 before remaining relatively stable between 2017Q3 and 2018Q2. An inspection of the graphs shows that real GDP growth, RM_3, FINO, and EXRT are likely to be non-stationary.

Figure 5: Graphical Presentation of the Variables



Source: Authors' computation using EViews

IV.2.2 Summary Statistics

Summary statistics presented in Table 1 show that the real broad money averaged ₦1.79 million during the review period and spread between ₦0.74 million and ₦3.01 million, suggesting increasing volume of economic activities during the review period except between 2015 and 2016. Real GDP growth and interest rate averaged 3.96% and 10.28%, respectively. Skewness revealed that real GDP growth and interest rate are negatively skewed while; real broad money balances, BDC exchange rate and financial innovation are positively skewed. In terms of kurtosis, the interest rate and financial innovation variables appear to be normally distributed because they are the only variables as close to three (3) as possible. This, however, contradicts the results of the Jarque-Bera statistic, which reveals that all the variables, except the EXRT and FINO, appeared to be normally distributed.

Table 1: Descriptive Statistics/Summary Statistics

Statistics	RM3	RYGROWTH	TBR	EXRT	FINO
Mean	1,787,263.35	3.9599	10.2826	232.8623	12,903.34
Maximum	3,011,106.70	10.1804	14.7000	472.4900	32,902.70
Minimum	744,315.53	-2.3408	1.7067	152.4933	4,665.07
Standard deviation	636,608.5	3.3077	3.4400	101.5030	8,250.12
Kurtosis	1.8423	2.3951	3.1076	2.4598	3.2944
Skewness	0.0287	-0.0663	-0.8875	0.9973	1.1802
Jarque Bera	1.9035	0.5432	4.4802	6.0491[b]	8.0155[a]
Note: a and b denote 1% and 5% levels of statistical significance.					

Source: Authors' computation using EViews

The above details highlighted distinctive characteristics in the data, which led to the subjection of the data to the ADF and PP unit root test.

IV.3 Unit Root Tests

The results of the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) tests are reported in Table 2. The results revealed that the variables in the model are integrated at orders I(0) and I(1). Irrespective of whether the underlying variables are I(0) or I(1) or a combination of both, ARDL technique can be applied [3]. The results therefore suggest the use of the ARDL approach and also emphasise the need for co-integration tests to determine the co-integrating relationship among the series.

Table 2: Unit Root Tests

Variable: log(RM_3)							
	Level			**First Difference**			**Order**
	Constant	**Constant & Trend**	**None**	**Constant**	**Constant & Trend**	**None**	
ADF	-1.6510	1.8286	1.4263	-4.2184[a]	-4.1566[b]	-3.8872[a]	I(1)
PP	-1.5767	-1.7475	1.5248	-4.2619[a]	-4.2059[b]	-3.9115[a]	I(1)
Variable: rygrowth							
	Level			**First Difference**			**Order**
	Constant	**Constant & Trend**	**None**	**Constant**	**Constant & Trend**	**None**	
ADF	-1.5187	-1.7354	-1.7581[c]	-5.2829[a]	-5.2599[a]	-5.2186[a]	I(1)
PP	-1.5778	-1.9741	-1.7350[c]	-5.3043[a]	-5.2757[a]	-5.2481[a]	I(1)
Variable: TBR							
	Level			**First Difference**			**Order**
	Constant	**Constant & Trend**	**None**	**Constant**	**Constant & Trend**	**None**	
ADF	-3.5467[b]	-3.2745[c]	-0.0499				I(0)
PP	-2.6453[c]	-2.2642	-0.0557	-4.6876[a]	-4.8390[a]	-4.6829[a]	I(1)
Variable: log(EXRT)							
	Level			**First Difference**			**Order**
	Constant	**Constant & Trend**	**None**	**Constant**	**Constant & Trend**	**None**	
ADF	-0.0933	-0.7759	1.9455	-3.8659[a]	-4.1879[b]	-3.6134[a]	I(1)
PP	-0.3431	-1.7447	1.5289	-3.8955[a]	-3.8586[b]	-3.5617[a]	I(1)
Variable: log(FINO)							
	Level			**First Difference**			**Order**
	Constant	**Constant & Trend**	**None**	**Constant**	**Constant & Trend**	**None**	
ADF	1.0255	-1.3927	5.4856	-5.1187[a]	-5.2350[a]	-3.1485[a]	I(1)
PP	1.0865	-1.4662	5.4851	-5.1112[a]	-5.2188[a]	-3.1102[a]	I(1)
Note: [a], [b], and [c] denote 1%, 5%, and 10% levels of statistical significance, respectively.							

Source: Authors' computation using EViews

The suitability of the particular approach depends on the underlying test equation and the order of integration of the series under consideration in line with Salisu (2015). Although there are several models to testing co-integration or co-integrating relationships given the existence of variables of different orders of integration up to $d \leq 2$, that is, I(d)=0 and I(d)=1, the ARDL has become popular. The ARDL test is a parameter significance test on the long-run variables in the error correction model (ECM) of the underlying VAR model and works when all or some variables are I(0), I(1) or even mutually co-integrated (Banerjee et al., 1993). Since there exists a one-to-one correspondence between an ECM of a VAR model and an ARDL model, and given that ARDL models are estimated and interpreted using familiar least squares techniques, ARDL models are de facto the standard of estimation when one chooses to remain agnostic about the orders of integration of the underlying variables.

[3] See Nkoro & Uko, page 78.

Peseran and Shin (1998) and Peseran, Shin and Smith (2001) argue that ARDL models are especially advantageous in their ability to handle co-integration with inherent robustness to misspecification of integration orders of relevant variables. Following from these and based on the results of the unit root test, the ARDL method was utilised. The Schwartz Information Criteria (SIC) was considered in determining the best model because of its parsimony. Also included was a fixed regressor (constant) based on the results of the unit root tests. The model revealed a parsimonious ARDL with four (4) independent variables having $ARDL(p, q_1, q_2, q_3, q_4)$ where p, q_1, q_2, q_3, and q_4 represent the lag lengths of the ARDL model. The parsimonious model used in the determination of the co-integration of the variables is thus given as:

$$ARDL(p, q_1, q_2, q_3, q_4,) = ARDL(4,4,4,1,4)$$

IV.4 Model Specification/Estimation Procedure

The result of the unit root test indicated the use of the Auto-regressive Distributed Lag (ARDL). ARDL models are among the most popular classes of models for estimating short- and long-run relationships among integrated economic variables. The ARDL approach is known to have superior small sample properties than that of Johansen and Juselius co-integration technique Pesaran and Shin (1999) and would be best used in this study given the 34 data points employed. The ARDL model is certain to provide unbiased estimates of long-run model and valid t-statistics even when some of the regressors are endogenous[4] (Constant and Yue, 2010). The model representing the relationship between the dependent and independent variables is presented as follows:

$$\mathrm{lnRM}_{3t} = \alpha_0 + \alpha_1 \mathrm{RYGROWTH}_t + \alpha_2 \mathrm{TBR}_t + \alpha_3 \mathrm{lnEXRT}_t + \alpha_4 \mathrm{lnFINO}_t + \varepsilon_t \quad (1)$$

All the variables are expressed in their log forms except RYGROWTH and TBR which are rates and so need not be log transformed for ease of interpretation. Equation 1, as emphasised by theory and previous studies, reveal that, real broad money balances are assumed to be positively related to growth in real income (α_1> 0), consistent with the transactions motive for holding money (Bathalomew and Kargbo, 2010). Also, money held in hand other than invested in an interest yielding/earning asset, comes with an opportunity cost, which is expected to have a negative influence on demand for money ($\alpha_2 < 0$). A depreciation of domestic currency which suggests an increase in wealth[5], would have a positive relationship with domestic money balances that is, (α_3> 0), representing wealth effects otherwise, currency substitution. A depreciation of the domestic currency may induce expectations of further depreciations leading to a portfolio shift from the domestic currency to foreign currency. It is expected that as FINO increases, people would move to less liquid assets such as M_2, M_3, etc. Thus, we expect a positive relationship between FINO and RM_3, that is (α_4> 0). Relating the dependent variable to its lagged values and the lag values of all the independent variables in the model, the ARDL representation of equation 1 in a conditional or unrestricted error correction model (ECM) is thus:

$$\Delta \mathrm{lnRM}_{3t} = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta lnRM_{3t-i} + \sum_{i=1}^{n} \alpha_2 \Delta \mathrm{RYGROWTH}_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta \mathrm{TBR}_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta \mathrm{ln} EXRT_{t-i} + \sum_{i=1}^{n} \alpha_5 \Delta \mathrm{ln} FINO_{3t-i} + \sum_{i=1}^{n} \phi_i \Delta \daleth_{it-i} + \varepsilon_t \quad (2)$$

[4] Regressors are said to be endogenous when the causation is wrong, that is, the model that has been tested and estimated does not properly capture the way the causation works in the real world.

[5] As at December 2017, the percentage of domiciliary account balances to M_3 stood at 15.2%, which is a reflection of trust citizens have in the foreign currency, currency substitution and increase in wealth. Also, the informal sector is said to have a huge tradable foreign exchange as observed by the volume of transactions carried out by Bureaux de Change Organisations.

However, from equation 2 above an ARDL model can be derived by incorporating the lag elements for all the variables as presented below:

$$\Delta \ln RM_{3t} = \beta_0 + \sum_{i=1}^{n} \beta_1 \Delta lnRM_{3t-i} + \sum_{i=1}^{n} \beta_2 \Delta RYGROWTH_{t-i} + \sum_{i=1}^{n} \beta_3 \Delta TBR_t + \sum_{i=1}^{n} \beta_4 \Delta \ln EXRT_t + \sum_{i=1}^{n} \beta_5 \Delta \ln FINO_t + \sum_{i=1}^{n} \psi_i \Delta \Gamma_{it-i} + ect(-1) + \varepsilon_t \quad (3)$$

The coefficients β_1 to β_5 lare the long-run elasticities and the ψ_i stand for short-run elasticities. Γ is a vector of the lag difference of all the variables in the model. The error term, ε_t, is expected to be serially independent. β_0 represents the constant variable, while Δ is the change operator. In line with Pesaran and Pesaran (1997), the model is subjected to a test for the existence of co-integration among the variables. This is achieved by using an F-test to test the null hypothesis of no co-integration against the alternative.

IV.5 Bounds Testing

Table 3 reports the results of the F-test for the existence of co-integration among the variables. The F-score of 21.05, which is above the upper bound of 4.01 at the 5 per cent level of statistical significance, rejects the null hypothesis of no level effect or equilibrating relationship. This thus reveals the presence of a long-run relationship among the variables in the model.

Table 3: ARDL Bounds Test Results

Test Statistic	Value	K
F-statistic	21.0487	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.50%	3.25	4.49
1%	3.74	5.06

Source: Author's computation using e-views

The short-run ARDL model was computed with the first differenced series using the following equation:

$$\Delta RM_{3t} = \theta \widehat{\varepsilon_{t-1}} + \sum_{i=1}^{N} \delta_i \Delta RM_{3t-i} + \sum_{j=0}^{N} \gamma_1 \Delta X_{t-j} + \varepsilon_t \quad (4)$$

where $\theta \widehat{\varepsilon_{t-1}}$is the adjustment factor and $X_{t-j}$is the vector of all independent variables in the model, that is, RYGROWTH, TBR, EXRT, and FINO.

IV.6 Interpretation of Results

From the estimation results presented on Table 4 in Appendix 1, the overall performance of the model is satisfactory as indicated by the coefficients of determination, R^2. The results reveal that EXRT, FINO and all its lags, RYGROWTH and the second lag of RM_3 have positive short-run impacts on real money demand while interest rate and all its lags, all lags of RYGROWTH, and the first and third lags of RM_3 exibit negative relationships with real money demand. Interestingly, interest rate entered as a short-run determinant of the RM_3 demand against the conclusion in Teriba (1974). This could be as a result of the effect of FINO introduced in this study as an increase in the use of ATM, POS and internet banking platforms, among others could cause economic agents to carry less cash but spend more and thus earn less on investments. Furthermore, this may reflect that RM_3 is being held for other purposes than for transactions as highlighted by Ibrahim (2001). The decisions of the Monetary Policy Committee (MPC) are crucial as changes in interest rate (down to its third lag) affect real money balances significantly. A one per cent increase in interest rate would reduce real money balances by 0.03 per cent in the quarter when the change occurs and this effect increases to 0.1 per cent in the first quarter, but reduces to 0.04 and 0.02 per cent in the following two quarters, respectively. An increase in exchange rate (that is, currency depreciation), leads to a rise in real broad money balances, connoting an increase in wealth effects among Nigerians as against currency substitution.

Though the results of the long-run estimates reveal evidence of a long-run relationship (Table 3), it shows that the relationship is significant only with respect to the FINO variable (Table 4). It also notes that financial innovations account for about 1.0 per cent of any increases in real money balances in Nigeria and it can thus be concluded that the more there is improved level of technology in the financial industry, the higher people would demand for money. Also, following the series of liberalisation in the financial industry, the improved cashless policy has generated an upward movement in the holdings of real money balances in Nigeria.

The error correction term of the model exhibited an appropriate statistic that is negative and significant relationship. The coefficient of the adjustment factor suggests that about 0.7 per cent of any disequilibrium between real broad money demand, growth in real GDP, interest rate, exchange rate and financial innovation would be corrected in about two quarters. The sample money demand function passed all post-estiamtion tests – specification, heteroskedasticity, serial correlation and structural stability, as indicated below. These results accord well with several existing studies such as Ighodaro and Ihaza (2008) and Bathalomew and Kargbo (2010).

IV.7 Post-Estimation Diagnostics

The adjusted R-squared (99.6%) of the post-estimation diagnostics revealed that all the variables are a good fit for the model and are thus said to influence the behaviour of money demand in Nigeria. The joint significance of the explanatory variables are, once again, statistically significant at the 1.0 per cent level as measured by the F-statistic. The results of the Ljung box and the ARCH-LM tests show evidence of no serial correlation and constant variance, respectively, which further support the correctness of the model while the result of the Jarque-Bera indicates that the data series used in the analysis are from a normal distribution.

V. Policy Implication, Conclusion and Recommendation

The paper examined the behaviour of money demand in the conduct of monetary policy using quarterly data from 2010Q1 to 2018Q2. The ARDL methodology was adopted owing to the result of the unit root test that indicated the existence of different orders of co-integration among the variables [I(0) and I(1)]. The results suggest that there exists a co-integrating relationship among all the variables in the long-run.

The growth rate of real GDP, exchange rate and financial innovation have positive short-run impacts on real money demand, while interest rate influenced it negatively. Furthermore, the estimates revealed evidence of long-run relationship, which was significant. The increase in the use of e-channels causes real money demand to rise. Furthermore, currency depreciation causes real money demand to rise. This implies that the more the Nigerian naira depreciates, the more Nigerians would increase their demand for real money balances to sustain the existing cash holdings for the attained level of economic activities. The model passed all the diagnostic tests – specification, serial correlation, heteroskedasticity and structural stability. Exchange rate depreciation also exhibited a wealth effect in the short-run given by the negative relationship between exchange rate and real money balances.

The implication of this for policy makers is that an increase in domestic interest rates, would cause Nigerians to hold more money for transactionary reasons rather than substitute the naira for other currencies. This would increase the potential of attracting currency outside banks into the coffers of the financial institutions. As a result, a sizeable volume of funds will remain within the influence of monetary authorities and could improve effective implementation of monetary policy. Furthermore, the positive relationship between financial innovation and money balances in the long-run implied a positive attitude of the public to the acceptance of financial innovation. Also, Commercial banks should be encouraged to maintain functional e-channel platforms that perform at the highest level of efficiency as Nigerians patronise such means as money demand rises.

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Appendix 1

Table 4: Long-Run and Short-Run Estimates of Money Demand

Long-Run Estimates

	RYGROWTH	**TBR**	log**EXRT**	log**FINO**
$\log RM_3 =$	0.1129	0.0671	-0.7018	0.9644^{b}
SER =	(0.0927)	(0.0445)	(1.0004)	(0.3857)
T − stat =	[-1.2172]	[1.5078]	[-0.7015]	[2.5002]

Short-Run Estimates

	Δlog**R**	Δlog**R**	Δlog**R**	**ΔRYGRO**	**ΔRYGROW**	**ΔRYGROW**	**ΔRYGR**	**ΔTBR**	**ΔTB**	**ΔTB**	**ΔTB**	Δlog	Δlog	Δlog (-1)	Δlog (-2)	Δlog (-3)	**C**	**E**(−
Δlog =	-0.1740^{b}	0.1437^{c}	-0.2028^{b}	0.0413^{a}	-0.0997^{a}	-0.1113^{a}	-0.03397^{a}	-0.0296^{a}	-0.0523^{a}	-0.04004^{a}	-0.0177^{a}	0.3225^{b}	0.9747^{a}	1.4964^{a}	1.0932^{a}	0.4230^{b}	5.1633^{a}	-0.6698^{a}
SER =	(0.0739)	(0.0697)	(0.0693)	(0.0064)	(0.0090)	(0.0114)	(0.0098)	(0.0044)	(0.0065)	(0.0058)	(0.0047)	(0.1338)	(0.1357)	(0.1580)	(0.1792)	(0.1523)	(0.4064)	(0.0533)
T − st =	[-2.3536]	[2.0617]	[-2.9241]	[6.4241]	[-11.1258]	[-9.7731]	[-3.4735]	[-6.7964]	[-8.1037]	[-6.8843]	[-3.7363]	[2.4103]	[7.1808]	[9.4726]	[6.1006]	[2.7780]	[12.7043]	[-12.5644]

$R^2 = 0.9957$; F − stat = 88.5517^{a}; Durbin Watson = 3.01

Linearity [Ramsey Reset test (F − stat)] = 0.7887

Serial Correlation [Ljung Box (Q − stat)] = 4.0031

Heteroskedasticity [ARCH − LM (F − stat)] = 1.6676

Normality [Jarque − Bera] = 0.8445

Note: ^{a}, ^{b}, and ^{c} represents 1% and 5% levels of statistical significance, respectively and SER represents Standard Error.

Source: Author's computation using e-views

Empirical Investigation on Exchange Rate Volatility and Trade Flows in Nigeria

Yakub, M. U., Sani, Z., Obiezue, T. O. and Aliyu, V. O. *

Abstract

This paper investigated the impact of exchange rate volatility on trade flows in Nigeria using monthly data for the period 1997 – 2016. A GARCH model was used to generate the nominal exchange rate volatility series. To detect the long-run relationship among variables, the ARDL bounds testing approach was employed. Also, the Granger causality test was applied to ascertain the direction of causality among the variables. The study found that exchange rate volatility affected Nigeria's trade flows negatively, in the short-run but does not in the long-run. As such the Central Bank of Nigeria would find some trade benefits from intervening immediately to stabilise the foreign exchange market in the face of volatility. Also, the study showed that ignoring exchange rate volatility could negatively impact on Nigeria's trade flows especially in the short-run.

