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Financial Innovation and Demand for Money in Nigeria: Further Empirical Insights

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Abstract The quest to achieve an efficient payment system that reduces the demand for money for cash transactions and other motives, and makes the economy more competitive in the global market, necessitated the introduction of financial innovation in the financial system. This paper examined the impact of financial innovation on the demand for money, searching into the nature of their relationship and evaluating the stability of the money demand function in Nigeria, to provide further empirical insights into the unresolved debate of demand for money in the Nigerian economy. The paper adopted the ARDL model to determine whether there is a long run relationship between financial innovation and demand for money; the Granger causality test, to investigate the nature of the relationship; and CUSUM and CUSUMSq to explore the stability of money demand function in Nigeria. Quarterly data from 2009q1-2020q4 were used in the analysis. A disaggregated measure of financial innovation using the value of e-payment transactions of ATM, POS, MOB, and WEB to ascertain the relative impact of each financial innovation channel on the demand for money was employed. The disaggregated approach to measuring financial innovation and examining the causality issue, constitutes the novelty and point of departure of this paper from previous studies in Nigeria. The findings showed a long-run relationship between financial innovation and demand for money existed. Also, there is the existence of a unidirectional causal relationship with causality running from broad monetary aggregate to financial innovation. The findings further revealed that financial innovation impacted demand for money positively, implying that the Nigerian economy is predominantly cash-based; and the money demand function was found to be stable in the face of financial innovation. The findings also showed that income (GDP), interest rate, and inflation are significant variables influencing the demand for money in Nigeria.

Keywords Demand for Money, Financial Innovation, Financial System, Granger Causality, E-Payment Channels

1. Introduction

The financial system in the contemporary world is characterized by dynamism. It involves the evolution of new ideas and technologies in its modus operandi. Its instruments are modernized and the payment systems are technologically driven, representing a significant improvement in the old ways of doing financial business. A great proportion of these changes is attributed to financial innovation. Thus financial innovation can be defined as ways and means of promoting new financial instruments, markets, and institutions using new technologies. Financial innovation manifests in various forms such as institutional innovation, product innovation and process innovation. Institutional innovation includes discount broking firms, specialized credit card, etc. Product innovation includes securitized assets as well as mortgaging of foreign currency, to mention but a few while Process innovation

essentially involves new ways of doing financial business which includes the use of Automated Teller Machines (ATMs), Point of Sale (POS), Web Banking (WEB), Mobile Banking (MOB), etc. On the other hand, demand for money has been defined as the desire to hold financial instruments in their liquid form. According to Keynes [18], the desire of individuals to hold their assets in liquid form as opposed to illiquid physical assets is borne out of three motives: transaction, precautionary and speculative. Transaction motive relates to money needed for daily transactions. Due to non-synchronization between paydays and expenditures, individuals desire to hold money to meet their daily expenses. Precautionary motive refers to money held to take care of unforeseen financial exigencies while speculative motive is the desire to hold money to take advantage of any attractive investment opportunity that requires liquid cash expenditure for possible future gains.

Prior to the introduction of the Structural Adjustment Programme (SAP) in Nigeria, in 1986, the financial system was highly regulated. There was a mandatory allocation of bank credit and measurable benchmark bank credits issued to the private sector. The financial system was further characterized by rigid interest and exchange rate controls. For instance, between 1970 and 1974, 3 percent was fixed as the savings deposit rate while inflation kept increasing from 1.75 percent in 1970 to 9.41 percent in 1972, and 13.53 percent in 1974. In 1975, the Central Bank of Nigeria (CBN) increased the savings deposit rate to 4 percent as against 3 percent in 1974 and the inflation rate further increased from 13.53 percent in 1974 to 33.9 percent in 1975 CBN [8]. It should be noted that an increase in the savings deposit rate should have encouraged savers to save, thereby reducing the volume of idle cash balances in the economy and thus reducing the inflation rate. But during the period, 1970 to 1975, this scenario did not play out in Nigeria as inflation increased to 33.9 percent despite the increase in the savings deposit rate CBN [8]. This perhaps may be due to the fact that the increase in the savings deposit rate was just marginal and insufficient to induce or encourage a savings culture. Again, the payment system and its accompanying instruments as well as institutions were grossly underdeveloped. For example, payments were mainly done with cash and cheques. The method of operation in financial institutions was predominantly manual and devoid of digitalization. All these features caused inefficiency and repression in the financial system with negative impacts on the Nigerian economy at large.

