Money Demand in the Conduct of Monetary Policy in Nigeria

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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 $Y, i, L, F \; and \; M^d$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.

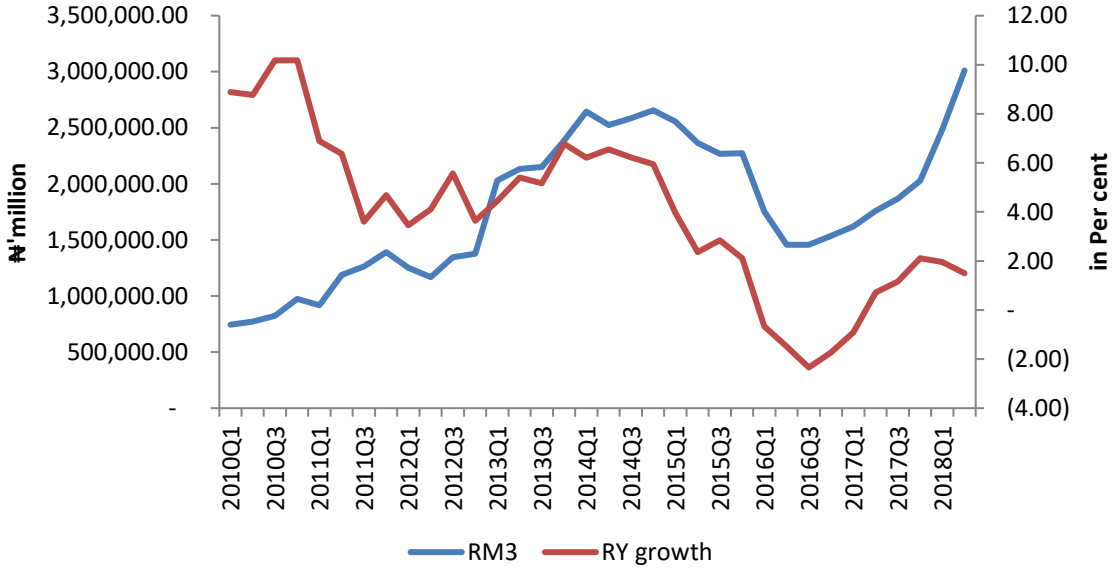
III.I Real Money Demand

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



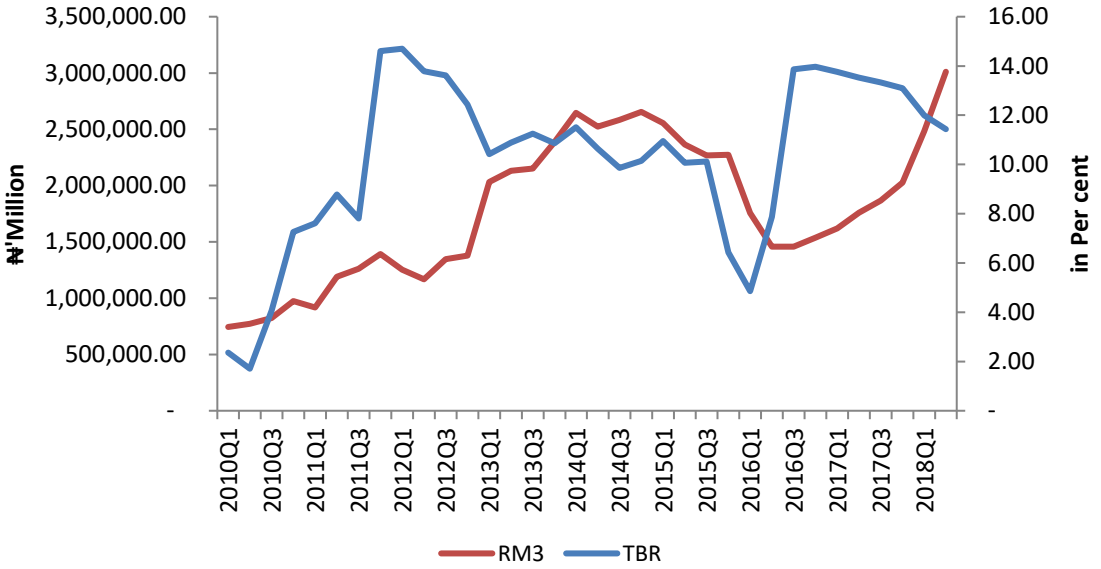
Source: CBN 2018

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)