Keywords: Volatility, Exchange Rate, Trade Flows

JEL Classification: *F31, F10, C5*

I. Introduction

Since the fall of the Bretton Woods agreements in 1973, the effect of exchange rate instability or volatility on trade flows has been a major debate among academics and policymakers alike. According to Asteriou et al. (2016), in countries where exchange rate volatility had adverse effects on trade flows, more stable exchange rate through central bank intervention in the foreign exchange market will help to boost their trade. Investigating the significance of this relationship for Nigeria is very timely and relevant for improved economic performance given that crude oil export, which is very volatile, is the primary source of Nigeria's foreign exchange. In Nigeria, since the adoption of the Structural Adjustment Programme (SAP) in 1986, several institutional framework and management strategies have been practiced in a bid to achieve exchange rate stability and policy; from the Second tier Foreign Exchange Market (SFEM) to the fully liberalised Foreign Exchange Market (FEM). Following continued volatility and instability over exchange rates, more policies were introduced. These include the Autonomous Foreign Exchange Market (AFEM), Inter-bank Foreign Exchange Market (IFEM), Dutch Auction System (DAS), the Wholesale Dutch Auction System (WDAS) and the Retail Dutch Auction System (RDAS).

Given that the determinants of exchange rate volatility change from time to time depending on the structural dynamics associated with the market, the frequency of volatility is difficult to measure (David et.al, 2016). There is a growing agreement in the literature that a prolonged and substantial exchange rate misalignment can create macroeconomic imbalances, and the correction of external balance will require both exchange rate devaluation and demand management policies. Numerous studies were conducted on Nigeria and particularly on the extent of naira exchange rate and its misalignment. These include Ali et al. (2015) which investigated the impact of Naira Real Exchange Rate Misalignment on Nigeria's economic growth using quarterly data spanning 2000 to 2014. Similarly, Ibrahim (2005) examined the impact of real effective exchange rate misalignment on economic growth in Nigeria using annual data spanning

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* *The authors are staff of the Research Department, Central Bank of Nigeria. The usual disclaimer applies.*

1960 to 2011. The paper used the augmented growth model estimates using purchasing power parity (PPP) and generalised method of moment (GMM) approaches. However in these studies, the impact of exchange rate volatility on trade flows was missing, and thus us considered critical.

The main contribution of this paper therefore, is to use the GARCH modeling technique combined with the ARDL bounds testing approach to examine the impact of both nominal and real exchange rate volatilities on monthly export and import volumes of Nigeria for the period, 1997 – 2016. The study would provide empirical evidence to drive policy formulation in the management of exchange rate as it impacts on trade and provides information that could guide more studies on the subject. The rest of the paper is organised as follows. Section II presents stylised facts on exchange rate and trade flows, while section III provides the review of related literature. Section IV discusses the data and methodology employed in the study. Finally, Section V contains conclusions and policy recommendations.

II. Exchange Rate and Trade Flows in Nigeria

This section dwells on the stylised facts on exchange rate developments and trade flows in Nigeria. In addition, the factors that influence trade flows are also discussed below.

II.1 Factors that Influence Trade Flows in Nigeria

II.1.1 Global Economic Developments

Developments in the global economy impact directly on Nigeria's trade flows due largely to the fact that the Nigerian economy is integrated into the global economy following the reduction of trade barriers by most nations. Trade, being an important engine of integration transmits economic disturbances between nations[1]. The lingering effect of the Global Financial Crisis and the slow recovery of most industrialised and emerging economies has weakened global trade and affected global demand particularly for commodity exports. In addition, the overbearing influence of the oil sector on the Nigerian economy underscores the importance of external developments to trade flows. Crude oil export has remained dominant and the highest foreign exchange earner for the country since the 1970s. Therefore, developments in the international crude oil market, particularly oil price, significantly affect the performance of Nigeria's trade.

Over the years, crude oil price, like other commodity prices experience swings in times of shortage or oversupply. In recent times, the global oil market has witnessed high levels of price volatility. Since the last quarter of 2014, crude oil prices witnessed a slump as a result of supply glut. The entrance of the US shale oil into the international oil market, weak global demand, huge oil inventory in Europe and the appreciation of the US dollar were some of the factors that also contributed to the slump in crude oil prices. The average price of Nigeria's reference crude, Bonny Light, decreased from US$102.63 per barrel in August 2014 to US$63.19 per barrel in December 2014. It maintained a downward trend all through 2015 and 2016 reaching an all-time low of US$31.21 per barrel in January 2016.

[1] Mussa, 2000: Factors Driving Global Economic Integration

Consequently, oil export which was ₦12, 989.82 billion in 2014 declined to ₦9,016.32 billion and ₦8,769.32 billion in 2015 and 2016, respectively.

II.1.2 Trade Policies

The overall objectives of Nigeria's trade policy is the encouragement of production and distribution of goods and services to satisfy both domestic and international markets for the purpose of achieving accelerated economic growth and development (Jamali and Anka 2011).

Nigeria's trade policies are largely governed by the regional considerations and her membership of international organisations such as the World Trade Organisation (WTO), Economic Community of West African States (ECOWAS) and African Union (AU). Nigeria's foreign trade policy is centered on two broad strategies namely, import substitution strategy (ISI) and export-led growth strategy. The ISI strategy was adopted in the 1960s and involved the use of tariff and non-tariff barriers to protect domestic manufacturing industries. Tariff barriers include the use of high import duties, while non-tariff barriers are quantitative restrictions such as quotas and subsidies. The recent restrictions on access to foreign exchange from the official window for 41 categories of import and other demand management policies are some of the recent ISI strategies embarked upon by the government with the aim of conserving foreign exchange and resuscitating domestic industries.

The export-led growth strategy involves the use of industrialisation strategy to promote the export of domestically produced goods of which the country has a comparative advantage. The objective was to boost foreign exchange earnings and diversify the foreign exchange base of the economy. Several measures were implemented to ensure the success of the strategy in the promotion of non-oil export. These include the establishment of export processing zones; implementation of lower tariff structure designed to stimulate competition and efficiency; custom and port reforms; and adoption of the ECOWAS five-band common external tariff. These policy measures basically determine the level of trade in a country. Favourable trade policies also determine the importance of trade and also give a direction to the extent of a country's level of integration of the economy to the world.

II.1.3 Competitiveness

Competitiveness plays an important role in the performance of trade as it is regarded as the measure of a country's ability to efficiently provide different products and services to other countries[2]. Competitiveness provides opportunity for countries to maximise their potential, opens up economic opportunities, and improves efficiency. Competitiveness affects a country's trade in terms of prices (exchange rate and inflation) and productivity. The composition of Nigeria's export and the level of diversification also affect competiveness. Nigeria is a mono-cultural economy dominated by crude oil export with dismal progress in diversifying the export base, despite government's effort.

Nigeria's external competitiveness is measured in terms of trade openness, and the movement in real effective exchange rate (REER). In terms of trade openness as measured

[2] Dubravska and Sira (2015): The Analysis of the Factors Influencing the International Trade of the Slovak Republic

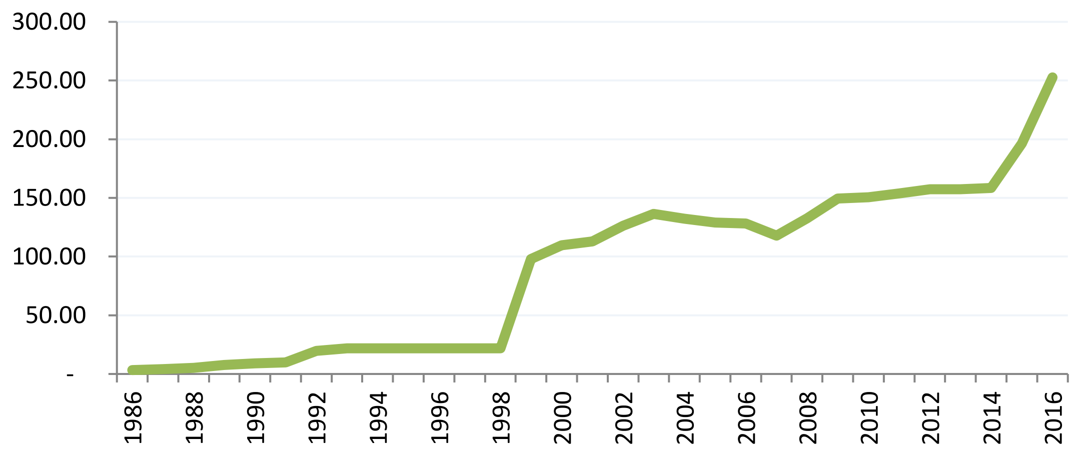
by the ratio of total trade to Nigeria's gross domestic product (GDP), Nigeria is considered to be moderately integrated with a ratio of 45.7, 55.0, 69.0, and 33.6 per cent in 2000, 2006, 2008 and 2012, respectively. It, however, dropped gradually to 23.9 per cent in 2016 due to significant drop in trade. A measure of Nigeria's external competitiveness in terms of REER index calculated using 13 countries as major trading partners showed an annual average REER index at 97.4 in 2009, which improved to 89.8 and 69.5 in 2011 and 2014, respectively. However, with the adverse impact of commodity price shock which led to significant depreciation of the naira exchange rate and higher domestic inflation, the REER index deteriorated to 70.8 and 78.7 in 2015 and 2016, respectively.

II.2 Exchange Rate Movements and Trade Flows In Nigeria

II.2.1 Exchange Rate Movements

The naira was introduced in 1973 to replace the Nigerian pound and the exchange rate was fixed at ₦0.65 to US$1. The Naira exchange rate was fixed for most part of the 1970s up to 1985. However, with the introduction of the structural adjustment program (SAP) in 1986, the foreign exchange market was liberalised and the naira exchanged for an average of ₦2.02 per US$1. It averaged ₦11.08 to a US dollar between 1987 and 1993 but depreciated to ₦22.00 in 1994 and was later fixed at ₦21.89 to a US$ by the federal government from 1994 to 1998 indicating a shift to fixed exchange rate regime during the period. The naira depreciated to ₦97.95 to US$1 following the liberalisation of the market in 1999. It averaged ₦125.00 to a US dollar between 2000 and 2006 and appreciated to ₦117.97 per US$1 in 2007. The stability in the exchange rate was as a result of the favourable terms of trade which led to the accumulation of external reserves. The adverse effect of the global financial crisis coupled with the decline in oil price led to excessive demand pressure at the foreign exchange market, which led to the depreciation of the naira to ₦149.58 to a US dollar in 2009 and further to ₦157.50 in 2012. The naira remained stable up to the third quarter of 2014.

Figure 1: Average Naira/US Dollar Exchange Rate



Source: CBN Annual Report (Various Issues)

The naira depreciated in the last quarter of 2014, due to heightened demand pressure. This led to the introduction of new reform policies at the foreign exchange market in November 2014. The reforms included the realignment of the exchange rate band by 200 basis points from ±3 per cent to ± 5 per cent and widening of the midpoint exchange rate from ₦155/US$1 to ₦168/US$1, as well as the exclusion of some invisible transactions from the official rDAS window. Consequently, the naira averaged ₦158.55 to a US dollar in 2014. The unabated demand pressure at the foreign exchange market, coupled with the continued decline in the nation's external reserves led to the closure of the official rDAS window in February, 2015 to curtail demand pressure and narrow the premium. In addition, the interbank rate was adopted for all eligible foreign exchange transactions. These measures and others abated the demand pressure and stabilised the exchange rate at an average of ₦196.49/US$ in 2015.

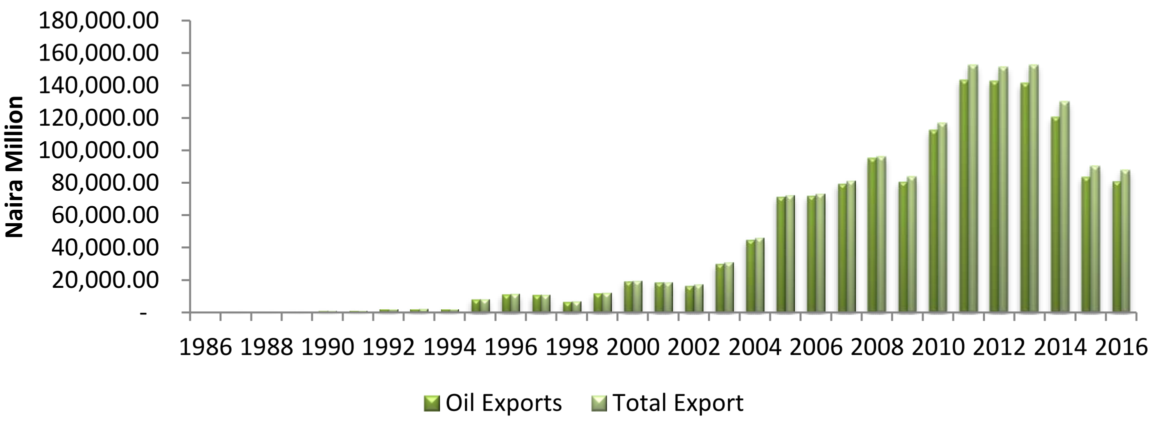
The Bank adopted a more flexible exchange rate regime in June 2016 which allows for greater flexibility in the determination of exchange rate. A 2-way quote system, futures market and foreign exchange primary dealers were also introduced. However, with the further decline in crude oil prices, resulting in increased demand pressure, the naira further depreciated to an average ₦253.19/US$ in 2016. In response, the investors' and exporters' window was introduced in April, 2017, which helped to stabilise the situation (Figure 1).

II.2.2 Trade Flows

II.2.2.1 Export

The export sector had been characterised by the dominance of one export commodity. Primary agricultural commodities were exported in the 1960s up to mid-1970s when Nigeria experienced a positive crude oil price shock. Since then, Nigeria has remained a major crude oil exporter. Over the years, the proportion of crude oil export in total export had increased remarkably, making it the dominant export commodity. Its share in total export has remained above 80.0 per cent up to 2005. For instance, the share of crude oil export in total export was an average of 97.5 per cent during the period 1999-2004. However, from 2005 when the country commenced the export of gas, the share of crude oil export reduced to an average of 88.0 per cent between 2005 and 2010 and further to 81.1 per cent of total export during the 2011-2015 period. Crude oil export accounted for 78.8 per cent of export in 2016. In terms of non-oil export, traditional agricultural commodity export remained dominant over the years followed by manufactured and semi-manufactured goods.

Figure 2: Oil and Total Exports

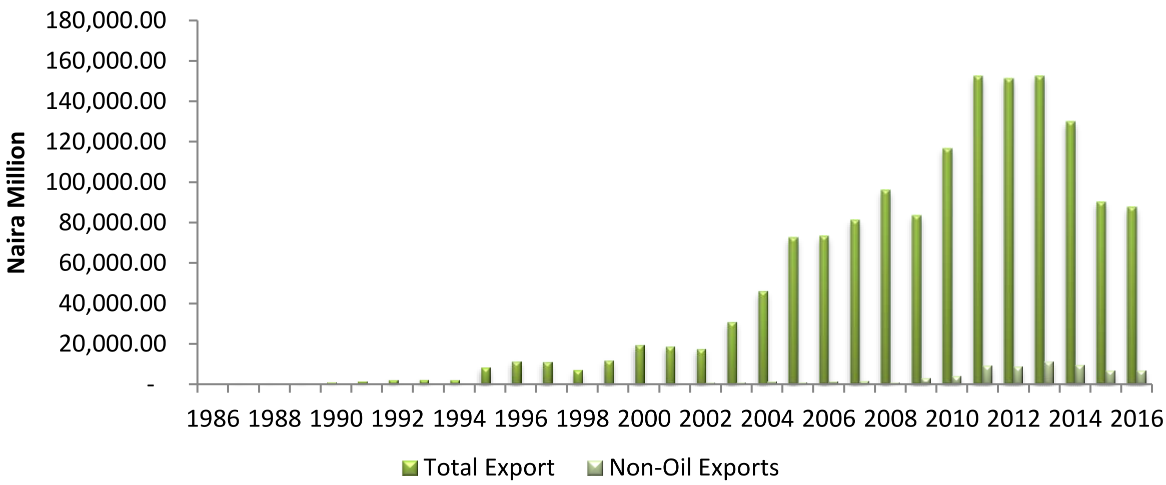


Source: CBN Annual Report (Various Issues)

In value terms, crude oil and gas export which averaged ₦45.33 billion between 1986 and 1990 rose to ₦307.66 billion during 1991 to 1995 as a result of favourable crude oil prices at the international market. It further increased to ₦1, 183.87 billion, ₦3,622.51 billion and ₦8,794.38 billion between 1996 and 2000, 2001-2005, and 2006-2010, respectively, reflecting favourable developments in the international oil market. Crude oil and gas export maintained an upward trend reaching a peak of ₦13,688.11 billion during 2011 to 2014 but however declined to ₦8,339.55 billion and further to ₦8,093.41 billion in 2015 and 2016, respectively due largely to the slump in crude oil prices at the international market and decline in domestic production during the period. In spite of the adverse development, crude oil and gas remained dominant accounting for more than 90.0 per cent of total export (Figure 2).

The contribution of non-oil export to total export remained dismal throughout the review period in spite of the government's effort to diversify the export base of the country. The value of non-oil export (mainly agricultural products) averaged ₦0.02 billion between 1986 and 1990 but rose to ₦0.07 billion and ₦0.08 billion during 1991-1995 and 2001-2005, respectively. It further rose to ₦0.22 billion and peaked at ₦0.97 billion from 2006-2010 and 2011-2014, respectively as a result of intensified government's effort to enhance value addition for export. However, the value of non-oil export declined to ₦0.68 billion in 2016 due largely to increased local demand, restrictions placed on some Nigerian agricultural goods from entering European markets due to non-compliance with international standards and high cost of production (Figure 3).