The deregulation of the financial system in the wake of the SAP in 1986 engendered healthy rivalry among financial institutions. Thus, to stay afloat, the financial institutions embarked on a lot of financial innovations. The quest to improve the payment system triggered off further financial innovations, which climaxed with the introduction of the cashless policy in 2011, which became operational on April 1, 2012. The policy aimed at shifting the Nigerian economy from a cash-based economy to a cashless one, and engendering an efficient payment system with a view to among others, improving the effectiveness of monetary policy in managing inflation and driving economic growth, Ovat [27]. For the cashless policy to achieve its objectives, several digital and electronic payment systems in the form of financial innovations were introduced to facilitate cash transfers, withdrawals, and deposits, prior to the commencement of the policy. These among others, include the Automated Teller Machine (ATM), Point of Sale (POS), Mobile Banking (MOB), and Internet Banking (WEB).

Financial innovation which evidently includes financial products and financial services has been found to be reliable, efficient, cheap, and fast in carrying out banking activities. It helps in achieving time reduction and cost-effectiveness. The need for this in Nigeria became imperative due to the banking sector recapitalization, which allows banks to introduce new financial products that equally have the features of savings, interest earnings, easy withdrawals, and transfers both locally and internationally. According to the National Bureau of Statistics (NBS) [24] and the Central Bank of Nigeria (CBN) statistical bulletin [9], in 2009, which is said to be the inception of electronic-based financial innovation in Nigeria, e-payment transactions recorded a total volume of 114,592,669 valued at 645 billion Naira. The volume of e-payment transactions increased to 416 million in 2012 valued at 19, 646.82 trillion Naira. In 2020, the volume of transactions that took place through e-payment channels overwhelmingly increased from 416 million in 2012 to about 5.1 billion in 2020 while its value increased from 19,646.82 trillion Naira to about 783.17 trillion Naira.

Given the growth in the use of these technologies in Nigeria, it has become increasingly important to investigate the impact of financial innovation on the demand for money, the nature of the relationship, and the stability of the demand for money function in Nigeria. Demand for money is said to be stable when the quantity of money can be predicted accurately by the demand for money function. The implication of this is that a stable demand for money function is crucial for the monetary authority to formulate monetary policy. To this effect, this study attempts to proffer answers to the following fundamental questions: What is the impact of financial innovation on the demand for money in Nigeria? What is the nature of the relationship between financial innovation and the demand for money in Nigeria? Is the demand for money function in Nigeria stable in the face of financial innovation? Accordingly, the primary objectives of this paper are to: (i) investigate the impact of financial innovation on demand for money; (ii) ascertain the nature of the relationship between financial innovation and demand for money and; (iii) determine the stability of the demand for money function in the face of financial innovations in Nigeria. The rest of the paper is structured as follows: section 2 reviews related literature and theoretical issues, section 3 presents the data and methodology. In section 4, empirical results are presented

and analyzed while section 5 summarizes and concludes the paper.

2. Literature Review and Theoretical Framework

2.1. Empirical Literature

2.1.1. Financial Innovation and Demand for Money

The literature on the impact of financial innovation on the demand for money is replete with an avalanche of studies. Hafer and Kutan [14] examined whether financial innovations in the Philippines distorted the long-run relation between real money balances, income, and interest rates. Adopting co-integration and error correction mechanisms and using data for the monetary base, M1, and M3 over the period 1980-1998, the findings revealed that no standard money demand relationship existed among M1, M3, real income, and interest rate. However, when they allowed for the impact of financial innovations, the findings were reversed for M1 indicating that financial innovations impacted real money balances for M1, but not M3.

Attanasio, et al [4] applied the ECM and the ARDL methods in establishing the impact of financial innovation on the demand for money in Sudan and found that there is a negative impact existing between financial innovation and demand for money. The authors stated that the level of adoption and acceptance of financial innovation might have influenced the negative result.

Considering the rate at which financial innovation grows in Sub-Saharan Africa, Dunne and Kasekende [11] investigated its impact on the demand for money for 34 countries using the panel data estimation method. They found that a negative relationship existed between financial innovation and demand for money. The authors' findings also indicated that financial innovation plays an essential role in determining the demand for money in the short run and the long run irrespective of whether the exchange rate is included as a variable or not. The implication of this is that financial innovation is very important as it plays a vital role in explaining the demand for money in Sub-Saharan Africa.