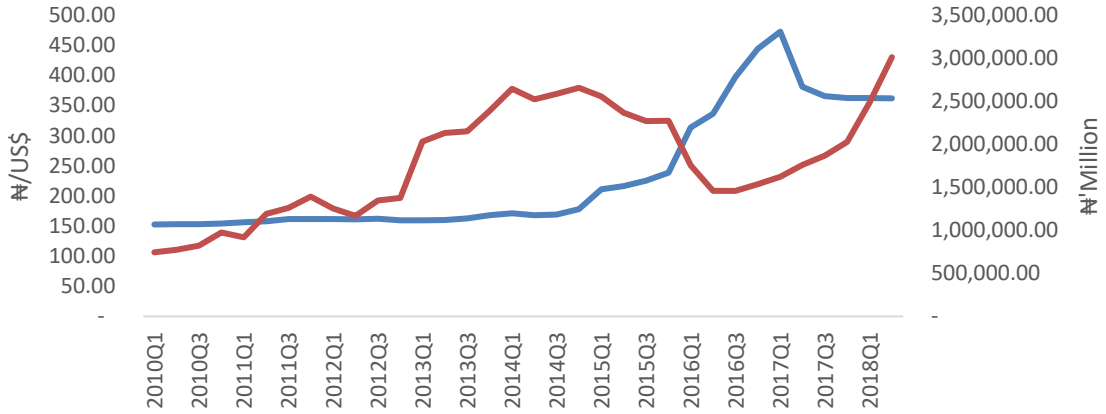


Source: CBN 2018

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

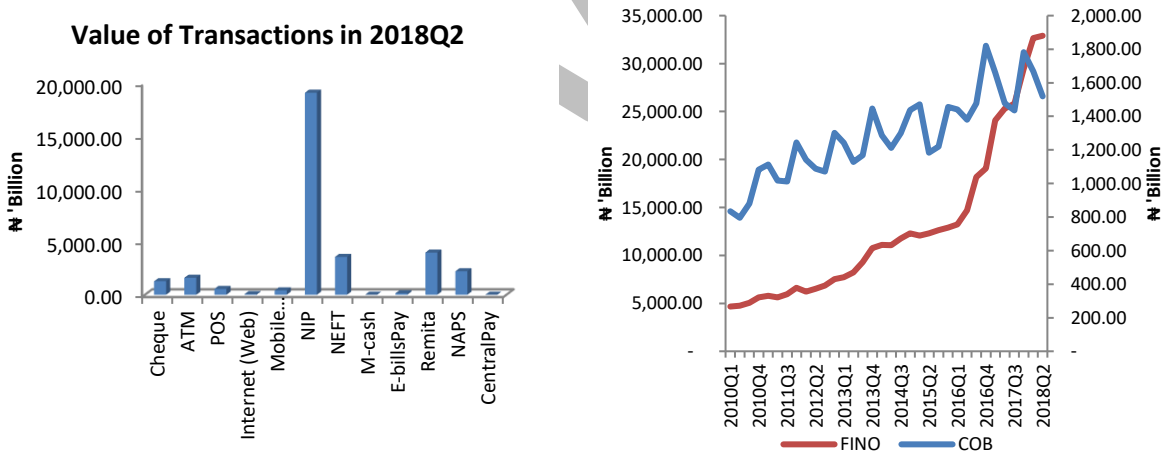
The inclusion of exchange rate in the determination of the money demand function in Nigeria is supported by the heavy dependence of the Nigerian economy on imports. Virtually all consumables in Nigeria are imported from all over the world, with the US, UK, China, India, EU, and a few West African countries, 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.