Figure 3: Non-Oil and Total Export



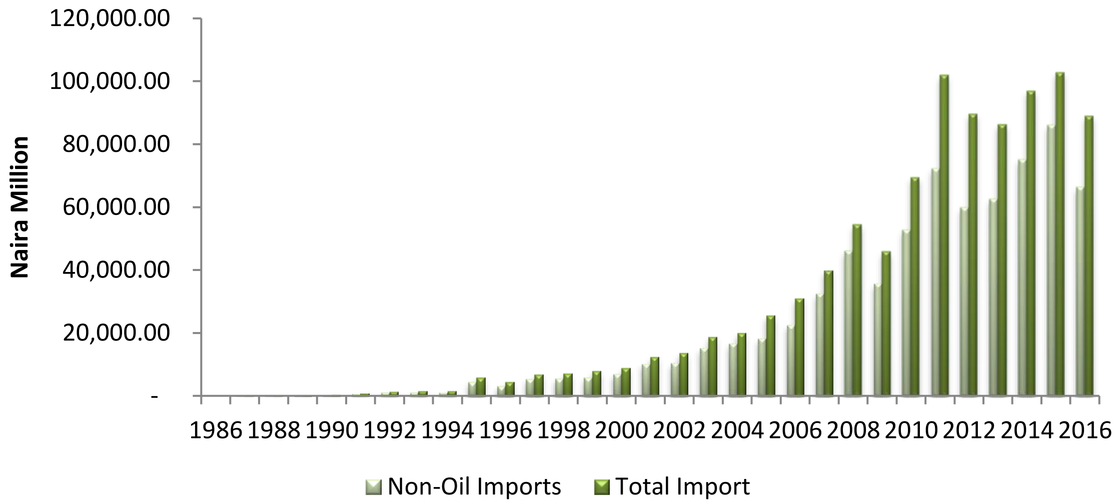
Source: CBN Annual Report (Various Issues)

II.2.2.2 Import

The structure of Nigeria's import has remained the same over the years with non-oil imports dominating total import. Within the non-oil import category, the share of capital goods and raw materials remained dominant due to government's effort to shore up the level of capacity utilisation and the ongoing rehabilitation of infrastructure in the country. The drop in Nigeria's refining capacity increased the share of oil import in recent years. For instance, the share of non-oil import averaged 23.8 per cent between 2012 and 2015 as against an average of 19.4 per cent between 2007 and 2011. It however stood at 25.4 per cent of total import in 2016.

As mentioned earlier, Nigeria's import is dominated by non-oil component consisting largely capital goods and raw materials. The value of non-oil import averaged ₦0.02 billion between 1986 and 1990. It grew gradually to ₦0.53 billion, ₦1,411.71 billion ₦3,792.14 billion during 1996-2000, 2001-2005 and 2006-2010, respectively as a result of increased demand to complement the Industrialisation drive of the government. Non-oil import maintained its upward trend averaging ₦6,751.28 billion and peaked at N8,613.94 billion from 2011-2014 and 2015, respectively. It however dropped to ₦6,643.09 billion in 2016 as a result of the demand management policies adopted by the CBN, high inflationary pressure and the depreciation of naira which made import more expensive (Figure 4).

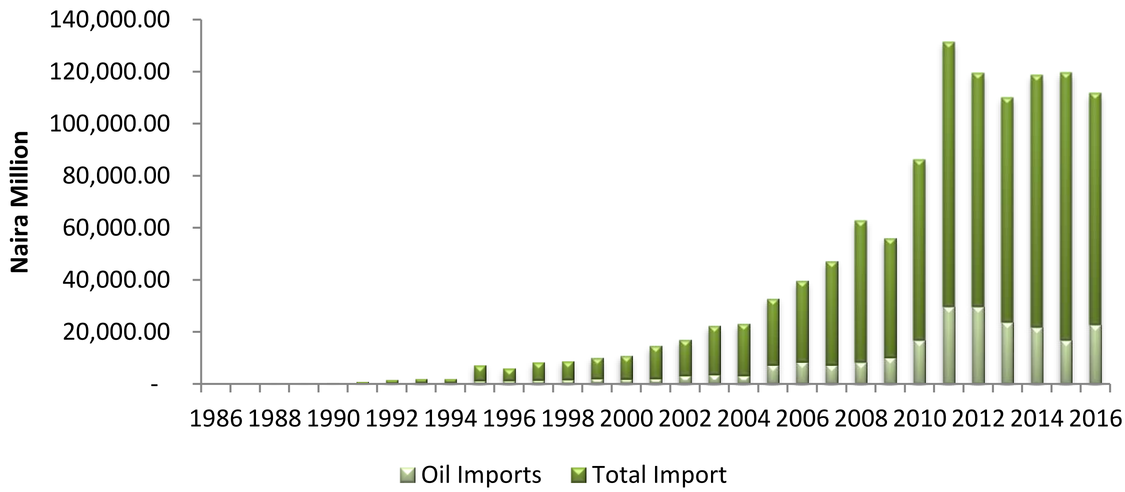
Figure 4: Non-Oil and Total Import



Source: CBN Annual Report (Various Issues)

In terms of oil import, the trend was also similar with lower value of less than ₦1.00 billion all through 1986 to 2008. However, due to the low domestic refining capacity, oil import gradually rose to an average of ₦1,878.74 billion and ₦2,295.81 billion during 2009-2011 and 2012-2015, respectively. It stood at ₦2,265.68 billion in 2016 (Figure 5).

Figure 5: Oil and Total Import



Source: CBN Annual Report (Various Issues)

III. Literature Review

III.1 Theoretical Literature Review

Most of the early works on the impact of exchange rate volatility on trade flows are based on partial equilibrium analysis and the behaviour of firms in the face of risk or uncertainty. The traditional school of thought holds that volatility increases risk of trade thereby depressing trade flows. The basis for their argument is on the fact that there exists a negative relationship between Exchange rate and trade flows. Clark (1973), Hooper and Kohlhagen (1978) explained this using a simple illustration of a firm under the following assumptions:

- Existence of a competitive firm with no market power producing only one good,
- Exports to one foreign market,
- There are no imported factors of production,
- Payments are made in foreign currency at the going rate; and
- No hedging possibilities

The illustration held that the supposed firm is solely an export-oriented firm which receives its payment in foreign currency and changes the proceeds of its transaction at the going (current) exchange rate, which is considered to be in fluctuation without predictability due to the assumption of the absence of hedging as maintained in this theoretical model. Under this circumstance of increased risk, as a result of volatile exchange rates and given that firms are profit oriented economic agents, a firm will be forced to rollback its exports rather than incur more adjustment costs to its established scale of production, in order to align with the direction of exchange rate volatility. Based on this thought process, proponents of this theory are of the view that there exists a negative relationship between exchange rate volatility and trade flows. Hence they considered not only the risk involved in doing business but also its degree.

III.2 Empirical Literature Review

There has been a wide but divergent range of studies and economic research works that seek to empirically analyse the nexus between exchange rate volatility and trade flows. In his work, Aliyu (2010) used the vector error correction and the VAR model to analyse the impact of exchange rate volatility on Nigeria's non-oil exports from 1986Q1 to 2006Q4. The result established a long-run stable and negative relationship between Naira exchange rate volatility and non-oil exports in Nigeria. In the alternative, the result was positive for the US Dollar exchange rate volatility and non-oil exports.

Joseph (2011) used the GARCH model on annual time series data of trade flows in Nigeria from the year 1970 to 2009. This study indicated that a negative and statistically insignificant transmission existed between exchange rate volatility and aggregate trade. The negative result though from annual time series data is in sync with that of Aliyu (2010). Dickson and Ukavwe (2013) also applied the error correction and GARCH model to investigate the impact of exchange rate fluctuations on trade variations in Nigeria using annual time series data from 1970 to 2010. The results of the study showed that exchange rate volatility is not significant in explaining variations in import, but was found to be statistically significant and positive in accounting for variations in export. Serenis and Tsounis (2014) examined the effect of volatility on two small countries, Croatia and Cyprus, on aggregate exports during the period 1990 to 2012. ARDL methodology was adopted and results suggested that there is a positive effect of volatility on exports of Croatia and Cyprus.

Ozturk and Kalyoncu (2009) used quarterly data of six (6) countries from the period 1980 - 2005 to investigate the impact of exchange rate volatility on trade flows in each of the countries, applying an Engle- Granger residual-based co-integration technique. The result showed a significant negative effect on trade in South Korea, Pakistan, Poland and South Africa and a positive impact on Turkey and Hungary. Mukherjee & Pozo (2011) studied the impact of exchange rate volatility on the volume of bilateral trade using a Gravity model from a sample of 200 countries and the result indicated a negative relationship although at a very high level of volatility, the effect diminishes and eventually becomes statistically indistinguishable from zero. Dell'Aricccia (1999) as well carried out an investigation on the European Union on the relationship between exchange rate fluctuations and trade flows using the gravity model and panel data from Western Europe. Evidence showed a negative effect of exchange rate volatility on international trade.

Arise et al (2000) applied the Johansen's co-integration procedure and ECM to detect a negative effect of real exchange rate volatility on export. Quarterly data spanning from 1973 to 1996 on thirteen Less Developed Countries (LDCs) were used in the analysis. The result revealed that an increase in REER resulted in a significant negative effect on export demand in each of the thirteen (13) countries in both short and long-run. Kasman and Kasman (2005) used quarterly data spanning from 1982 to 2001 and applied co-integration and Error correction model to investigate the impact of real exchange rate volatility on Turkey's export to its major trading partners. Exchange rate volatility exhibited significant positive effect on export volume in the long-run.

Generally, empirical works that end up establishing a positive relationship between exchange rate volatility and trade flows are in tandem with the risk portfolio school of thought, which believes that, 'the higher the risk the higher the reward', therefore, the consequent risk occasioned by exchange rate volatility will only breed more trade(investment) opportunities. Studies that resulted in a significant positive relationship between exchange rate and trade variable(s) could be seen in the works of Aliyu (2010); Kasman and Kasman (2005); among others. The case of ambiguous relationship between these two variables is evident in Kumar and Whitt (1992); Arestotelous (2001); Tenreyo (2007, etc. The main contribution of this paper is to use the GARCH modeling technique combined with the ARDL bounds testing approach to examine the impact of both nominal and real exchange rate volatilities on monthly export and import volumes of Nigeria for the period, 1997M1 – 2016M12. The study would provide empirical evidence to drive policy formulation in the management of exchange rate as it impacts on trade and provide information that could guide more studies on the subject.

IV. Methodology

IV.1 Estimation Technique

The focus of the study requires that the volatility form of REER be generated. Consequently, the study employed the Generalised Autoregressive Conditional Heteroscedasticity (GARCH) model to generate the volatility series for REER. This was consistent with the studies by Pozo (1992), Kroner and Lastrapes (1993), Caporale and Doroodian (1994), Sauer and Bohara (2001), Clark et al. (2004), DeVita and Abbott (2004) and Asteriou et al. (2016) who have extensively adopted the method in modelling volatility.

Following that, the study used the generated volatile form of REER in an autoregressive distributed lag (ARDL) model (ARDL bounds test for co-integration) and ECM-based granger causality in order to estimate the short and long-run relationships and the direction of causality, respectively, among the variables. The ARDL is preferred to other methods, such as Engel and Granger (1987), Johansen (1988, 1991), Johansen-Juselius (1990) and Phillips and Hansen (1990), because it allows for a more flexible procedure that can be applied even when the variables are of different orders of integration (Pesaran and Pesaran, 1997).

The ARDL bound testing procedure uses the F-statistic for the joint significance of the estimators of the lagged levels in the model to test the null hypothesis of "no co-integration". As we cannot use the standard F-distribution, Pesaran et al. (2001) provide two asymptotic critical values: the lower value assumes that all variables are I(0) and the upper value assumes that all variables are I(1). If the calculated F-statistic is higher than the upper critical value, then the null hypothesis (no co-integration) is rejected. Alternatively, if the calculated F-statistic is below the lower bound, we conclude that there is no co-integration. However, if the F-statistic is within the respective bounds, the co-integration test is inconclusive. Once a co-integration relationship is detected, the ARDL model can be applied to investigate the long-run and the short-run relationship between the variables.

According to Narayan and Smyth (2004), the presence of co-integration only indicates the presence of a long-run relationship and the existence of causality at least in one direction. Hence, the next step after confirming the existence of a long-run relationship is to establish the direction of causality. The causal relation between exchange rate volatility and trade flows was investigated using the ECM-based approach, which has the ability to model the time path of returning to long-run equilibrium.

IV.2 Data and Variables

Nigeria's monthly time series dataset was used for the period 1997M1 to 2016M12. Export (lX_t) and import (lM_t) volume data are taken from the World Bank Development Indicators (WDI) annual database. The original annual data for Nigeria are taken from WDI and converted into monthly frequency using the "quadratic-match average" frequency conversion method[3]. To calculate the world demand condition (Y*) for Nigeria, the average of the gross domestic product of the country's 14 biggest trading partners was calculated[4]. Y* and Y (Nigeria's real GDP) were sourced from the WDI and converted into monthly frequency through the same method. Relative export and import prices (P^x and P^m) were sourced from the WDI and converted from annual to monthly series. Nigeria's monthly official and parallel market exchange rates were sourced from the Central Bank of Nigeria's (CBN) database. The variable, V_1 represents the proxy for exchange rate volatility which was included in the model to take into account the effects of exchange

[3] Following Asteriou et al. (2016)

[4] The 14 top Nigeria's trading partners over 2007 to 2016 (United States, 19.5%; India, 10.2%; China, 8.5%; Netherlands, 6.9%; Brazil, 6.4%; Spain, 5.5%; France, 4.7%; Germany, 3.9%; United Kingdom, 3.8%; South Africa, 3.1%; Japan, 2.3; Cote d'Ivoire, 2.1; Italy, 2.0; and Korea, 2.0) contributed 80.8% of total trade.

rate uncertainty, while the subscript t represent time and *l* is the logarithmic form variable. $V_t^{parallel}$ and $V_t^{official}$ represent volatility of the parallel and official exchange rates, respectively.

IV.3 Models Specification

To derive the volatile form of REER, the study followed a step by step approach involving: (i) generating REER returns series; (ii) Checking for ARCH effect on the returns; and (iii) Modelling an optimal ARCH/GARCH family-type model given that there was ARCH effect. We resound that the study did not model GARCH absolutely, but only adopted the method to make '*conditional variance',* which empirically represents the volatility series of REER. Model (1) – (4) indicate the steps followed in deriving the above:

$$REERR = Log\ (REERt / REERt\text{-}1) \qquad (1)$$

Where: REERR= Real Effective Exchange Rate Returns;
REERt = Current Real Effective Exchange Rate; and
REERt-1 = Real Effective Exchange Rate Lagged one period

The series generated using the process was used in a simple autoregressive mean model in order to test for the existence of an ARCH effect (AR(k)) (k=1) thus:

$$REERR_t = \alpha_0 + \alpha_1 REERR_{t-1} + \varphi_t \qquad (2)$$

Given equation 2, the next step involved regressing the square of the contemporaneous residual in equation 2 on the squares of their lagged residuals thus:

$$\hat{\varphi}^2{}_t = \eta_0 + \sum_{i=1}^{p} \eta_i \hat{\varphi}^2{}_{t-1} \qquad (3)$$

Where: $\hat{\varphi}^2{}_t$ =squared error term of the mean equation;
p = length of ARCH lags;
$i=1$ =starting from lag1 to p
$\eta_i = \eta_1$ ------ η_p = Coefficients of lagged squared error term of the mean equation

The hypothesis of the ARCH effect (*H0*) is stated as: "no ARCH effect" thus:

$$H_0 : \eta_0 = \eta_1 = \ldots = \eta_p = 0$$

The process continued with measuring the extent of volatility which is a system model that combines both the mean equation and the variance equation, thus:

$$\begin{bmatrix} REERR_t = \alpha_0 + \alpha_1 REERR_{t-1} + \varphi_t \\ \varphi^2{}_t = \eta_0 + \eta_1 \varphi^2{}_{t-1} + \eta_2 \varphi^2{}_{t-2} + \eta_3 \varphi^2{}_{t-3} + \ldots + \eta_n \varphi^2{}_{t-n} + \iota_t \end{bmatrix} \qquad (4)$$

Equation 4 was used to make the '*GARCH variance*' series which represents the REER volatility used in the ARDL-ECM Framework. To empirically investigate the impact of exchange rate volatility on trade flows in Nigeria, we estimate the export supply and import demand functions adapting Arinze et al. (2000); and Asteriou et al. (2016). Equations 1 and 2 are the export functions with the respective parallel and official exchange rates volatilities, while equations 3 and 4 represent the import functions with the respective parallel and official exchange rates volatilities. The export and import functions are as follows;

$$lX_t = \delta_{10} + \delta_{11} lY_t^* + \delta_{12} lP_t^x + \delta_{13} V_t^{parallel} + \omega_{1t} \quad (5)$$
$\delta_{11} > 0$, $\delta_{12} < 0$, δ_{13} ?

$$lX_t = \delta_{20} + \delta_{21} lY_t^* + \delta_{22} lP_t^x + \delta_{23} V_t^{official} + \omega_{2t} \quad (6)$$
$\delta_{21} > 0$, $\delta_{22} < 0$, δ_{23} ?

$$lM_t = \delta_{30} + \delta_{31} lY_t + \delta_{32} lP_t^m + \delta_{33} V_t^{parallel} + \omega_{3t} \quad (7)$$
$\delta_{31} > 0$, $\delta_{32} < 0$, δ_{33} ?

$$lM_t = \delta_{40} + \delta_{41} lY_t + \delta_{42} lP_t^m + \delta_{43} V_t^{official} + \omega_{4t} \quad (8$$
$\delta_{41} > 0$, $\delta_{42} < 0$, δ_{43} ?

IV.3.1 Co-integration

Following Odhiambo (2008) and Narayan and Smyth (2008), the ARDL-bounds specification for models 1 - 4 is presented in Equations 1-16.

ARDL Model Specifications for Model 1(lX_t,lY_t^*, $V_t^{Parallel}$, and lP_t^x)

$$\Delta lX_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Parallel} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Parallel} + U_{1t} \quad (9)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Parallel} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Parallel} + U_{1t} \quad (10)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Parallel} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Parallel} + U_{1t} \quad (11)$$

$$\Delta V_t^{Parallel} = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Parallel} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Parallel} + U_{1t} \quad (12)$$

Where a_0 is a constant, a_1 - a_4 and B_1 – B_4 are regression coefficients, and U_{1t} is an error term.

ARDL Model Specifications for Model 2 (lX_t,lY_t^*, $V_t^{official}$, and lP_t^x)

$$\Delta lX_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Official} + U_{2t} \quad (13)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Official} + U_{2t} \quad (10)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-i}^* + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^x + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + B_1 \Delta lX_{t-1} + B_2 \Delta lY_{t-i}^* + B_3 \Delta lP_{t-1} + B_4 \Delta V_{t-1}^{Official} + U_{2t} \quad (14)$$

$$\Delta V_t^{Official} = a_0 + \sum_{i=1}^{n} a_1 \Delta lX_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY^{*}_{t-i} + \sum_{t=0}^{n} a_3 \Delta lP^{x}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Official}_{t-i} + B_1\Delta lX_{t-1} + B_2\Delta lY^{*}_{t-i} + B_3\Delta lP_{t-1} + B_4\Delta V^{Official}_{t-1} + U_{2t} \quad (15)$$

Where a_0 is a constant, a_1 - a_4 and B_1 – B_4 are regression coefficients, and U_{2t} is an error term.