Again, Safdar and Khan [28] evaluated the impact of financial innovation on money demand and analyzed the impact of money market equilibrium the on output gap in Pakistan using co-integration modeling. The results indicated that both the numbers of ATMs and cards are negatively related to the demand for money. The result further revealed that there exists a quantity theory with the inclusion of financial innovation in the money demand function in Pakistan.

Matthew et al. [21] investigated whether financial innovations that occurred in Nigeria after the introduction of the Structural Adjustment Programme had affected the demand for money in Nigeria. Adopting Engle and Granger's Two-Step co-integration techniques, the findings indicated that, though income conforms to a priori expectation by turning out with a positive sign and interest rate had an inverse relationship with demand for real cash balances, financial innovation introduced in Nigeria has not significantly affected the demand for money in Nigeria.

In a related study, Tule and Oduh [34] examined the implications of financial innovation on Nigeria's monetary policy, using trend analysis, error correction mechanism, and structural model estimated with generalized method moments. The study found that financial innovation improves the interest rate channel of monetary policy transmission and the efficiency of the financial system. However, it increases the output gap and adds an element of uncertainty in the monetary policy, and impinges on the potency of the operating target through its impact on the stability of the money multiplier, money velocity, and demand for money.

Furthermore, Apere [3] empirically investigated financial innovation as it relates to money demand in Nigeria from 1981-2016 using the VAR approach. The findings revealed that income and interest rate exert influence on the demand for money, so also, is financial innovation which was statistically significant and negatively related to the demand for money.

While some studies established a negative relationship between financial innovation and demand for money, others found a positive relationship. For example, Mannah-Blankson and Belyne [20] in Ghana found that financial innovation has a positive effect on demand for money using M1 as a dependent variable and applying the OLS and the ARDL methods. But, with the use of M2, their results indicate a negative relationship. Trying to justify their results, the authors claimed that with improved financial innovation in the payments systems, demand for money is likely to be higher for more liquid monetary aggregates compared to the less liquid ones. Similarly, Hye and Adnan [16] conducted a study in Pakistan and applied time series data and a co-integration method. The findings revealed that financial innovation affects demand for money positively in the short and long run respectively.

2.1.2. Stability of Demand for Money Function

Bahmani-Oskooee and Gelan [6] investigated the stability of the M2 demand for money in 21 African countries using quarterly data for the period 1971Q1-2004Q3. A bounds test approach to the co-integration and error correction model (ECM) was used to estimate the stability of the demand for money function in African countries. The results revealed that in almost all the 21 African countries that were empirically studied, there was stability in M2 demand for money. On the basis of that, they recommended that inflation-targeting policies should be implemented while savings interest should be increased so as to induce a savings culture with a view to keeping the demand for money stable.

In another development, Bahmani-Oskooee [5] employed the Auto-regressive Distributed Lag (ARDL) model to investigate the stability of the M2 demand for money function in Japan. The findings showed that not only was M2 co-integrated with income and interest rate, but the estimated relation was also stable. Again, Suliman and Dafaalla [31] carried out an econometric analysis of the demand for money function in Sudan from 1960-2010 with the aim of testing whether a stable money demand function exists in Sudan within the period under study. The money demand function includes variables like real money balances, real GDP (as scale variables), the rate of inflation, and the exchange rate (as opportunity cost of holding money balances variables). Employing co-integration and error correction mechanisms, the study found a long-run relationship between real money balances and the explanatory variables. The result further showed that the money demand function is stable between 1960 and 2010.

Sichei and Kamau [29], in examining the stability of demand for money function for different monetary aggregates in Kenya for the period 1997-2011, used variables such as price, GDP, Treasury bill rate, and nominal deposit rate. The result indicated that the demand for money function was however unstable over the period of study. This suggests that the monetary targeting policy framework that was employed is unsuitable. Similarly, Kiptui [19], attempted to examine the stability of the demand for money in Kenya owing to conflicting results derived from previous studies which have cast doubt on the relevance of monetary targeting. Bounds testing and error correction techniques were adopted in the analysis. The findings revealed that demand for broad money aggregate was stable and that income elasticity estimates derived from the empirical result, fall within the range expected in the Baumol-Tobin framework while interest rate (Treasury bill rate) elasticity is in the expected range of -0.1 to -0.5.