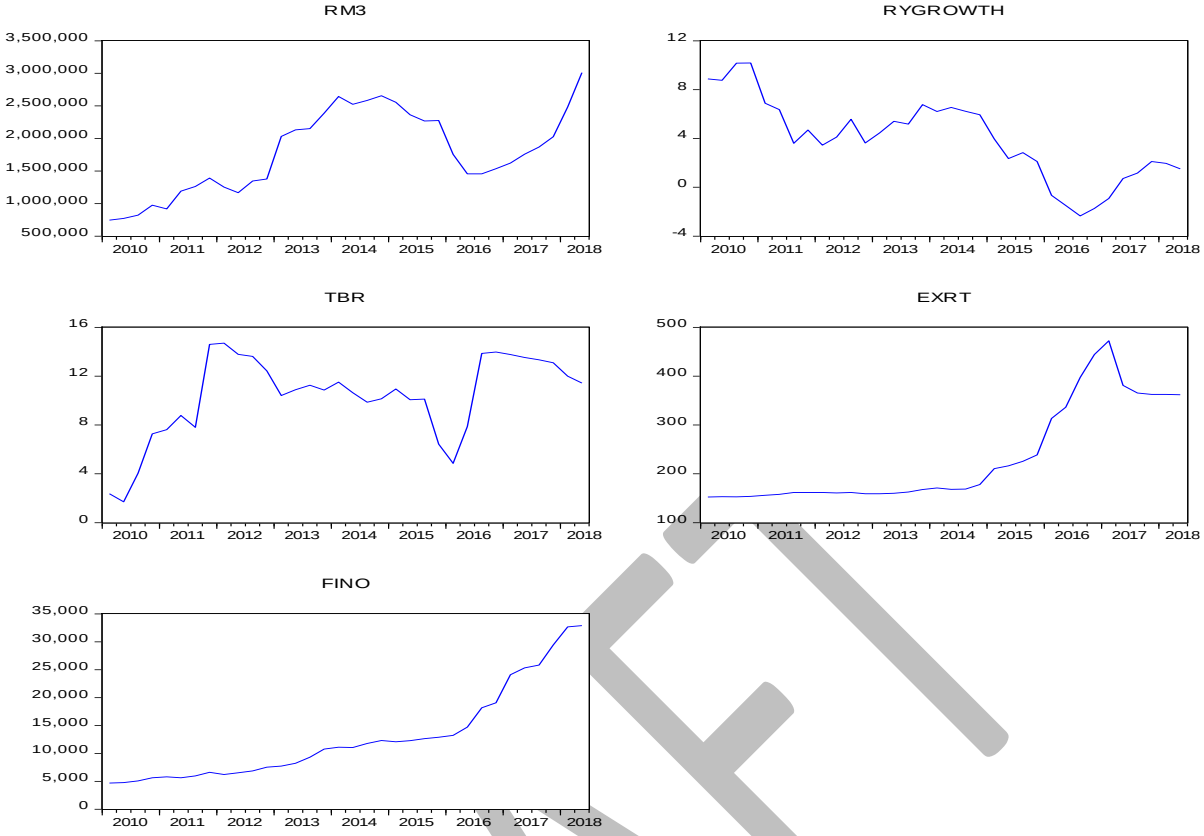
All data employed in the analysis were sourced from the statistical database of the Central Bank of Nigeria. The unavailability of the RGDP quarterly series and M_3 series prior to 2010Q1 as a result of the GDP rebasing that took place that year and the recent move to the new definition of money demand, 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	RM_3	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:

$$\ln\mathrm{RM}_{3t} = \alpha_0 + \alpha_1 \mathrm{RYGROWTH}_t + \alpha_2 \mathrm{TBR}_t + \alpha_3 \ln\mathrm{EXRT}_t + \alpha_4 \ln\mathrm{FINO}_t + \varepsilon_t \quad (1)$$

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 ($\alpha_1 > 0$), 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, ($\alpha_3 > 0$), 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 ($\alpha_4 > 0$). 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:

$$\Delta\ln\mathrm{RM}_{3t} = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta ln RM_{3t-i} + \sum_{i=1}^{n} \alpha_2 \Delta\mathrm{RYGROWTH}_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta\mathrm{TBR}_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta\ln EXRT_{t-i} + \sum_{i=1}^{n} \alpha_5 \Delta\ln FINO_{3t-i} + \sum_{i=1}^{n} \phi_i \Delta 7_{it-i} + \varepsilon_t \quad (2)$$

[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**	**ΔRYGROV**	**ΔRYGROV**	**ΔRYGR**	**ΔTBR**	**ΔTBI**	**ΔTBI**	**ΔTBI**	Δlogl	Δlog	**ΔlogF (-1)**	**ΔlogF (-2)**	**ΔlogF (-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]	-0.00404[a]	-0.0177[a]	0.32325[b]	0.97447[a]	1.49644[a]	1.09332[a]	0.42300[b]	5.16333[a]	-0.66698[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 − sta =	[-2.3536]	[2.0617]	[-2.9241]	[6.4241]	[-11.1258]	[-9.7731]	[-3.4735]	[-6.7964]	[-8.1037]	[-6.8843]	[-3.7363]	[2.41403]	[7.18808]	[9.47426]	[6.10606]	[2.77880]	[12.70443]	[-12.56644]

$R^2 = 0.9957; F - stat = 88.5517^{a}$; 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