ARDL Model Specifications for Model 3 (lM_t, lY_t, lP_t and $V_t^{Parallel}$)

$$\Delta lM_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Parallel}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Parallel}_{t-1} + U_{3t} \quad (16)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Parallel}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Parallel}_{t-1} + U_{3t} \quad (17)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Parallel}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Parallel}_{t-1} + U_{3t} \quad (18)$$

$$\Delta V_t^{Parallel} = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Parallel}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Parallel}_{t-1} + U_{3t} \quad (19)$$

Where a_0 is a constant, a_1 - a_4 and B_1 – B_4 are regression coefficients, and U_{3t} is an error term.

ARDL Model Specifications for Model 4 (lM_t, lY_t, lP_t and $V_t^{official}$)

$$\Delta lM_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Official}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Official}_{t-1} + U_{4t} \quad (20)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Official}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Official}_{t-1} + U_{4t} \quad (21)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Official}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Official}_{t-1} + U_{4t} \quad (22)$$

$$\Delta V_t^{Official} = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP^{m}_{t-i} + \sum_{t=0}^{n} a_4 \Delta V^{Official}_{t-i} + B_1\Delta lM_{t-1} + B_2\Delta lY_{t-1} + B_3\Delta lP_{t-1} + B_4\Delta V^{Official}_{t-1} + U_{4t} \quad (23)$$

Where a_0 is a constant, a_1 - a_4 and B_1 – B_4 are regression coefficients, and U_{4t} is an error term.

IV.3.2 A Granger-Causality Model Specification

The ECM-based Granger-causality models are specified for Models 1 to 4. According to Odhiambo (2009), the introduction of the lagged error correction term reintroduces the long-run relationship that could have been lost with differencing. It also allows analysis of causality in both the short-run and long-run.

ECM-based Granger-causality for Model 1

The ARDL Granger-causality model specification for Model 1 is given in Equations 24 – 27.

$$\Delta lX_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_1 ECM_{t-1} + U_{1t} \quad (24)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_2 ECM_{t-1} + U_{2t} \quad (25)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_3 ECM_{t-1} + U_{3t} \quad (26)$$

$$\Delta V_t^{Parallel} = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_4 ECM_{t-1} + U_{4t} \quad (27)$$

Where a_0 is a constant, a_1 - a_4 and θ_1 – θ_4 are regression coefficients, and $U_{1t} - U_{4t}$ is an error term.

ECM-based Granger-causality for Model 2

The ARDL Granger-causality model specification for Model 2 is given in Equations

$$\Delta lX_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Official} + \theta_1 ECM_{t-1} + U_{1t} \quad (28)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Official} + \theta_2 ECM_{t-1} + U_{1t} \quad (29)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Official} + \theta_3 ECM_{t-1} + U_{1t} \quad (30)$$

$$\Delta V_t^{Official} = a_0 + \sum_{i=1}^{n} a_1\, \Delta lX_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-i}^{*} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{x} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Official} + \theta_4 ECM_{t-1} + U_{1t} \quad (31)$$

Where a_0 is a constant, a_1 - a_4 and θ_1 – θ_4 are regression coefficients, and $U_{1t} - U_{4t}$ is an error term.

ECM-based Granger-causality for Model 3

The ARDL Granger-causality model specification for Model 3 is given in Equations

$$\Delta lM_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lM_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-1} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_1 ECM_{t-1} + U_{1t} \quad (31)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lM_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-1} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_2 ECM_{t-1} + U_{2t} \quad (33)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1\, \Delta lM_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-1} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_3 ECM_{t-1} + U_{3t} \quad (34)$$

$$\Delta V_t^{Parallel} = a_0 + \sum_{i=1}^{n} a_1\, \Delta lM_{t-1} + \sum_{t=0}^{n} a_2\, \Delta lY_{t-1} + \sum_{t=0}^{n} a_3\, \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4\, \Delta V_{t-i}^{Parallel} + \theta_4 ECM_{t-1} + U_{4t} \quad (35)$$

Where a_0 is a constant, a_1 - a_4 and θ_1 – θ_4 are regression coefficients, and $U_{1t} - U_{4t}$ is an error term.

ECM-based Granger-causality for Model 4

The ARDL Granger-causality model specification for Model 4 is given in Equations

$$\Delta lM_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + \theta_1 ECM_{t-1} + U_{1t} \quad (36)$$

$$\Delta lY_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + \theta_2 ECM_{t-1} + U_{2t} \quad (37)$$

$$\Delta lP_t = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + \theta_3 ECM_{t-1} + U_{3t} \quad (38)$$

$$\Delta V_t^{Official} = a_0 + \sum_{i=1}^{n} a_1 \Delta lM_{t-1} + \sum_{t=0}^{n} a_2 \Delta lY_{t-1} + \sum_{t=0}^{n} a_3 \Delta lP_{t-i}^{m} + \sum_{t=0}^{n} a_4 \Delta V_{t-i}^{Official} + \theta_4 ECM_{t-1} + U_{4t} \quad (39)$$

Where a_0 is a constant, a_1 - a_4 and θ_1 – θ_4 are regression coefficients, and $U_{1t} - U_{4t}$ are an error term.

V. Empirical Analysis and Discussion of Results

V.1 Empirical Analysis

In carrying out the empirical analysis, we first generate the volatility series using GARCH model (the different measures of exchange rate volatility are depicted in the table 1). We affirm the appropriateness of the GARCH model by carrying out serial correlation and heteroscedasticity tests since univariate volatility model is only valid if there is presence of serial correlation and ARCH effects. Second, we employ the ARDL bounds testing approach in order to test the existence or absence of long-run relationship between exchange rate volatility and trade flows. Third, since ARDL doesn't determine the direction of causality, we estimate an error correction model (ECM) i.e. the short-run dynamic parameters associated with the long-run estimates.

V.2 Discussion of Results

Two pre-steps are followed in applying the GARCH models to capture the volatility of exchange rates. First, GARCH modeling requires the data to be stationary. Thus, the augmented Dicker-Fuller (ADF) test was used as presented in Table 1. Here, LOFF and LPAR represent the logarithm forms of official and parallel market exchange rates. The results in Table 1 suggest that LOFF and LPAR are level stationary. Second, we identify the appropriate ARIMA models to be fitted to both LOFF and LPAR.

Table 1: ADF result for the variables

Variable	Level
LOFF	-5.334**
LPAR	-4.471*

**Significance at 1%, * Significance at 5%

Table 2 presents the results from the Breusch-Godfrey serial correlation and ARCH-LM heteroscedasticity tests of the nominal and real exchange rates. The Schwartz (SIC) and Akaike (AIC) information criteria were used as model selection tools. The model that gave the minimum AIC and SIC values was chosen. Univariate volatility model is only valid if there is presence of serial correlation and ARCH effects[5]. As such we are expected to reject the null hypothesis of no heteroscedasticity and no serial correlation for the univariate volatility framework to be valid for analyses. Based on the results, serial correlation and ARCH effects were only detected for parallel exchange rate as we reject the null hypothesis of no serial correlation and no heteroscedasticity.

Table 2: Fitted ARIMA (p,d,q) models

	LOFF	**LPAR**
AR(1)	0.9986 (0.0000)	0.9979 (0.0000)
C	4.0705 (0.0383)	4.3068
(p,d,q)	1,0,0	1,0,0
B-G LM Test	0.1103	0.0000
ARCH-LM Test	0.9831	0.0000

Note: (a) p values are presented for the tests and in parenthesis; (b) null hypothesis for Breusch-Godfrey serial correlation test: No serial correlation; (c) null hypothesis for ARCH-LM heteroscedasticity test: No ARCH effect.

The GARCH model is therefore estimated for LPAR and used to predict the volatility in the exchange rate. The results are presented in Table 3 and optimum lag lengths are determined by SIC.

Table 3: Fitted GARCH (p, q) models for LPAR

	LPAR
AR(1)	0.9979 (0.0000)
C	4.3068
(p,q)	1,1
resid(-1)^2	0.3092 (0.0000)
Garch (-1)	0.6523 (0.0000)
Constant	0.0685 (0.0000)
ARCH-LM Test	0.7212

Note: (a) p-values in parentheses; (b) null hypothesis for ARCH-LM heteroscedasticity test: No ARCH effect; (c) p values are presented for the tests.

After obtaining the volatility series, we carry out the graphical and summary statistics of the distribution of the series before conducting the stationarity test. Summary statistics presented in Figure 1 at the appendix show that V_t^{par} averaged 0.002 during the review period and spread between 0.0007 and 0.019, suggesting volatility during the review

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period. LEV and LIV averaged 4.38 and 3.94, respectively. Following jarque-bera statistic, which is a test statistic for normal distribution, we find that all variables used are normal. Also, the result showed that all the variables except LIV, LGDP and V_t^{par} are negatively skewed. Kurtosis which is a measure of the peakedness (leptokurtic) or flatness (platykurtic) of the distribution of the series relative to the normal (3), revealed that all but the volatility series are leptokurtic.

The stationarity for all variables used in models (1) to (4) was conducted employing ADF unit root tests. The results as presented in Table 4 suggest that while domestic demand, world demands, and the volatility series are stationary in levels, other variables are stationary in first-difference form. In other words, lX_t, lP_t^x, and lM_t are I(1) while V_t^{par}, lY_t^* and lY_t are I(0).

Table 4: ADF Results for the Variables

Variables	Level	First Difference
Export volume	-3.9500 (3)	7.4209**(2)
Import volume	-3.2522 (14)	-5.7234**(13)
Domestic demand	-6.2253** (14)	
World demand	-2.3510**(14)	
Export prices	-4.4169 (4)	-7.4305**(11)
Import prices	-4.6429 (14)	-6.9640**(13)
Volatility PAR	-7.7804**(2)	

Note: Lag lengths are presented in parenthesis and determined by SIC. **Significance at 1%

The unit root test results presented in Table 4 indicate that while some variables are stationary in levels, others are stationary in first difference. Therefore, the autoregressive distributed lag (ADRL) bounds test to co-integration which allows the incorporation of I(0) and I(1) variables in the same estimation is the best approach for our empirical analysis. In employing the ARDL model, we first obtain the optimal lag orders on the first differenced variables by using the Schwartz Criterion (SIC) from the unrestricted models. Second, we use the bounds test to investigate the long-run relationship among the variables. The results of the bounds F-test are presented in Table 5 with import and export volumes as dependent variables.

Table 5: Bound Test Results (Dependent Variable, Import Volume)

Variable	F-Statistic	Lower critical value (2.5%)	Upper critical value (2.5%)	Volatility Measure
Import volume	5.26	3.69	4.89	PAR
Export volume	4.68	3.23	4.35	PAR

Note: Unrestricted intercept and no trend. Bound test critical values are taken from Pesaran et al. (2001).

All F-values are above the upper critical value, which implies that there are unique co-integration vectors for all models. In other words, we strongly reject the null hypothesis of no long-run relationship. The co-integration relationship between the variables is also justified by the error correction terms (ECT). The results in Table 6 show that all error correction terms are negative, less than one and statistically significant as required. The ECT represents the speed of recovery to long-run equilibrium. In the export supply function, ECT – 0.03 means that any deviation from the long-run equilibrium is recovered in 33.3 months (1/0.03). In the same vein, ECT – 0.3 in the import demand function reveals that any deviation from the long-run equilibrium is recovered in 3.3 months (1/0.3). These results show that while the long-run equilibrium among variables is stable in the two models, they are corrected in a relatively shorter period of time in the import demand function.

Table 6: ARDL-ECM results

Model 1	Model 2
- 0.03(0.00)**	-0.3**(0.00)

Model 1: Export demand function for exchange rate volatility
Model 2: Import demand function for exchange rate volatility
Note: (a) p values in parenthesis; (b) only the error correction terms are reported

We can also detect co-integration from the long-run estimates. Results from the export and import demand functions are presented in Tables 7 and 8, respectively. In the export demand function, world income was positive and significant while the estimated coefficients for exchange rate volatility and export price were insignificant in the long-run. This is because crude oil remains Nigeria's dominant export and as a member of OPEC, Nigeria's production volume is capped by the international organisation. As such in the long-run, exchange rate volatility and export price may not impact on Nigeria's export volume. It is not surprising that world income is positive and particularly important in Nigeria's export demand function because higher world income means higher export demand. In the import function, domestic income was positive and significant while the estimated coefficients for exchange rate volatility and import price were insignificant in the long-run. This implies that exchange rate volatility does not have any significant impact on Nigeria's trade flows in the long-run, but it does have a negative impact in the short-run.

Table 7: ARDL Estimates for Export Supply Function

Volatility measure(4,1,0,1)	V_t^{par}	lY_t^*	lP_t^x	lX_{t-1}
Short-run	-1.0717(0.0719)	1.1390**(0.0151)	0.0007(0.8244)	0.2658**(0.0000)
Long-run	-6.0663(0.4829)	0.6383**(0.0000)	0.0218(0.8240)	

Note: (a) p values in parenthesis; **Significance at 1%, and * Significance at 5%

Table 8: ARDL estimates for import demand function

Volatility measure(4,0,4,1)	V_t^{par}	lY_t	lM_{t-1}	lP_t^m
Short-run	-1.9337**(0.0074)	0.0391**(0.0000)	0.2163**(0.0001)	0.7527**(0.0000)
Long-run	-2.5185 (0.8264)	1.2746**(0.0000)		0.0640 (0.7638)

Note: (a) p values in parenthesis; **Significance at 1%, and * Significance at 5%

Table 9: Granger causality test results

Null Hypothesis	*F statistics*	Probability
V_t^{par} **does not Granger cause** lX_t	1.7736	0.1043
lX_t **does not Granger cause** V_t^{par}	4.1279**	0.0005
V_t^{par} **does not Granger cause** lM_t	1.8173	0.0955
lM_t **does not Granger cause** V_t^{par}	0.5758	0.7495

Note: (a) p values in parenthesis; **Significance at 1%

Having established that there is a long-run relationship between variables, the next step is to detect the causality between the variables of interest. Following Granger (1988) when a pair of 1(1) series is co-integrated, there must be causation in at least one direction. The findings of Granger causality test is given in Table 9. The Granger causality test was applied only on Models 2 and 4. Results for model 2 show that nominal exchange rate volatility is caused by export volume. This is because crude oil and gas export account for more than 95 per cent of Nigeria's foreign exchange revenue and the demand for oil is determined by international market conditions. Therefore, the causality is from lX_t to V_t^{par}, but not from V_t^{par} to lX_t. This is consistent with the results of Umaru et al. (2013) and Asteriou et al., (2016). However, results from model 4 show that nominal exchange rate volatility does not Granger cause import volume. This indicates the import-dependent nature of Nigeria's economy. Oyovwi (2012) examined exchange rate volatility and imports in Nigeria. In line with our result, he found that exchange rate volatility did not significantly explain imports.

VI. Conclusion and Policy Recommendations

Given that the primary source of foreign exchange earnings in Nigeria has been the export of crude oil with the attendant volatility in its price, investigating the impact of exchange rate volatility on trade flows is timely and of policy relevance. We tested the impact of exchange rate volatility on export and import demand for Nigeria for the period 1997 – 2016 using monthly data. We used GARCH model to generate nominal exchange rate volatility series. To detect the long-run relationship among variables, the ARDL bounds testing approach was employed, and the Granger causality test was applied to investigate the short-run behaviour of the variables. In the short-run, we find that volatility negatively affect Nigeria's trade flows, but does not in the long-run. As such the Central Bank of Nigeria would find some trade benefits from intervening immediately to stabilise the foreign exchange market in the face of exchange rate shock or volatility (sterilised foreign exchange intervention used to limit exchange rate volatility (Daude et al., 2014).

Also, the study has shown that ignoring the unexpected effects of exchange rate shocks could negatively impact on Nigeria's trade flows especially in the short-run. As such the monetary authority should consistently pursue policies that would ensure stability of the exchange rate. The empirical results are limited to some extent as the lowest frequency of the data used was monthly. Also the conversion of some variables from annual to monthly might affect the quality of the results. Moreover, there are important improvements to the GARCH approach, which was used to generate the volatility series, such as multivariate GARCH, switching regime GARCH (SWARCH), asymmetric extension of GARCH or exponential GARCH (EGARCH) models. Future research might concentrate on which GARCH model best capture the impact of exchange rate on trade flows in Nigeria.