Akinlo [2] while testing for the stability of demand for money in Nigeria used the ARDL approach with CUSUM and CUSUMSQ tests. The results showed that income, interest, and exchange rate are co-integrated with M2. The results further showed that a stable demand for money function exists. This implies that the quantity demanded of money can be predicted accurately by the demand for money function.

In Nigeria, the earliest attempt to investigate the determinants of demand for money and the stability of the money demand function as well as providing a better definition of money in the Nigerian context occurred in the 1970s, pioneered by Tomori [33]. The conclusions reached by Tomori [33] were: income is a significant variable explaining variations in the demand for money; income is a more significant determinant of demand for money than interest rate; the narrow definition of money (M1) seems to perform better than the broad definition (M2); coefficient of interest rate is not statistically significant; and real income tends to show a more significant relationship with the demand for money than nominal income. Tomori's study triggered heated reactions among some economists at the time, in what has come to be known in the economic literature in Nigeria as the "TATOO" debate. The scholars involved in the debate were: Tomori, Ajayi, Teriba, Ojo, and Odama. "TATOO" is an acronym coined from their initials.

Ojo [26] attacked the conclusions drawn by Tomori [33] on the basis of statistical methodology. Odama [25] also vehemently criticized Tomori's work, maintaining that the model specified was inappropriate for policy formulation; that there was a need for the formulation of an alternative model relevant for policy action. To Teriba [32], Tomori's study was plagued with many methodological shortcomings and interpretational defects. Ajayi [1] also made a critical evaluation of Tomori's study while attempting to proffer solutions to some of the contentious issues like the stability of the demand for money function, adjustment mechanism, and calculation of elasticity for policy decision making, using a narrow definition of money (M1). The "TATOO" debate however said nothing about financial innovation involving the use of new technologies in the financial system, thus creating a research gap in the literature that subsequent studies including this paper have attempted to fill.

2.1.3. Measurement of Financial Innovation and Demand for Money

Different measures have been employed in studies carried out by different researchers in developed and developing countries for measuring financial innovation. Examples of such proxies are ATM concentration, volumes of cash transfer through ATM, the ratio of broad definition of money to narrow definition (M2/M1), private sector credit growth rate, and dummy variables. (Attanasio et al., [4]; Mannah-Blankson & Belyne [20]; Fischer, [13]; Hye & Adnan, [16]; Matthew et al., [21]). Other proxies are, bank concentration (measured as the ratio of the number of banks to the total population), the growth rate of credit to the private sector as a percentage of GDP (Nagayasu, [23]; Michalopoulos, et al., [22]). On the other hand, demand for money has been measured using different monetary aggregates such as the narrow definition of money (M1), the broad definition of money (M2), and the broadest definition of money (M3) (Tomori, [33]; Harb, [15]; Bashier and Dahlan [7]; Shahid, Umbreen and Mamoon, [30]).

2.1.4. Research Gap

The various proxies of financial innovation used by researchers as stated above underscore the difficulty in choosing appropriate measures for financial innovation. This study however departs from previous studies by using the value of electronic payment transactions disaggregated into different channels such as Automated Teller machine (ATM), Point of Sale (POS), Web Banking (WEB), and Mobile Banking (MOB) as proxies of financial innovation; and broad monetary aggregate (M2) as a measure of

demand for money. The choice of these proxies is informed by the fact that the value of electronic payment transactions represents a direct measure of financial innovation which increases the efficiency of the financial system and significantly reduces the level of instability in demand for money. The disaggregation of financial innovation into various e-payment channels which has never been done by previous studies is aimed at examining the specific impact of each proxy of financial innovation on demand for money. In addition to the use of a disaggregated measure of financial innovation, the paper investigated the nature of the relationship between financial innovation and demand for money which to the best of our knowledge has also never been examined by previous studies in Nigeria. This constitutes the novelty of this paper, to provide further empirical insights into the unresolved debate of demand for money in Nigeria.