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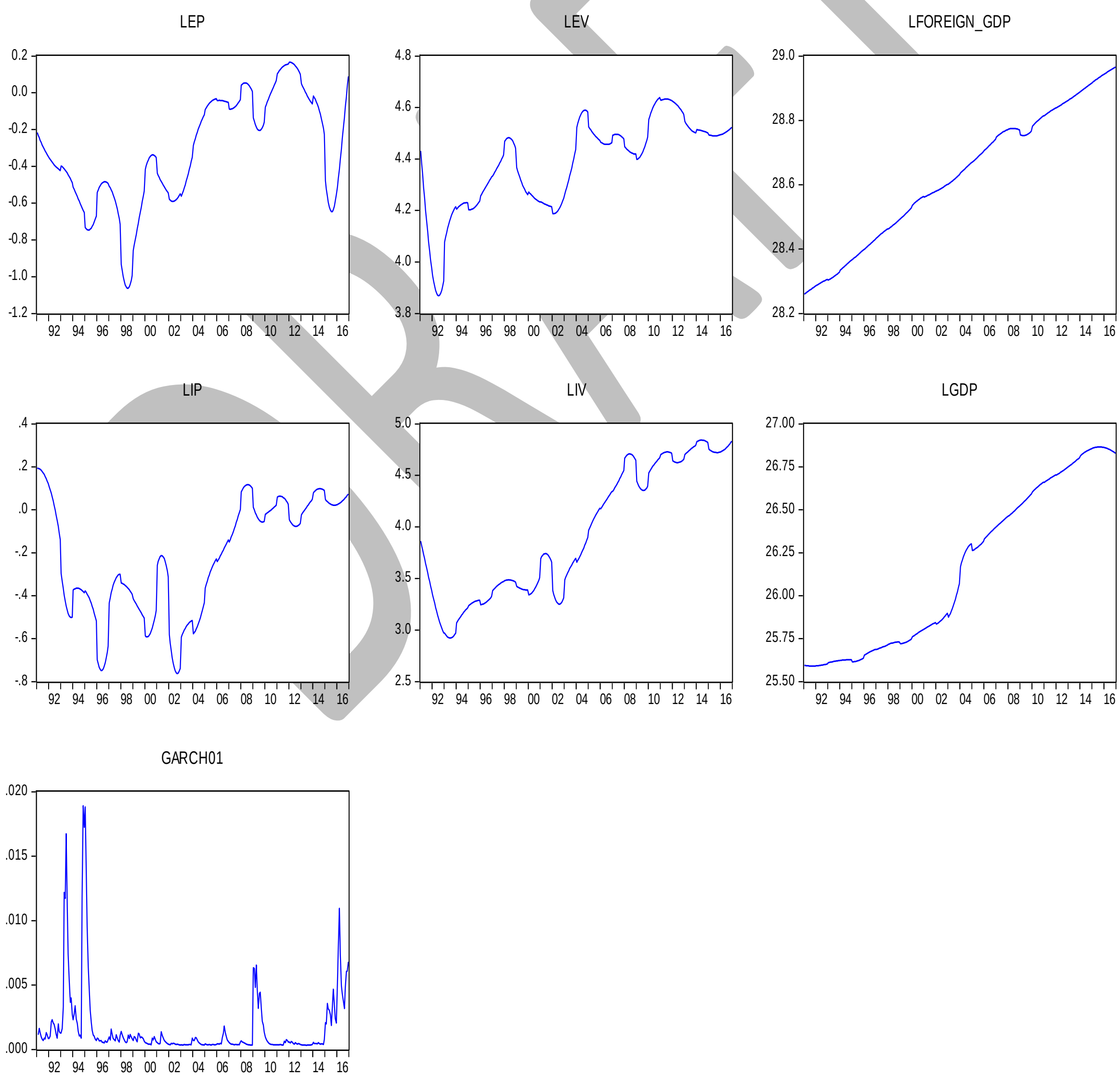
Appendix 1
Summary Statistics

	LEP	LEV	LFOR_GDP	LIP	LIV	LGDP	$V_t^{parallel}$
Mean	-0.318633	4.380279	28.62761	-0.226215	3.938357	26.15791	0.001668
Median	-0.345333	4.427759	28.63614	-0.218780	3.738293	26.16915	0.000661
Maximum	0.166173	4.638621	28.96542	0.193251	4.842508	26.86579	0.018903
Minimum	-1.063192	3.868539	28.26193	-0.762845	2.922662	25.59067	0.000326
Std. Dev.	0.299546	0.175831	0.207201	0.264873	0.635330	0.470962	0.002812
Skewness	-0.283565	-0.772702	-0.145422	-0.281438	0.088519	0.185030	3.754728
Kurtosis	2.341999	3.283610	1.794704	1.837095	1.421709	1.394387	18.97102
Jarque-Bera	9.778390	31.99035	19.92121	21.62976	32.68539	35.18106	4036.073
Probability	0.007527	0.000000	0.000047	0.000020	0.000000	0.000000	0.000000
Sum	-99.09481	1362.267	8903.185	-70.35301	1224.829	8135.110	0.518726
Sum Sq. Dev.	27.81557	9.584103	13.30906	21.74887	125.1298	68.75961	0.002452
Observations	311	311	311	311	311	311	311



Appendix 2
Measures of Exchange Rate Volatility

	Measures of exchange rate volatility (V)	**Used as a primary measure of volatility in:**
1	Absolute percentage change of the exchange rate, i.e. $V_t = \|(e_t - e_t - 1)\|/e_t - 1$ Where e is the spot exchange rate and t refers to time.	Thursby and Thursby (1985) Bailey, Tavlas and Ulan (1986)
2	Average absolute difference between the previous forward and the current spot rate, i.e. $V_t = \sum_{i=1}^{n} \|f_{t-1} - e_t\| /n$ Where f is forward rate.	Hooper and Kohlhagen(1978)
3	Variance of the spot exchange rate around its trend which is predicted from $(In\ e_t = \emptyset_0 + \emptyset_1 t + \emptyset_2 t^2 + \mathcal{E}_t)$	Thursby and Thursby (1987)
4	Moving average of the standard deviation of the exchange rate. For example, as used by Koray and Lastrapes (1989) $v_t = \left[(1\|m) . \sum_{i=1}^{m} (Z_{t+i-1} - Z_{t+i-2})^2\right]^{1/2}$ Where Z is the long relative price of foreign consumer goods in terms of US consumer goods and m=12	Cushman(1983), (1986) and (1988a,b) Akhtar and Spence-Hilton(1984) Gotur(1985) Kenen and Rodrik (1986) Bailey Tavlas and Ulan(1987) Caballero and Corbo (1989) Korey and Lastrapes(1989) Klein (1990) Bini- Smaghi (1991) Kumar and Dhawan (1991) Chowdhury (1993)
5	Long-run exchange rate uncertainty, measured as : $v_t = \frac{max\ X^t_{t-k} - min\ X^t_{t-k}}{\min X^t_{t-k}} + \left[1 + \frac{\|X_t - X^p_t\|}{X^p}\right]^2$ Where X_t is the nominal exchange rate time t, $max\ X^t_{t-k}$ and $min\ X^t_{t-k}$refers to maximum and minimum values of the nominal exchange rate over a given time interval of size k up to the time t, and $X^p_t$is the equilibrium exchange rate.	Peree and Steinherr (1989)
6	Standard deviation of the yearly percentage changes of a bilateral exchange rate around the mean observed during the subperiod	De Grauwe and Bellefroid (1986) De Grauwe(1987) De Grauwe(1988)
7	ARIMA model residuals	Asseery and Peel (1991) McIvor (1995)
8	Non Parametric Technique	Belanger et al. (1992)
9	ARCH models	Poza (1992) Kroner and Lastrapes (1993) Caporale and Doroodian(1994) Qian and Varangis (1994) Mckenzie and Brooks (1997) Mckenzie(1998)

Source: M.D., M. (1999). The Impact of Exchange Rate Volatility on International Trade Flow

Comparative Analysis of Technical, Allocative and Cost Efficiency of Nigerian Deposit Money Banks

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Abstract

This paper investigated the consistency of technical, allocative and cost efficiency of deposit money banks in Nigeria over the period 2010 to 2017 using non-parametric, data envelopment analysis (DEA) techniques. Among others, the results suggested moderate consistency between cost and technical efficiency and higher allocative efficiency scores rankings. Based on these findings, the paper concluded that the efficiency levels of the sector were relatively strong, implying that as financial deepening improved, the sector's ability to finance real activity grew stronger; further improving banking habits and the efficiency of intermediation. However, technical inefficiency was the major source of inefficiency, which calls for managerial development in order to scale up the efficiency levels.

Keywords: Efficiency, Banks, Data Envelopment Analysis

JEL Classification Numbers: D24, G21, L25, N17

I. Introduction

Globally, the banking sector has witnessed significant developments during the last three decades, as changes in the operating environment have had substantial implications for the way and manner banking services are carried out. Deregulation, globalisation, financial innovation and technological progress have all impacted gradually on their operational efficiency (Dong et al., 2014). However, given the importance of efficiency measures, as a tool for policy makers and market participants in assessing banks' ability to offer value-adding services, both regulators and practitioners rely increasingly on economic theory and empirical analysis to measure the efficiency of banks and compare peers in consolidating market position (Fiorentino et. al., 2006).

Therefore, the measurement of efficiency and productivity in the performance of individual banks and the industry are fundamental to their operational sustainability and economic growth. Banking system assets constitute a substantial proportion of total output. Banks take deposits, create credits, and provide liquidity for a smooth functioning payments system. An efficient banking system is essential for building sustainable economic growth and vibrant economic system. Therefore, the essence of enhanced economic efficiency is to reduce spreads between lending and deposit rates, which allows financial and real resources to flow freely to their highest-return uses. This is likely to stimulate both greater mobilisation of savings through the banking system and increase loan demands for small businesses and industrial investment (Karimzadeh, 2012).

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According to Ikhide(2000; pp. 4) "Banks in most developing countries, operate with relatively wide spreads. Although, government policies and regulations, as well as, poor state of infrastructure are considered major causes of such wide spreads. However, studies on banking efficiency have pointed at operating inefficiencies as one other possible source that needs to be investigated. Wide spreads affect intermediation and distort prices thus impairing the role of the financial system in contributing to rapid economic growth".

Nevertheless, the Nigerian banking sector has witnessed remarkable reforms in recent decades, given the increasing wave of globalisation, structural and technological changes, and integration of financial markets. These reforms have been channeled towards: achieving further liberalisation of banking business; ensuring competition and safety of the system; and proactively positioning the industry to perform the role of intermediation and playing a catalytic role in economic development (Kama, 2006). Consequently, the Central Bank of Nigeria (CBN), in collaboration with the other stakeholders, has adopted several policies to promote the transformation of Nigerian banking system into market-oriented industry. Policy and regulatory frameworks, including the system of prudential regulation and supervision, were overhauled, including code of conduct and laws on sound transactions. Beyond these, banking consolidation was implemented to position the industry to meet up with the global market and technological progression.

The reforms, among others: ensured the protection of depositors' funds, by ring-fencing banking from other non-banking businesses, as redefined in the licensing model of banks and minimum requirements to guide bank operations, going forward; regulated the business of banks without hindering growth aspirations; and facilitated more effective regulator intervention in public interest entities. The redefined model allows for three categories of banks, as follows: commercial (international, national or regional), merchant (national) and specialised (non-interest-national or regional, primary mortgage, micro-finance, development banks), with their respective capital requirements.

Studies on banks' efficiency have been conducted in several countries. In Nigeria, the studies include Fagge et al., (2012); Ehimare, (2013); Oluitan et al., (2015); Jibrin et al., (2015); Nyong, (2017); Ajayi et al., (2017); and Oke et al., (2017) with varying results and policy implications. For instance, Fagge et al., (2012) conducted a study on the extent to which banks' efficiency has changed over time in Nigeria. The results revealed mixed developments in terms of technical, pure technical and scale efficiencies of banks during the assessment period. Average pure technical efficiency at 39.8 per cent was higher than the scale and technical efficiencies at 30.0 and 24.5 per cent, respectively. Whereas average technical change and efficiency change index were at 1.2 and 2.3 points, respectively.

Ehimare (2013) and Ajayi et al., (2017), conducted similar studies on banks' efficiency, using DEA technique. The results of these studies suggested that while some banks remained efficient throughout the study periods 2006 – 2009, others were inefficient banks.

Specifically, the national licensed banks recorded better mean efficiency scores in 2011, 2012 and 2013, whereas the international licensed banks achieved efficiency scores in 2014 and 2015. The inefficiency scores were attributed to scale inefficiency rather than pure technical inefficiency. The papers called for the regulatory authority to ensure regulatory compliance. Oke et al., (2017), suggested that small banks tend to be more cost-efficient than medium and big banks. Similarly, medium-sized banks tended to be more cost-efficient than big banks, whereas big banks recorded the highest cost efficiency scores in post-consolidation period, due to scale economies. However, cost efficiency of the sector was the highest during consolidation period, followed by pre-consolidation and least in three years after consolidation. Therefore, the study called for improved corporate governance, best managerial practice to achieve efficiency.

Findings from Nyong (2017), revealed high record of inefficiency among the banks, due to waste in utilisation of resources. Inefficiency ranges from 36 per cent in 2001 to 45 per cent in 2002 and from 34 per cent in 2009 to 35 per cent in 2008. The banks' inefficiency is due more to pure technical efficiency rather than scale efficiency. The sources of inefficiency were linked to: low capital-to-asset ratio; high operating expense-to-income ratio; low returns on equity; market share; interest expense-to-deposit ratio; and low liquidity ratio. The results had strong policy implications for banks and called for the regulatory/supervisory authorities to minimise distress and avert bank failure.

This research work was carried out to fill the gaps on the basis of the issues raised in some of the previous studies. Specifically, this study expanded the scope of the study by Fagge et al., (2012) by examining technical, allocative and cost efficiency of Nigerian deposit money banks. The choice for this scope covers the period of economic crisis and its effect on the baking system as well as the policy measures taken to address the issues.

The objective of this paper, therefore, is to assess the efficacy of Nigeria's banking system by examining the developments in technical, allocative and cost (economic) efficiency of deposit money banks. The paper is divided into five sections. Following the introduction, Section 2 presented a brief review of the related literature, while Section 3 examined the empirical model and methodology. Sections 4 contained model specification and analysis of data, while Section 5 provided the conclusion and policy recommendations.

II. Related Literature

A number of studies have been conducted on banks' efficiency. This paper seeks to enrich the existing literature on economic efficiency of the banking sector. Mamonov and Vernikov (2015) conducted a study comparing efficiency of public, private and foreign banks in Russia, using stochastic frontier analysis (SFA) of bank-level using quarterly data spanning 2005 to 2013. The results suggested that foreign banks appeared to be the least cost-efficient, while the core state banks were, on the average, nearly as efficient as domestic private banks. The results further showed that foreign banks were capable of being more cost-efficient than others, if they increase loans-to-assets ratios above the sample median level. Conversely, core state banks led in terms of cost efficiency, if their loans-to-assets ratio fell below the sample median level.

Jreisat and Al-Barghouthi (2015) examined cost efficiency for 17 Jordanian banks (2 large, 8 medium, 4 small and 3 foreign) for the period 1996-2007, using the parametric stochastic frontier analysis (SFA) technique, based on the measures or indicators of cost efficiency identified by Papke and Wooldridge (1996). The research findings showed that both the domestic and foreign banks had shown slight improvements. In addition, the paper investigated whether or not ownership structure, size, number of branches and automated teller machine (ATM), bad loan and age of the bank significantly affected the cost efficiency levels of Jordanian banks. The results showed that differences in ownership structure significantly affected Jordanian banks performance in terms of cost efficiency.

Zhao and Kang (2015) examined the cost efficiencies of 18 Chinese commercial banks, divided into state-owned and the joint-stock banks, using stochastic frontier analysis (SFA) technique. The findings revealed that there was an upward trend in the overall mean of cost efficiencies of the sample banks. The cost efficiencies of the state-owned banks had improved greatly, while the cost efficiency gap between the state-owned banks and the joint-stock banks decreased. Overall, the economic (cost) efficiency of the 18 Chinese commercial banks increased.

Raina and Sharma (2013) examined the cost efficiency of Indian commercial banks, using data envelopment analysis (DEA) over the period 2005:06 to 2010:11. They specifically incorporated interest and non-interest income measures in their estimation. The result showed that despite the existence of enabling environment, which served as a catalyst in improving the level of cost or economic efficiency, there was noticeable record of inefficiency among the banks, due to the regulatory challenge, rather than the managerial difficulties.

Raphael (2013) used data envelopment analysis (DEA) technique to assess the relative efficiency of 58 selected commercial banks operating within the East African Community, which include Tanzania, Kenya, Uganda, Rwanda and Burundi, from 2008 to 2011. The estimation results were mixed indicating a sharp decline of technical efficiency from 0.81 in 2008 to 0.56 in 2009. It, however, showed an increasing trend afterwards, reaching 0.73 in 2011. The result further revealed that most commercial banks in the Zone were operating at a decreasing return to scale, implying inefficient utilisation of input. The study recommended that banks should make use of their underutilised resources and reduce operating expenses In order to be relatively efficient in the production frontier.

Tabak et al., (2011) studied the influence of banks' concentration on cost and profit efficiency, using a sample of 495 Latin American banks over the period 2001-2008. The results indicated that: scale efficiency of the banks were close to their optimal size; banks were more inefficient in profits than in costs; concentration impaired cost efficiency; larger banks had higher performance, but this advantage decreased in concentrated markets; private and foreign banks were the most efficient; and most banks were operating with increasing returns of scale.

Xianga et al., (2011) employed a mixed two-stage approach to estimate and explain differences in the cross-country efficiency of 10 Australian, 5 UK and 8 Canadian banks over the period 1988 to 2008, using stochastic distance, cost and profit frontiers. Their results showed that Australian banks exhibited superior efficiency, compared with their Canadian and UK counterparts. Key factors found to have affected efficiency positively included the level of intangible assets and the loans-to-deposits and loans-to-assets ratios. In contrast, key factors found to affect efficiency negatively included bank size and the ratios of loan loss provisions-to-total loans and the debt-to-equity ratios.

Brack and Jimborean (2010) investigated the economic efficiency of French banks vis-a-vis their European (Germany, Italy, Spain, and the United Kingdom) and the United States' 10 biggest counter-parts over the period 1994-2006 using DEA technique. The results showed improvement in cost-efficiency of French and Spanish banks, while there was deterioration in the other countries. Further tests of convergence suggested that inefficient banks had reduced the gap during the period. They also applied censured Tobit model and proved that capitalised, newly-established banks, with tighter ratios of Tier 1 capital and operating in a country with a lower GDP per capita recorded the highest cost-efficiency scores.

Isik and Hassan (2002) employed both parametric and non-parametric data envelopment analysis (DEA) techniques to examine technical, pure technical, scale, allocative, cost and profit efficiency measures in the Turkish banking industry over the period 1988 - 1996. The findings revealed that the heterogeneous characteristics of banks had significantly impacted on their efficiency. Cost and profit efficiency had exacerbated over time. The results also indicated that the dominant source of inefficiency was technical, rather than allocative inefficiency, which was mainly attributed to diseconomies of scale. The study recommended that government should implement financial reforms that would foster competition in the sector and devise incentive schemes to improve managerial efficiency.

Oluitan et al., (2015) conducted a study on cost efficiency of some deposit money banks (DMBs) in Nigeria. The work involved a sample of 15 banks using the stochastic frontier model with data spanning 2002 to 2013. The findings showed that the efficiency of the banks examined varied between 0.97 and 0.99 with an average value of 0.98. The study established that these banks were highly efficient with cost in determining their non-interest revenue at 99.9 per cent, which represented the highest level of cost efficiency attained.

III. Methodology

The literature distinguishes two main approaches in measuring banking efficiency; parametric and non-parametric approach in which the specifications of a production function is required in both methods. The parametric approach involves the specification and econometric estimation of a statistical or parametric function, such as stochastic frontier analysis (SFA), while the non-parametric technique offers a linear boundary by enveloping the experimental data points, known as "Data Envelopment Analysis" (DEA) (Karimzadeh, 2012).

This study adopts the non-parametric technique of DEA because it allows the assessment of the performance of banks as homogeneous decision making units (DMUs). The key advantage of DEA is that it allows for a specification of multiple outputs and inputs unlike the SFA. This study, thus, estimates technical, allocative and cost (economic) efficiency of banks. The main objective of DEA is to establish which firms are operating on their efficient frontier and which firms are not. If the firm's input-output combination lies on the DEA frontier, the firm is considered efficient; but the firm is considered inefficient if the firm's input-output combination lies inside the frontier.

As cited by Tahir et al., (2009: PP 99) "the evaluation of bank efficiency creates several problems, which arise as a result of the nature and function of financial intermediaries, especially as banks are multi-product firms that do not produce or market physical products. One of the major problems in the study of bank efficiency is the specification of bank inputs and outputs. There has been long-standing disagreement among researchers over what banks produce. The most debatable issue is the role of deposits and, more specifically, whether they should be treated as inputs and/or outputs. Some researchers, such as Elyasiani and Mehdian (1990) and Lang and Welzel (1996) treat them as inputs, but researchers such as Berger and Humphrey (1991) and Ferrier and Lovell (1990), treat deposits as outputs, while other researchers, such as Humphrey (1990) and Aly et. al., (1990) treat them simultaneously as inputs and outputs"(pp 99).

Thus, these studies as highlighted above indicate two ways of measuring bank outputs; the production approach and the intermediation approach. Under the production approach, banks create accounts and process deposits and loans, and acquire operating costs. Under the intermediation approach, banks are treated as financial intermediaries that combine deposits, labour and capital to produce loans and investments. The values of loans and investments are treated as output measures; labour, deposits and capital are inputs; and operating costs and financial expenses comprise total cost.

III.1 Data Envelopment Analysis

DEA has been identified as a linear programming technique that provides a means of calculating apparent efficiency levels within a group of organisations. The efficiency of a firm is calculated, relative to the group's observed best practice. Thousands of DEA studies have been reported in areas, including agriculture, education, financial institutions, health care, transportation, public sector firms, sports, armed forces, market research, among others. (Fagge et al., 2012).

As highlighted above, DEA is a deterministic technique for examining relative efficiency, based on the data of selected inputs and outputs of a number of entities, called decision making units (DMUs). From the set of available data, DEA identifies relatively efficient DMUs (that are used as reference points), which define the efficiency frontier, and also evaluates the inefficiencies of other DMUs, which lie below that frontier (Karimzadeh, 2012). It also identifies for inefficient DMUs, the sources and level of inefficiency for each of the inputs and outputs (Charnes et al., 1995; Repkova, 2015).

Similarly, DEA serves as an alternative analytic technique to regression analysis. Regression analysis approach is characterised as a central tendency approach and it evaluates DMUs relative to an average. In contrast, DEA is an extreme point method and compares each DMU with the only best DMU. The main advantage of DEA is that, unlike regression analysis, it does not require an assumption of a functional form to relate inputs and outputs. Instead, it constructs the best production function solely on the basis of observed data; hence, statistical tests for significance of the parameters are not necessary (Chansan, 2008; Karimzadeh, 2012).

According to Cook and Seiford (2009), the DEA approach has its origins in Farrell (1957) who applied it to a production unit, employing a single input with which to produce a single output. It was later generalised by Charnes et al. (1978), with the assumption of constant returns to scale (CRS) to handle DMUs facing multiple inputs and multiple outputs. In contrast to CCR model, the BCC's model (Banker et al., 1984) assumes a variable output with respect to the scale. The model showed that the concept of efficiency measurement can be divided into two components, technical efficiency (TE) and allocative efficiency (AE). Furthermore, the technical efficiency is decomposed to pure technical efficiency and scale efficiency in order to measure the output to scale as well as efficiency itself.

Similarly, Farrell (1957) describes technical efficiency as the firm's ability to obtain maximal output from a given set of inputs, while allocative efficiency means the firm's ability to use inputs in optimal proportions, given its respective prices and production technology. The most conjoint concept is technical efficiency, which transforms physical inputs (services of employees and machines) into outputs, relative to best practice. Technical efficiency happens when there is no possibility to increase the output without increasing the input. Thus, it is really a prerequisite for economic efficiency. Economic efficiency occurs when the production cost of an output is as low as possible. In order to achieve economic efficiency, technical efficiency must have been achieved. An organisation operating at best practice is said to be 100 per cent technically-efficient. However, if the organisation operates below best practice levels, then the organisation's technical efficiency is expressed as a percentage of best practice (Darrat et al., 2002). Managerial practices and the scale or size of operations affect technical efficiency. Allocative efficiency occurs when there is an optimal distribution of goods and services, taking into account consumer's preferences. Thus, it is at an output level where the price equals the marginal cost (MC) of production.

Mathematically, relative efficiency of a DMU is defined as the ratio of weighted sum of outputs to weighted sum of inputs. However, CRS efficiency scores will never be higher than that of VRS efficiency scores. Similarly, in the CRS model, the input-oriented efficiency scores are exactly equal to the inverse of the output-oriented efficiency scores (Karimzadeh, 2012).

According to Karimzadeh (2012), allocative efficiency is expressed as a percentage score, with a score of 100 per cent, indicating that the organisation is using its inputs in the proportions that minimises its costs, given relative input prices. Finally, cost efficiency (total economic efficiency) refers to the combination of technical and allocative efficiency. An organisation will only be cost-efficient, if it is both technically and allocatively efficient. Thus, cost efficiency is calculated as the product of the technical and allocative efficiency scores, expressed as a percentage. So an organisation can only achieve a 100 per cent score in cost efficiency if it has achieved 100 per cent in both technical and allocative efficiency.

According to Darrat et al., (2002) to compute cost efficiency for a particular bank(x), we first find the minimum cost of producing outputs, given input prices(y). Suppose that there are (*n*) banks, utilising (*m*) different inputs, to produce (*s*) different outputs, cost minimisation is calculated by the following linear programming problem:

$$\text{Min}_{1i} \sum_{i=1}^{m} w_i I_i, \quad \textit{subject to} \quad \sum_{j=1}^{n} \lambda_j O_{rj} \geq O_{rjo},$$

$$\sum_{j=1}^{n} \lambda_j I_{ij} \leq I_{ijo}, \qquad (1)$$

$$\sum_{j=1}^{n} \lambda j = 1, \qquad \lambda j \geq 0.$$

Where for bank *j*, λ_j and w_j are the intensity variable and input prices, respectively. O_{rj} is the r^{th} output variable of the bank; I_{ij} is the i^{th} input variable of the bank; O_{rjo} is its observed output vector; and I_{ijo} is its observed input vector. Cost efficiency for bank *j* is measured by the ratio of minimum cost to actual cost incurred by the bank. In order to calculate technical efficiency (TE) for bank j, we solve the following linear programming problem:

$$\text{Min} \quad \Theta, \quad \text{subject to} \sum_{j=1}^{n} \lambda_j O_{rj} \geq O_{rjo}$$

$$\sum_{j=1}^{n} \lambda_j I_{ij} \leq \Theta . I_{ijo}, \qquad (2)$$

$$\lambda j \geq \text{O}.$$

As highlighted above, technical efficiency (TE) can be decomposed into pure technical efficiency (PTE) and scale efficiency (SE). Scale efficiency occurs if the bank does not operate at constant return to scale, while pure technical efficiency accounts for efficient input utilisation.

IV. Analysis of Data and Model Specification

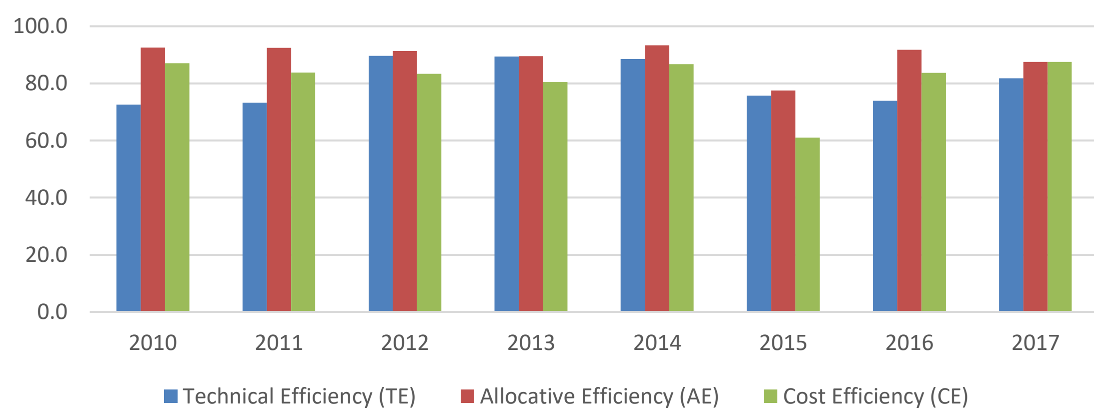
This paper relied on the intermediation approach, given the financial intermediary role banks play in the economy, to define bank inputs and outputs. Accordingly, four inputs were used consisting of average total assets; total deposits; capital employed; other operating expenses, while the four outputs included profit before tax; gross earnings; total loans and advances; and value-added.

IV.1 Empirical Findings

In this section, we present the estimated results of the technical, allocative and cost efficiency scores for the examined banks, using performance improvement measurement PIM-DEA software. DEA provides an efficiency rating that generally ranges between 0 and 1, which will interchangeably be referred to as an efficiency percentage ranging between zero and 100 per cent. The upper limit is set as 1 or 100 per cent to reflect the view that a DMU cannot be more than 100 per cent efficient. However, where it's more than 100 per cent, it's called super-efficient.

Figure 1 (Appendix 1: Tables 1 - 4) showed the respective technical, allocative and cost efficiency scores of the banking sector for the reference period 2010 – 2017. The average technical efficiency results for 2010,2011,2012,2013,2014,2015,2016 and 2017 were 72.6, 73.3, 89.7, 89.4, 88.5, 75.8, 74.0 and 81.8 per cent, respectively. Similarly, the average allocative and cost efficiency scores for these periods were 92.5, 92.4, 91.4, 89.5, 93.3, 77.5, 91.8 and 87.5 per cent; and 87.0, 83.8, 83.4, 80.4, 86.8, 61.0, 83.7 and 87.5 per cent, respectively. While the mean technical, allocative and cost efficiency indices were 80.6, 89.5 and 81.7 per cent, respectively.

Figure 1: Average Efficiency Scores for Banks (2010-2017)



The efficiency estimates indicated that the efficiency levels of the sector were relatively strong and the banking habit and efficiency of intermediation improved. Thus, these factors helped in building up the efficiency levels for the Nigerian banking system over the years. At micro level, in 2010, the technical efficiency measurement showed that 10 out of 22 DMUs recorded relative efficiency rating of 100 per cent each. These 10 banks comprised the best practice set or best efficiency frontier. In other words, their input-output combinations lie on the efficiency frontier, while the remaining 12 banks had their input-output conditions inside the frontier showing the remaining levels of inefficiency. This implied that there were more inefficient banks in operation with other less-efficient banks. Despite being inefficient, efforts were made by bank 03, bank 09, bank 12, bank 05 and bank 19, having scored 97.2, 91.2, 88.1, 85.8 and 84.5, per cent, respectively, to operate on their frontier (Table 1).

Similarly, in 2011 and 2012, 9 out of 22 DMUs recorded relative efficiency rating of 100 per cent, lower than the preceding period by 10 percentage points. Also, these 9 banks comprised best efficiency frontier, which implied that their input-output combinations lied within the efficiency frontier. Comparable analysis holds for the 2013, 2015 and 2016, respectively, as 8 out of 22 DMUs were found to have operated on the frontier points. However, in 2014 and 2017, the sector recorded the highest performance with 11 out of 22 banks and 17 out of 22 banks, each attaining 100 per cent relative efficiency level, respectively.

The overall ratings of the industry suggested that 36.4 per cent of the DMBs were efficient in 2013, 2015 and 2016; 40.9 per cent in 2011 and 2012; 45.5 and 50.0 per cent in 2010 and 2014; and 77.3 per cent in 2017. Similarly, an average of 19.5 per cent was required for overall technical efficiency. This result further suggests that an average Nigerian bank, if producing its output at 72.6 per cent on the efficiency frontier, instead of its current (virtual) location, would need only 27.4 per cent of the input currently being used in 2010. This interpretation of efficiency frontier scores could be extended to subsequent periods in the sample analysis.

This result connotes that the magnitude of overall average technical inefficiency in the banking sector would also need an index to the tune of 26.7 per cent in 2011; 10.3 per cent in 2012; 10.6 per cent in 2013; 11.5 per cent in 2014; 24.2 per cent in 2015; 26.0 per cent in 2016; and 19 per cent in 2017, to scale up the efficiency levels.

This analysis further revealed that, by adopting best practice technology, deposit money banks could, on the average, reduce their inputs of average total assets, total deposits, capital employed and other operating expenses by at least the levels of overall technical inefficiencies for the respective periods, under review and still produce the same levels of outputs. However, the potential reduction in inputs for adopting best practices varied, from bank to bank.

IV.2 Comparing Technical, Allocative and Cost Efficiency Scores

According Batir et al., (2017) technical efficiency measures the proportional reduction in input usage, while allocative efficiency measures the proportional reduction in costs if the right mix of inputs are chosen by banks. In addition, cost efficiency is equal to the product of allocative and technical efficiency as cited in (Cooper, Seiford, & Tone, 2007, pp. 258-260; Isik & Hassan, 2002a, pp. 723,724):

They further maintained that cost efficiency as a measure of proportional reduction in costs, which can be acquired if the bank is technically and allocative efficient while the allocative efficiency is the measure of proportional reduction in costs when the bank chooses the right mix of inputs and technical efficiency is the measure of proportional reduction in input usage that can be obtained if the bank operates efficiently (Isik & Hassan, 2002a, p. 719).

Therefore, efficiency scores are used to benchmark banks against the most efficient banks operating under the same environment. As earlier mentioned, the average technical, allocative and cost efficiency scores of the banking sector for the period 2010 – 2017 were 80.6, 89.5 and 81.7 per cent, respectively. This result showed that an average bank operated at a technical efficient level of 80.6 per cent of the best performing bank in the sample. This implied that the best performing bank used fewer resources in producing the same amount of output as compared to the average bank in the sample. It indicated that the average bank could have used 19.4 per cent less resources, if it had used the method adopted by the most efficient bank. In other words, had the average bank operated at the same efficient level as the most efficient bank in the sample, it could have saved 19.4 per cent of the resources in producing the same amount of output.

The average allocative efficient score for the banking sector was 89.5 per cent, indicating that the average bank could have applied the same amount of input using 10.5 per cent less resources, if they had produced following the most efficient bank in the sample. The results implied that using the same amount of resources, the average bank could have used a relatively low volume of resources, if it had adopted the standard of the best performing bank in the sample. Similarly, the average cost efficiency of the banking sector for the period 2010 - 2017 stood at 89.5 per cent, indicating that an average bank operated at an efficient level of 89.5 per cent of the best performing bank in the sample. This means that the best performing bank used fewer resources in producing the same amount of output, compared to the average bank in the sample. It implied that the average bank could have used 10.5 per cent less resources if it had used the method adopted by the best practice bank. In other words, had the average bank operated at the same efficient level as the most efficient bank in the sample, it could have saved 10.5 per cent of the resources in producing the same amount of output.

Given that technical, allocative and cost inefficiency scores were low at an average of 19.4, 10.5 and 18.3 per cent, respectively, suggested that banks experienced low levels of wastage in the intermediation process. The banks had substantial room for significant technical, allocative and cost savings, if they had operated at the level of best practice, performing bank in the sample (Table 4). Theoretically, a bank is fully-efficient, if it produces the output level and mix that maximises profits and minimises possible costs. Therefore, this result revealed that most banks were economically-efficient, indicating profit maximisation at a given costs. According to Batir et al., (2017) as cited in Isik & Hassan (2002a), technical efficiency is related to managerial issues, while allocative efficiency is explained by regulatory factors.

More so, as indicated in Table 4, choosing the proper input mix and given the prices as well as employing all factor inputs, the analysis showed that the average technical efficiency index in 2010, at 72.6 per cent, was lower than allocative efficiency at 92.5 per cent. The result implied that the main source of technical inefficiency was the cost inefficiency at 13.0 per cent, which called for regulatory and managerial advice to scale up the efficiency levels. Similarly analysis holds for all the remaining periods, except in 2013, where the allocative efficiency was marginally higher than the technical efficiency by 0.01 percentage points.

V. Conclusion

In Nigeria, the banking sector has witnessed significant developments over the last three decades, as changes in the environment had substantial implications for their business activities. Deregulation, consolidation, globalisation, financial innovation and technological progress, all have gradually impacted on efficiency and performance of the industry, propelled by investment in corporate and good governance, better supervision, risk management, new information technology (IT innovation) and competition. The banks have also improved on their functional attitude, strategies and policies. Applying a non-parametric DEA approach, this study examined efficiency measures (technical, allocative and cost efficiency) of Nigerian deposit money banks. Industry-wise, the trends showed an average cost efficiency scores of 72.6, 73.3, 89.7, 89.4, 88.5, 75.8, 74.0, and 81.8 per cent, respectively, in 2010, 2011, 2012, 2013, 2014, 2015, 2016 and 2017, with a conforming average inefficiency of 27.4, 73.3, 10.3, 10.6, 11.5, 24.2, 26.0 and 18.2 per cent, respectively, which served as their sources to capture both cost (managerial) and allocative (regulatory) efficiencies.

Rationally, this inefficiency, though tolerable, has to be reduced in order to provide better services to the customers and supply adequate financial resources to the needs of the growing economy. The result also revealed that the Nigerian banking sector reforms of 2004 and 2009 had impacted on the banks' size, profitability, technological advancement, service delivery and, above all, economic efficiency, as evidenced by the improvement in the measure of efficiency of the sector, which averaged, 80.0 per cent in the review period.