2.2. Theoretical Framework

Several theories that explain the relationship between financial innovation and demand for money have been developed over time by economists. The demand for money per se, arises from two important functions of money, viz: the medium of exchange function and the store of value function. In this regard, economic agents wish to hold money partly in cash and partly in the form of assets. The theories relevant to offer a plausible explanation to the relationship between financial innovation and demand for money in the Nigerian context are Keynesian liquidity theory and the financial innovation-demand for money theory. The Keynesian liquidity preference theory was propounded by John Maynard Keynes in 1936 and was contained in his celebrated book, "The General Theory of Employment, Interest and Money". According to this theory, demand for money arises out of its liquidity, and there are three motives why individuals demand money. These motives are transaction, precautionary and speculative motives. Transaction motive arises out of the medium of exchange function of money to bridge the gap between periodic receipts and payments. It is an increasing function of income as it varies in direct proportion to changes in money income. Given the society's basic institutional and technical customs and practices which govern income receipts and the flow of expenditures, the transaction's demand for money depends on personal income and business turnover. It is borne out of "the need of cash for the current transactions of personal and business exchange" [18]. Thus the main determinant of transaction demand for money is income. The transaction demand for money is modeled as:

$$L1 = k(Y) \quad (1)$$

Where L_1 = Transaction demand for money, $_K$ = the proportion of money held as transaction balances, and Y = money income. Precautionary motive arises out of unforeseen circumstances or expectations regarding the uncertain future by economic agents. It is also dependent on the level of income and is associated with the level of uncertainty. Economic agents keep cash in reserve to meet unexpected needs. Keynes posited that households sometimes keep the money for unexpected contingencies such as medical emergencies, repairs, and maintenance purposes, etc., while firms hold balances above transaction balances based on expectations about the economy e.g. a boom or depression. Similarly, businessmen keep cash in reserve to stem the tides of unfavourable conditions or to gain from unexpected deals. The precautionary demand for money just like the transaction demand for money is expressed symbolically as:

$$L2=f(Y) \quad (2)$$

Where:
L_2 = precautionary demand for money, and Y = money income. Speculative motive emanates from the store of value function of money. Individuals may choose to hold either money or bonds. This however falls under the idle balances held by economic agents according to Keynes [18]. He posited that people hold or hoard money with the hope that they would be able to make a profit by envisaging that the prices of bond would increase as against the amount they bought it initially. They however have the knowledge that there is an inverse relationship existing between the prices of the bond and the interest rate. This thus makes them hoard money to be able to buy bonds at a cheaper price and sell them when the price rises, thus earning interest on the money. This implies that bonds with low prices reveal high-interest rates and bonds with high prices show low-interest rates. Symbolically, this is expressed as:

$$V = R/r \quad (3)$$

where V = current market value of bond, R = annual return on bond and r = market rate of interest. Keynes stated that the speculative demand for money is determined by the changes in the prices of bonds or the interest rate in the current market. To this end, Keynes concluded that the speculative demand for money is a decreasing function of interest rate. The higher the rate of interest the lower the speculative demand for money and vice versa. Thus Keynes's speculative demand for money can be expressed as:

$$L3 = f(r) \quad (4)$$

Where:
L_3 = speculative demand for money, r = interest rate.
According to Keynes, money held for transactions and precautionary motives is primarily a function of the level of income (Y). Therefore $L_1 + L_2 = f(Y)$, and the speculative demand for money is a function of the rate of interest (r) i.e. $L_3 = f(r)$. Thus the total demand for money (L) is a function of both income and interest rate [17]. This is expressed as:

$$L = f(Y, r) \quad (5)$$

Where:

L = total demand for money.

Another theory relevant to this study is the financial innovation demand for money hypothesis as propounded by Finnerty and Emery [12]. According to this hypothesis, financial innovation usually results in the emergence of new financial technologies which promote the productivity of capital, reduce transaction costs, and hence stimulate higher levels of economic development. In this respect, financial innovation can be measured by way of the emergence of sophisticated payment channels such as Inter-bank transfers, ATMs, Mobile Banking, Internet Banking, POS, and Automated Cheques Clearing Systems (ACCS).