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APPENDIX 1

Appendix 1: Technical, Allocative, Cost and Industry Average Efficiency Scores

Table 1

Charnes, Cooper and Rhodes (CCR) Technical Efficiency (TE) Percent

DMUs	2010	2011	2012	2013	2014	2015	2016	2017
Bank01	100	100	100	100	100	100	100	100
Bank02	100	100	100	100	100	100	100	100
Bank03	97.2	98.64	91.8	79.73	95.78	100	100	100
Bank04	100	100	98.74	85.43	99.32	71.77	69.17	100
Bank05	85.78	100	94.96	87.26	86.16	78.81	97.69	100
Bank06	100	100	78.72	89.26	100	83.16	81.66	100
Bank07	79.01	81.36	91.22	86.42	92.79	58.9	98.18	100
Bank08	100	80.52	92.07	84.73	82.95	67.33	100	100
Bank09	91.22	100	91.57	88.95	92.46	81.3	0	0
Bank10	100	100	99.85	100	100	100	100	100
Bank11	0	0	74.31	67.75	56.39	70.28	55.86	100
Bank12	88.08	61.92	87.4	86.21	100	58.97	0	0
Bank13	100	100	100	100	100	100	100	100
Bank14	0	0	8.07	56.5	82.87	32.27	78.8	100
Bank15	100	96.08	100	96.1	100	73.69	100	100
Bank16	100	85.84	77.06	76.78	73.09	72.49	63.53	100
Bank17	100	100	100	98.15	100	100	90.93	100
Bank18	71.64	76.9	87.13	100	100	100	95.95	100
Bank19	84.55	91.49	100	100	100	100	95.7	100
Bank20	0	0	100	84.37	85.82	37.83	0	0
Bank21	0	39.65	100	100	0	79.74	100	100
Bank22	0	0	100	100	100	0	0	0
Average	72.6	73.3	89.7	89.4	88.5	75.8	74.0	81.8

Table 2

Allocative Efficiency Ratings

DMUs	2010	2011	2012	2013	2014	2015	2016	2017
Bank01	100	100	100	100	100	92.84	100	91.09
Bank02	90.83	93.53	92.44	87.56	100	100	100	77.5
Bank03	90.67	91.01	93.22	96.28	97.42	65.58	100	81.83
Bank04	100	100	88.46	87.71	92.98	72.96	93.04	93.06
Bank05	89	89.26	95.59	94.32	96.95	74.77	94.84	76.29
Bank06	92.75	100	83.44	84.86	95.68	60.88	88.94	72.48
Bank07	92.81	86.87	91.02	87.57	87.15	88.91	91.06	81.69
Bank08	100	89	94.77	88.89	92.42	71.42	89.72	86.64
Bank09	98.94	100	98.41	95.55	92.12	66.03	NaN	NaN
Bank10	100	99.71	95.92	94.3	92.28	64.14	91.43	88.75
Bank11	NaN	NaN	69.37	86.32	86.53	57.27	62.27	57.87
Bank12	91.6	81.04	89.93	81.66	83.02	92.13	NaN	NaN
Bank13	78.3	100	95.21	100	93.46	60	96.74	100
Bank14	NaN	NaN	63.98	78.59	82.97	80.31	96.8	80.22
Bank15	100	95.27	96.97	89.7	100	95.57	100	142.02
Bank16	68.71	73.49	88.93	82.9	92.3	71.61	86.43	85.24
Bank17	100	100	100	87.49	93.22	52.87	93.1	79.01
Bank18	90.36	94.21	92.87	75.12	87.81	100	93.94	81.59
Bank19	88.79	94.65	96.42	100	100	100	92.79	99.87
Bank20	NaN	NaN	82.77	89.67	92.57	95.41	NaN	NaN
Bank21	NaN	75.79	100	90.57	NaN	64.48	80.56	100
Bank22	NaN	NaN	100	90.32	100	NaN	NaN	NaN
Average	92.5	92.4	91.4	89.5	93.3	77.5	91.8	87.5

Table 3

Cost Efficiency Ratings

DMUs	2010	2011	2012	2013	2014	2015	2016	2017
Bank01	100	100	100	100	100	92.84	100	91.09
Bank02	90.83	93.53	92.44	87.56	100	100	100	77.5
Bank03	88.14	89.78	85.58	76.77	93.31	65.58	100	81.83
Bank04	100	100	87.34	74.93	92.35	52.37	64.36	93.06
Bank05	76.35	89.26	90.78	82.3	83.54	58.92	92.64	76.29
Bank06	92.75	100	65.68	75.75	95.68	50.63	72.63	72.48
Bank07	73.33	70.68	83.03	75.68	80.86	52.37	89.41	81.69
Bank08	100	71.67	87.25	75.32	76.66	48.09	89.72	86.64
Bank09	90.26	100	90.12	84.99	85.18	53.68	NaN	NaN
Bank10	100	99.71	95.78	94.3	92.28	64.14	91.43	88.75
Bank11	NaN	NaN	51.55	58.48	48.8	40.25	34.78	57.87
Bank12	80.68	50.18	78.59	70.4	83.02	54.33	NaN	NaN
Bank13	78.3	100	95.21	100	93.46	60	96.74	100
Bank14	NaN	NaN	5.16	44.41	68.76	25.91	76.27	80.22
Bank15	100	91.54	96.97	86.21	100	70.43	100	142.02
Bank16	68.71	63.08	68.53	63.65	67.46	51.91	54.91	85.24
Bank17	100	100	100	85.87	93.22	52.87	84.66	79.01
Bank18	64.73	72.45	80.91	75.12	87.81	100	90.13	81.59
Bank19	75.07	86.59	96.42	100	100	100	88.8	99.87
Bank20	NaN	NaN	82.77	75.65	79.44	36.1	NaN	NaN
Bank21	NaN	30.05	100	90.57	NaN	51.41	80.56	100
Bank22	NaN	NaN	100	90.32	100	NaN	NaN	NaN
Average	87.0	83.8	83.4	80.4	86.8	61.0	83.7	87.5

Table 4

Industry Average Efficiencies

	2010	2011	2012	2013	2014	2015	2016	2017	Overall Mean
Technical Efficiency (TE)	72.6	73.3	89.7	89.4	88.5	75.8	74.0	81.8	**80.6**
Allocative Efficiency (AE)	92.5	92.4	91.4	89.5	93.3	77.5	91.8	87.5	**89.5**
Cost Efficiency (CE)	87.0	83.8	83.4	80.4	86.8	61.0	83.7	87.5	**81.7**
Number of Efficient DMUs/Banks									
Technical Efficiency (TE)	10	9	9	8	11	8	8	17	**10.0**
Allocative Efficiency (AE)	6	6	4	3	5	3	4	**1**	**4.0**
Cost Efficiency (CE)	6	5	4	3	5	3	4	**1**	**3.9**
Industry (%)									
Technical Efficiency (TE)	45.5	40.9	40.9	36.4	50.0	36.4	36.4	**77.3**	**45.5**
Allocative Efficiency (AE)	27.3	27.3	18.2	13.6	22.7	13.6	18.2	4.5	**18.2**
Cost Efficiency (CE)	27.3	22.7	18.2	13.6	22.7	13.6	18.2	4.5	**17.6**

Note: In 2017, bank15 recorded Efficiency and Super-efficiency scores in both AE and CE levels.

Source: Author's Computation

Analyses of Foreign Trade Using Gravity-Type Models

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Abstract

Despite the increasing importance and overall net gains of international trade, there is growing concern about the potential negative net effects on developing economies. This necessitates the need for an in-depth analysis to better understand the economic principles underlying foreign trade policies and practices. This paper, therefore, employed gravity-type models to estimate long-run trade relationships in developing economies over a period of 38 years' across five continents. All the models showed that gross domestic product (GDP), foreign direct investment (FDI) and trade openness significantly promote multilateral trade. Conversely, real exchange rate volatility inhibited foreign trade significantly. However, migrant remittances and population impacted on cross border trade, insignificantly. The paper, therefore, recommended the need for rebalancing global net trade gains.

Keywords: Gravity-type Models, Foreign Trade, Trade Interdependencies, Rebalancing, Trade Gains
JEL Classification: F47, P45, Q27

I. Introduction

The strategic importance of international trade in the development process of global economies has escalated due, largely, to globalisation and its increasing influence of international dependencies. Fundamentally, international trade is premised on comparative advantage of countries in ensuring efficient allocation of national resources in a free global market system. In order to benefit maximally from international trade, countries and regional blocs are committed to sustainable alternatives to bilateral, regional and the multilateral levels of trade negotiations that provide the necessary guarantees for mutually-beneficial exchanges. Thus, optimisation of mutual benefits underlines the need to ensure that economic principles reflect the framework of foreign trade policies and practices of individual nations and regional blocs, as against subjecting such important decisions on political whims and caprices. The implication is that cost-benefit analysis, based on principles and pragmatism, has become the vogue in shaping and blending the international trading system (World Trade Report, 2003).

Striving for frameworks that are accommodative enough to ensure positive net gains of international trade for an economy, is essential in view of the indispensable role it plays in the global economy. For instance, in 2017, the ratio of trade growth to GDP growth rose to 1.5, buttressing the crucial role of trade in driving economic growth and development, and job creation (World Trade Organisation, 2018). However, the increased importance of trade is not without growing concerns, particularly the potential negative effects, of trade on developing economies, despite overall net gains. The potential opportunities offered by international trade to developing countries are compromised by challenges of

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inefficiencies (Nicita et al., 2013). International trade will lead to economic growth, only if the policy measures are designed to promote economic benefits in the multilateral trading system. In Nigeria, for example, the long-run relationship between foreign trade and economic growth is predominantly characterised by "own shocks" (Arodoye & Iyoha, 2014). The consequences are imbalance in the global trade configuration (Ekesiobi et al., 2011) which requires urgent solution to douse the growing global tension. This has been explained by inconsistencies in the country's international trade policies (Akanni et al., 2009). All these point to the need for an in-depth analysis of the relationship between foreign trade and economic growth and the need to rebalance the overall trade gains.

Thus, the motivation for this study is to provide insights into the economic principles that are fundamental to foreign trade policies and practices for net gains, by employing more reliable data and robust econometric models. It is incumbent on individual countries, and regional unions, to design a framework of foreign trade policies that provides the necessary economic infrastructure to cope with the changes in global economic order. This is necessary because a well-articulated international trade policy exerts "a profound influence on the economic growth of a country" (Vijayasri, 2013:113). It is essential, therefore, to weigh the political economy of a country's trade policy on the basis of cost-benefit analysis. This behooves on individual countries, and blocs, to apply models that are appropriate in understanding, interpreting and predicting the dynamics of international trading activities. Accomplishing this task entails identifying priority international markets based on the complementary patterns of comparative advantage of foreign trade policy (Alleyne and Lorde, 2014).

The main objective of this paper, therefore, is to employ gravity-type models to analyse the underlying economic principles for equitable optimal trade policy. The significance of the analysis is to provide deeper understanding of foreign policy directions, predicated on economic interests of a country.

II. Literature Review

II.1 International Trade and Gravity Models

Adam Smith, pioneered the importance of international trade (Smith, 1776) and Ricardo (1817) subsequently drew from the principles of division of labour to establish what has come to be known as the law of comparative. Krueger (1980:289) fostered the position of the classical economists by maintaining that international trade would generate growth "if only policy makers would abstain from unproductive intervention". The subsequent challenge, therefore, was ascertaining interventions that were productive or otherwise.

Historically, the attempt of Ravenstein (1889) to use the gravity model in explaining migration patterns in the 19th century pioneered the adaption of the model to applications in economic problems in the UK. The gravity model was derived from the Newton's law of gravitation (Newton, 1728). Subsequently, the model was employed by Isard (1954) to make predictions on bilateral trade flows, based on the distance between a couple of countries as well as their respective economic dimensions.

Even though the gravity model had been employed in solving economic problems earlier, Tinbergen (1962) was the first to use the model by applying econometric techniques to explain trade flows. This was a significant introduction that allowed the economic measures and interpretation of the coefficients. The improvements of the model was anchored on the inclusion of the effect of political borders, common language and the likes as supplementary variables, to proxy for trade frictions which enhanced the model's usefulness. Thus, the theory, which initially covered spatiality and geographical factors, was extended to cover pure economics and to play an important role in the prediction of international trade. However, this development also highlighted the need for economic theory that could lay a solid foundation for the model's economic relevance. Anderson (1979) applied Cobb-Douglas and constant elasticity of substitution to derive the gravity model with the aid of properties of linear expenditure systems.

This application has resulted to richer and more accurate estimations and interpretations of the relations described in the model (Salvatici, 2013). Gravity equation has proven to be among the "most stable and robust empirical regularities in economics" over time and across different samples of countries and methodologies (Chaney, 2013). It is in furtherance of this development that several varieties of the model are widely used in international economics (Mitze, 2010), which include system generalised method of moments [GMM] (Nardis et al., 2009).

II.2 Nature and Dynamics of International Trade

II.2.1 Nature of International Trade

International trade is the exchange of products and services from one country to another. Nations engage in trade with one another because no country has the resources or capacity to satisfy all domestic needs of one another. On the other hand, by developing and exploiting their domestic resources, countries can produce a surplus which is sold abroad through international trade. With international trade, competition ensures that consumers have affordable choices. According to OECD (2000), "the two main data items used in the concept of international trade are imports and exports"(p. 151) While imports of goods measure the value of goods that enter the domestic territory of a country, irrespective of their final destination, exports of goods measures the value of goods, which leave the domestic territory of a country. In international trade system, the definition of the statistical territory of a country coincides with its economic territory (United Nations, 1998). This study adopts the OECD (2000) definition.

The two main theories associated with foreign trade are import and export substitution theories. Import substitution is a trade theory that advocates the need to replace of imports with domestic production so as to reduce a country's foreign dependency through local production of goods and services, especially in areas where it has comparative advantage. The major benefits include self-sufficiency, eventual export-orientated economy, economic wealth and diversification, as well as ensuring less reliance on foreign goods. Another strong argument for this strategy is that all industrialised countries employed the strategy by which investment is directed to export-oriented industries in a bid to replace some imports (Sanderatne, 2011). The strategy is also important for raising revenues, saving foreign reserves, generating positive externalities and learning effects (Jayanthakumaran, 2000). However, the export substitution strategy has been criticised for promoting interventionist economic policies with the consequent misallocation of resources, misalignment of domestic and world prices, as well as rent-seeking opportunities associated with the shielding. Adomanis (2015) argue that the strategy has not been successfully transformed in some developing economies, partly, because of weak regulations and infrastructural deficiencies, as well as general aversion to investment which hindered its effective implementation.

Export substitution is a trade policy that is aimed at speeding up the production process of a country to facilitate exportation of goods and services for which the economy has comparative advantage. Reduced tariff barriers, floating exchange rates, and government support for exporting sectors are the usual policies adopted to promote the strategy. Export substitution trade policy is promoted to motivate export-led growth. It is essential for trade-dependent economies for which international trade makes up a large percentage of their gross domestic product. Trade reforms towards export substitution are targeted at reducing the gap between domestic and border prices by incentivising exports on the lines of comparative advantages in order to attain export-led growth (Jayanthakumaran, 2000).

II.2.2 Dynamics of International Trade

II.2.2.1 Gross Domestic Product

Gross domestic product (GDP) is a measure of economic production and growth. As a proxy for potential market, GDP reflects the attractiveness of a country and its market to foreign trading partners. When GDP growth is strong, the economy is expected to produce enough to export and import inputs to augment the production. In addition, GDP growth leads to more spending by consumers on goods and services; hence, exports are bolstered. Foreign partners also have the confidence to invest more when economic growth is strong, and investment lays the foundation for future exports. Conversely, when economic activities are dampened and GDP growth is very low or the economy goes into a recession, there is less to export and consumption of goods and services is constrained, thereby reducing imports into, and export out of, the economy.

There is overwhelming empirical agreement of the positive influence, running from GDP to Foreign trade. The regression relationship between trade and GDP growth shows overwhelmingly that there is bi-directional causality between trade and GDP growth in Togo, implying that the two variables complement each other in that economy (Gnoufougou, 2013). In the Jordanian economy, however, there is a causal relationship going from the economic growth to foreign trade, and not vice versa; implying that changes in the economic growth essentially explain the changes that occur in international trade (Shihab et al., 2014). Empirical results also indicate growth-led foreign trade pattern in Turkey (Kahya, 2011; Karahasan, 2011). The empirical consensus, therefore, is that there is a strong positive causality running from GDP to trade.

II.2.2.2 Real Exchange Rate

The relative valuations of currencies and their volatility often have important repercussions on international trade, however determined. Even though extant literature shows that exchange rate plays an important role in a country's trade performance, the determination of the direction and extent is yet to be resolved. Disaggregated trade data, for a large number of countries between 1970 and 1997, found strong evidence, supporting the prediction that exchange rate volatility impacts trade in products, differently. According to their degree of differentiation, commodities are less affected by exchange rate volatility than more highly-differentiated products (Broda & Romalis, 2011). This insight necessitates the need to identify the channels of causation in an attempt to structurally address the effects of exchange rate volatility on trade.

An investigation by Auboin & Ruta (2013) indicated that, on average, exchange rate volatility had a negative impact on trade flows. Furthermore, the findings further revealed that the extent of the effect depended on a number of factors, such as: the prevalence of hedging instruments; the structure of production, such as the existence of small firms; and the degree of economic integration across countries. Dike (2016) identified the channels through which the fluctuation of exchange rate affected international trade. His findings on seven developed and four developing economies, using the GARCH approach showed mixed results. While the result from developing economies unequivocally supported that fluctuation of real exchange rate had negative effect on trade, the relationship was found to be ambiguous among developed countries.

However, Nicita (2013) analysed the impact of exchange rate volatility on trade by estimating fixed effects models on a panel dataset, comprising 100 countries spanning over 10 years, and found no relationship between them. He concluded that since the relative valuation of currencies explained only a small part of global trade, exchange rates adjustment could only supplement other policy actions in order to make an effective impact on the rebalancing of global trade.

II.2.2.3 Foreign Direct Investment

It is yet to be empirically determined as to whether foreign direct investment (FDI) and exports are net substitutes or net complements. Theoretically, horisontal FDI models uphold a substitution relationship between FDI and exports while models of vertical FDI sustain the existence of complementarity (Liu & Graham, 1998). Although, empirical results are mixed due, perhaps, to the fact that studies use different samples, different FDI proxies and levels of analysis, empirical findings indicate that most countries experience complementarity between FDI inflows and trade (Forte, 2004). The explanation for the strong complementarity is hinged on the existence of vertical production relationship between headquarters and hosts FDIs' products (Fontagné, 1999). It has been noted that countries that experience substitution effect between FDI and foreign trade have no significant relationship between the two variables (Blonigen, 2001). Turkey is a good example of an economy where there is no causal relationship between FDI and trade (Kiran, 2011). Given the indeterminate nature of the relationship between FDI and trade "a lot of work remains to be done in order to clarify the type of existing relationship between FDI and international trade". (Forte, 2004: 23).

II.2.2.4 Migrant Remittances

International migration is a complex phenomenon involving a multiplicity of international linkages, including trade (International Organisation for Migration, 2018). Migrant remittances have become an important component of inflows into the economy. For instance, global remittances reached US$613 billion, while remittance flows to low- and middle-income countries (LMICs) rose to US$466 billion in 2017 (World Bank Group, 2018). The World Development Indicators (WDI) definition of remittance includes "all current transfers in cash or in kind between residents and nonresident individuals … independent of the sources of the sender" (World Bank, undated).

Granger causality results from Spanish data between 1975 and 2013 showed that remittances and international trade formed a positive feedback loop (Metelski & Mihi-Ramirez, 2015). However, panel regression analysis of remittances in the trade balance of 11 labor-abundant Middle East and North Africa (MENA) countries showed that the inflow of remittances had had an increasing effect on trade deficits by triggering import-led consumption expenditures (Farzanegan & Hassan, 2016). This finding points to the fact that capturing the use of remittances in an economy is helpful in determining the relationship between migrant remittances and external trade. This is essential because where a significant portion of the remittances is invested in trade and business as well as financing import of capital goods, remittances would serve as a vehicle to boost international trade. This has been the case in Bangladesh (Ferdaous, 2014). It appears that the application of remittances in an economy is fundamental in explaining its relationship with international trade.

II.2.2.5 Trade Openness

Trade-led growth hypothesis holds that trade openness (TOP) can potentially enhance access to goods and services, achieve efficiency in the allocation of resources and improve total factor productivity through technology diffusion and knowledge dissemination in the long-run (Keho & Wang, 2017). It is in view of these expected gains that countries are adopting and consolidating trade liberalisation reforms as alternatives to import-substitution industrialisation strategy. The reforms, which aim at reducing import and export tariffs and non-tariff barriers, have been adopted by many developing countries. However, there are arguments that increase in trade openness may expose developing countries to increasing inflation and lowering exchange rates (Cooke, 2010). It is further argued that trade openness has adverse effects on economies that are characterised by production of low-quality products (Haussmann et al., 2007).

In spite of these conflicting views, the consensus is that openness to international trade is beneficial to developing countries. This is imperative because openness is an indispensable enabler of trade in a global landscape that has devolved production processes internationally into global value chains (GVCs) that offer developing economies enormous global trading opportunities. The GVCs opportunities have, however, intensified global trade competition. In order to reap the benefits of international trade in a contemporary economy, it is crucial to pursue a twin strategy of trade and competitiveness. The competitiveness of an economy determines how well it can convert the potential that openness offers into opportunities. Coping with the global competitiveness entails reforms which incorporate policies and regulations that ensure conducive business climate, stable macroeconomic conditions, good governance, and infrastructural development. A holistic infrastructure that encompasses "hard" or core physical infrastructure in transport, communications, energy, and logistics as well as "soft" infrastructure, in education and skills is encouraged (Jackson, 2015).

II.2.2.6 Population

There are mixed findings regarding the believe that population size gives a country comparative advantage in international trade, especially in primary goods. The economic rankings of developing countries do not seem to support this theory (Morrison, 1977). The countervailing population size effects listed to explain the deviation include the facts that small domestic markets encourage exports; countries with large population encourage import substitution strategies; the dependence of small countries on export encourage open trade policies; and population is not a perfect proxy for natural resources. Morrison's (1977) conclusion from empirical findings is that country-specific influences in the samples explain the differences recorded in research outcomes. This is further elucidated by subsequent empirical findings. In an extension of the original gravity model of bilateral trade with special emphasis on the influence of the population size on a country`s trade flows, Nuroğlu (2010) showed that the impact of population on bilateral trade flows was positive for the exporting country, while it is negative for the importing country. A related study involving time-series cross-section empirical analysis for a large sample of developed and developing countries by Doces (2011) revealed that international trade had a statistically significant inverse effect on the birth rate. It has been observed that though the relationship between trade and population is premised on growth of people, global trade actually benefit multinational corporations, lobbyists, and some government officials, who constitute about one (1) per cent of the global population (UNCTAD, 2018). The take from these reviews is that population may have positive or negative effect on a country's international trade, depending on the prevailing circumstances.

III. Methodology

Traditionally, classical gravity models have been expressed as single equations using cross-sectional data to estimate trade flows between a pair of countries for a particular period. However, the use of structural gravity models, by the application of panel data techniques, has long been established. Further to this development, several varieties of the model are widely used in international economics (Mitze, 2010). For example, Sevela (2002) and Aliyu & Bawa (2013) employed employed gravity-type models using panel data approach in the analyses of foreign trade. Afolabi et al., (2017) extensively employed FMOLs, CCR and DOLs as dynamic panel cointegration method as gravity-types models. The use of panel data in gravity model is becoming increasingly popular because it provides for multiple sites with periodical observations over a defined timeframe and could be used with several estimation techniques (Gul & Yasin, 2011).

III.1 Data Characteristics

The panel data for this study has a structure of T>N. There are a total number of 342 observations made up of annual data for 38 years (T), spanning 1980 – 2017, as against seven variables (N) for 9 countries employed in the model. The countries are Brazil, China, Ghana, Japan, Malaysia, Nigeria, South Africa, United Kingdom and USA. The variables employed are international trade, gross domestic product, real exchange rate, trade openness, foreign direct investment, migrant remittances and population. These are chosen on the basis of economic theory and data availability. However, the sample is a good representation of five continents as well as developed and emerging economies. The data were collected from World Bank and IMF sources. Table 1 summarises the theoretical underpinnings of the variables.

Table 1: Variables Description and *Á priori* Expectations

Variable	Description	Expected Effect	Explanation
TRD	Total Trade (US$)		The two data items used in the concept of international trade are imports and exports (OECD, 2000)
GDP	Gross domestic product (US$)	+	GDP is a measure of economic production and growth and reflects the attractiveness of a country for foreign trade (Gul, & Yasin, 2011)
EXR	Real Exchange Rate	-	An explanatory variable and a proxy for prices and an adjustment for domestic and foreign inflation (Gul & Yasin, 2011)
FDI	Net Foreign Inflows	+/-	This has substitution and complementary effects between trading partners (Liua et al., 2016)
REM	Net Remittances	+/-	All current transfers, in cash or in kind, between residents and nonresident individuals, independent of the sources of the sender (World Bank, undated)
TOP	Trade Openness	+/-	Ratio of imports to total trade. The more open a country, the greater its involvement in trade (Gul & Yasin, 2011)
POP	Population	+/-	The number of people living in a country at a particular time period may reflect the market size (Tayyab et al., 2012)

III.2 Model Selection

Variety of methods are used in a T>N panel structure. However, the Fully Modified OLS (FMOLS), Canonical Co-integrating Regression (CCR) and Dynamic OLS (DOLS) are more commonly employed (Priyankara, 2018). These models are usually preferred to the OLS estimator because they take care of small samples and endogeneity bias by adding the leads and lags of the first-differenced regressors. As a result, panel co-integration regression procedures have become the vogue for cross-sectional data analysis (Yorucu & Kirikkaleli, 2017).

Preliminary examination of stationarity of the sample data, using Augmented Dickey-Fuller (ADF), showed that all the variables are stationary at first level [I(1)]. In addition, Pedroni Residual co-integration test and Kao Residual co-integration test also revealed that all the variables were stationary, at first differencing [I(1)]. However, due to the fact that Pedroni and Kao co-integration tests are one-way co-integration, the Johansen (1988) testing, which has the advantage of a system-based co-integration test for the whole panel set instead of single equation based, was included for robustness. In the Johansen System Co-integration Test results, the summary of all the sets of Johansen System Co-integration model results (Table 2) indicated that both Trace and Max-Eigen values had two (2) equations at 0.05 significant levels.

Table 2: Summary of All Sets of Johansen System Co-integration

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	2	2	2	2	2
Max-Eig	2	2	2	2	2

*Critical values based on MacKinnon-Haug-Michelis (1999)

More tests were carried out to further strengthen the reliability of the sample data. Tables 3 and 4 showed that the Engle-Granger and Phillips-Ouliaris Co-integration, each with the null hypothesis that the series are not co-integrated, were rejected while in Table 5, the null hypothesis of Park Added Variables that series are co-integrated was accepted.

Table 3: Engle-Granger Co-integration Test

	Value	Prob.*
Engle-Granger tau-statistic	-4.295102	0.2381
Engle-Granger z-statistic	-36.08790	0.2017

*MacKinnon (1996) p-values.

Table 4: Phillips-Ouliaris Co-integration Test

	Value	Prob.*
Phillips-Ouliaris tau-statistic	-4.452866	0.1801
Phillips-Ouliaris z-statistic	-35.90026	0.2063

*MacKinnon (1996) p-values.

Table 5: Park Added Variables Co-integration Test

	Value	df	Probability
Chi-square	23.32381	1	0.0000

The outcomes of all the tests indicated that the variables were co-integrated. This translates that there is long-run relationships among the variables. Therefore, confirming the reliability of the sample data for the co-integration models. The convergence implies that the collective outcomes of the tests signify the appropriateness of FMOLS, CCR and DOLS models for panel regression estimations. These co-integrating equation estimations seek to appraise the long-run relationships among the variables.

III.3 Specifications of Models

Having satisfied the conditions for co-integration regressions, the explicit specifications for general equation for all the FMOLS, CRR and DOLS models comprise of time-variant variables. Thus, specification of gravity model of multilateral trade in a cross-sectional way was specified as in Afolabi et al. (2017):

$$lnTRD_{ij}^{t} = b_i + \beta_2 EXR_{ij}^{t} + \beta_3 TOP_{ij}^{t} + \beta_4 lnFDI_{ij}^{t} + \beta_5 lnREM_{ij}^{t} + \beta_6 lnPOP_{ij}^{t} + \varepsilon_{ij}^{t} \quad (1)$$

where i refers to the cross-section, t refers to the time, α refers to the constant term, $lnTRD$ stood for total trade, $lnGDP$ refered to real gross domestic product, EXR represented to real exchange rate, TOP was the trade openness index, $lnFDI$ refered to foreign direct investment, $lnREM$ proxied to the remittances, $lnPOP$ represented population and ε refered to the error or residual term. Variables with symbols starting with ln underwent natural logarithm transformation to control for scale differences and obtain regression results of elasticity. TOP was not transformed because it is an index. Since the paper sought to investigate the long-run relationship between trade and the identified independent variables, $lnTRD$ was the dependent variable, assuming normalisation. Furthermore, the model included $lnGDP$, $lnEXR$, TOP and $lnFDI$ as core explanatory variables or variables of interest to capture their isolated effect on foreign trade. $lnREM$ and $lnPOP$ were included as control variables to separate their effects from those of the explanatory variable of interest.

III.3.1 The Fully Modified (FMOLS) Estimator

The FMOLS technique provides optimal estimates of co-integration consistent with the parameters, even when the sample size is small, and overcomes the problems of endogeneity, serial correlation, omitted variable bias and measurement errors. It also allows for the heterogeneity in the long-run parameters. The long-run correlation between the cointegrating equation and stochastic regressors innovations. The resulting Fully Modified OLS (FMOLS) estimator is asymptotically unbiased and has fully efficient mixture normal asymptotics allowing for standard Wald tests using asymptotic Chi-square statistical inference.

The FMOLS estimator employs long-run covariance matrices of the residuals. It may be estimated directly from the difference regressions.

$$\Delta X = \hat{\Gamma}'_{21} \Delta D_{1t} + \hat{\Gamma}'_{22} \Delta D_{2t} + \hat{\upsilon}_{2t} \quad (2)$$

If $\hat{\Omega}$ and $\hat{\Lambda}$ are the long-run covariance matrices computed using the residuals, then define the modified data

$$Y_t^{+} = Y_t - \hat{\omega}_{12}\hat{\Omega}_{22}^{-1}\hat{\upsilon}_2 \quad (3)$$

and an estimated bias correction term

$$\hat{\lambda}_{12}^{+} = \hat{\lambda}_{12} - \hat{\omega}_{12}\hat{\Omega}_{22}^{-1}\hat{\Lambda}_2 \quad (4)$$

Then, in line with Adom et al. (2015), the FMOLS estimator can be obtained as in equation (2):

$$\hat{O}_{FME} = \left(\sum_{t-1}^{T} Z_t Z_t'\right)^{-1}\left(\sum_{t-1}^{T} Z_t Y_t^{+} - \begin{bmatrix}\hat{\lambda}_{12}^{+\prime} \\ 0\end{bmatrix}\right) \quad (5)$$

where $Z_t = (X_t', D_t')'$. Construction of long-run covariance matrix estimators $\hat{\Omega}$ and $\hat{\Lambda}$ is the key to FMOLS estimation

III.3.2 The Canonical Co-integrating Regression (CCR) Estimator

The CCR estimator is used for testing co-integration with the integrated process of I(1). The technique is based on a transformation of the variables that removes the second-order bias of the OLS estimator. The major difference of CCR from FMOLS is that CCR concentrates on only data transformation, while FMOLS focuses on the transformation of both data and parameters. In addition, CCR applies multivariate regression without modification and loss of efficiency (Park, 1992). CCR estimator according to Adom et al., 2015, is obtained as:

$$\hat{O}_{CCR} = \left(\sum_{t-1}^{T} Z_t^{*} Z_t^{*1}\right)^{-1}\left(\sum_{t-1}^{T} Z_t^{*} Y_t^{*}\right) \quad (6)$$

where $Z_t^{*} = (X_t^{*\prime}, D_{1t}')'$. The equation assumes that adding the lags and leads of the differenced regressors soaks up all of the long-run correlation of the long-run covariance matrices of the residuals and that the least-squares estimates have the same asymptotic distribution as those obtained from FMOLS and CCR.

III.3.3 The Dynamic OLS (DOLS) Estimator

The dynamic OLS method augments the co-integrating regression with lags and leads, such that the resulting co-integrating equation error term is orthogonal to the entire history of the stochastic regressor innovations. The DOLS model assumes that the introduction of lags and leads of the differenced regressors takes care of all the long-run correlation between the error terms, that make the model to have the same asymptotic distribution (Kurozumi & Hayakawa, 2009) as those obtained from FMOLS and CCR. Masih & Masih (1996) also argue that DOLS does not impose additional requirements that all variables should be integrated of the same order [I(1)] and that the regressors themselves should be co-integrated. The advantage of this technique is that, in the event of an error in stationarity determination, the DOLS model makes up for the shortcoming. The specification for the DOLS' estimator is given in Equation (4) following Stock & Watson (1993):

$$y_t = \alpha + bX_t + \sum_{i=-k}^{i=k} \phi_i \, \Delta X_{t+i} + \varepsilon_t \qquad (7)$$

This model assumes that adding the lags and leads of the differenced regressors soaks up all of the long-run correlation covariance matrices of the residuals and that the least-squares estimates have the same asymptotic distribution as those obtained from FMOLS and CCR.

IV. Empirical Results and Discussion

The results of FMOLS, CCR and DOLS estimations are presented in Table 6. All the models were estimated with a lag and a constant. The findings showed that the models were stable, robust and consistent with theory. The adjusted R-squared indicated that all the estimators explained over 98 per cent of the effects on regressand. The results indicated a positive and significant relationship at 1 per cent, for $lnGDP$, $lnFDI$ and TOP, while each of the estimators had a negative but significant relationship for $lnEXR$ at 1 per cent level of significance. The models' results also revealed that $lnREM$ and $lnPOP$ were insignificant at 1 per cent level of significance.

Table 6: Results of Estimation of Co-integration Models

Variable	FMOLS	CCR	DOLS
lnGDP	[0.871]	[0.792]	[0.865]
	0.000	0.000	0.000
lnEXR	[-0.209]	[-0.372]	[-0.246]
	0.002	0.002	0.005
lnFDI	[0.043]	[0.082]	[0.047]
	0.000	0.000	0.001
lnREM	[0.010]	[0.010]	[0.008]
	0.242	0.495	0.384
TOP	[1.230]	[1.102]	[1.232]
	0.000	0.000	0.000
lnPOP	[-0.026]	[-0.040]	[-0.023]
	0.424	0.495	0.487
Constant	[1.024]	[2.414]	[1.157]
	0.182	0.078	0.1709
R-Squared	0.986	0.981	0.988
Adjusted R-Squared	0.986	0.981	0.987
Long-run Variance	0.256	0.810	0.252

Note: The figures in brackets [] denotes coefficients, while the figures below them are p-values.

Since the variables, except openness (TOP) which ia an index, had undergone transformation to natural logarithms, the coefficients could, therefore, be treated as elasticity coefficients, which indicated the percentage change of $lnTRD$, when any of them changes by 1 per cent. The outcomes of all the three models indicated statistical evidence that GDP had positive impact on international trade. The implication is that a buoyant economy would boost foreign trade, and vice versa. This is in congruence with extant literature that rising real exchange rate constrains foreign trade, which agrees with extant literature.

The findings agreed with Auboin & Ruta's (2013) observations that the extent of the adverse effects is subject to several factors, including the prevalence of hedging instruments, the structure of production, and the existence of small firms. In view of country-specific peculiarities, it is important to give consideration to Dike's (2016) position that conscious efforts should be made to identify the channels through which the fluctuation of exchange rate affects international trade and put in place appropriate strategies to curtail its adverse effects on trade. However, Nicita's (2013) conclusion that the relative valuation of currencies explained only a small part of global trade suggested that exchange rates adjustment could only supplement other policy actions in effecting global trade rebalancing. The inference is that a holistic approach to attaining optimal trade benefits is essential.

All the estimations found strong positive effect of FDI on cross-border trade. This supported the theoretical postulation that FDI is either a substitute or supplement to international trade, depending on whether the FDI is horisontal or vertical (Liu & Graham, 1998). The import of this is that countries may invoke the horisontal FDI strategy to promote import substitution by reducing the volume of trade, while enhancing GDP growth through improved balance of payment (Blonigen, 2001). The strong trading relation of vertical FDIs with the parent country may offset the gains of international trade to the host country.

The findings of strong positive impact of trade openness on international trade are in consonance with existing literature (Keho & Wang, 2017). It is important to note, though, in an open trade environment, countries that mainly export primary products are vulnerable to trade shocks (Haussmann et al., 2007). It is imperative, therefore, that, for a country to beneficially engage in trade openness, it has to invigorate the global competitiveness of its economy, so as to be able to convert the potential that openness offers into opportunities. This entails reforms that incorporate policies and regulations that ensure conducive business climate, stable macroeconomic conditions, good governance, and infrastructural development (Jackson, 2015). It is, therefore, important to note that unguarded trade openness may expose developing countries to pass-through currency devaluation to inflation (Cooke, 2010).

The study also revealed that migrant remittance and population are statistically insignificant. This may be largely attributed to country-specific characteristics and influences (Morrison, 1977). However, it is gainful to note that the impact of population on bilateral trade flows is positive for the exporting country, as against the importing country (Nuroğlu, 2010). The significance of this is that all international trade theories are predicated on optimising the gains inherent in free trade based on comparative advantage.

V. Conclusion

The strategic importance of international trade in the development process of global economies underlines the need for its in-depth analysis to unravel the growing concerns about the potential negative effects, particularly, the unbalanced benefits prevalent in developing economies, despite overall net gains. It has become imperative to optimise mutual trade benefits of individual nations by analysing trade policies and practices with reliable data and robust models, as against risking such important decisions on political whims and caprices.

This paper employs the FMOLS, CCR and DOLS co-integration panel models to estimate the long-run trade relationships with data spanning 38 years for countries across five continents. The aim is to test extant research findings and add empirical support to existing literature in this direction. The empirical findings revealed that GDP, FDI and trade openness had a positive and significant relationship with international trade. Conversely, all the models showed that real exchange rate volatility hindered foreign trade significantly. The models also revealed that migrant remittances and population had no significant relationship with cross border trade. These findings provide the guiding principles in formulating foreign policy to rebalance the net gains from global trade.

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