3. Data and Methodology

This study employed a quasi-experimental research design. This design is used to establish the fundamental relationship between the dependent variable and the independent variables in such a way that the researcher cannot manipulate the outcome of the results since the events are antecedent to the investigation. Specifically, the paper made use of Auto-Regressive Distributed Lag (ARDL) bounds test and Error Correction mechanisms (ECM) to test for co-integration and estimate the short-run and long run models respectively. ARDL model is considered appropriate for the analysis of long-run relationships in time series data with mixed order of integration and is a robust technique in analyzing small sample sizes. CUSUM and CUSUM square diagnostic test which analyze the stability of coefficients in a multiple regression model is also used in this paper since one of the specific objectives of the paper is to test for the stability of the money demand function in Nigeria. Before estimating the ARDL model, some pre-estimation tests like unit root and causality tests were conducted.

3.1. Model Specification

The model specified for this paper is eclectic, anchoring on the Keynesian liquidity preference theory and the financial innovation demand for money hypothesis. According to the Keynesian liquidity preference theory, Liquidity preference or demand for money *(L)* is a function of income and interest rate as expressed in (5) above. If equation (5) is augmented to include other variables like nominal exchange rate (NER) and inflation (INF) as contained in the existing literature on demand for money, (5) is re-specified as follows:

$$L = f(Y, r, NER, INF) \quad (6)$$

The inclusion of the exchange rate is necessitated by the fact that changes in the exchange rate will affect the demand for money either positively or negatively depending on whether it is depreciation or appreciation. Inflation also has an impact on the demand for money since rising prices require more monetary holdings for a given quantity of goods and vice versa. Equation (6) is further modified to include other variables as specified by the financial innovation-demand for money hypothesis like the value of electronic (E) payment channels such as Automated Teller Machine (ATM), Point of Sale terminal (POS), Mobile Banking (MOB), and Web Banking (WEB) as specified in (7).

$$L = f(Y, r, NER, INF, ATM, POS, MOB, WEB) \quad (7)$$

From equation (7), income *(Y)* is defined as Gross Domestic Product (GDP) and interest rate *(r)* as the Treasury bill rate (RTB). Treasury bill is used as a proxy for interest rate because when the rate is high people will prefer to hold and keep government bonds and promissory notes rather than cash which invariably affects demand for money. Given that in equilibrium, Money Supply *(Ms)* = Money Demand *(Md)*, broad Monetary aggregate (M2) is used as a proxy for demand for money *(Md)*. Therefore in this context, *Md = L = M*. With the modification of (7), the equation to be estimated with financial innovation variables is specified as follows:

$$M = f(GDP, RTB, NER, INF, ATM, POS, MOB, WEB) \quad (8)$$

Where:
M = Broad monetary Aggregate (M2) in millions of Naira
GDP = Gross Domestic Production in millions of Naira representing income
RTB = Treasury Bill Rate in percentage
NER = Nominal Exchange Rate in percentage
INF = Inflation Rate in percentage
ATM = Automated Teller Machine value in billions of naira
POS = Point of Sale value in billions of naira
MOB = Mobile Banking value in billions of naira
WEB = Web Banking value in billions of naira.

Equation (8) is further transformed into an econometric form by including the stochastic error term and expressed in log linear form as follows:

$$\ln M_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 RTB + \beta_3 INF + \beta_4 NER_t + \beta_5 \ln ATM_t + \beta_6 \ln POS_t + \beta_7 \ln MOB_t + \beta_8 \ln WEB_t + \varepsilon_t \quad (9)$$

Where:
ln = Natural logarithm
ε= Stochastic error term, and other variables as previously defined in (8). The a priori expectations of the coefficients of the model are as follows: $\beta_1, \beta_3 > 0$; $\beta_2, \beta_5, \beta_6, \beta_7, \beta_8 < 0$ and $\beta_4 >< 0$.

For purposes of comparison, in order to show the impact of financial innovation on the demand for money, (9) was initially estimated without proxies of financial innovation as specified in (10) below and then re-estimated with the financial innovation variables as earlier specified in (9).

$$\ln M_t = \beta_0 + \beta_1 \ln GDP_t + \beta_2 RTB + \beta_3 NER_t + \beta_4 INF_t + \varepsilon_t \quad (10)$$

If it is established that a long- run relationship exists among the variables, the nature of causation in the relationship is examined, in order to know whether it is unidirectional or bi-directional, using the Granger causality test as specified in (11) below:

$$Y_t = \alpha_{10} + \sum_{j=1}^{k} \alpha_{1j} Y_{t-j} + \sum_{j=1}^{k} \beta_{1j} X_{t-j} + U_{1t}$$
$$X_t = \beta_{20} + \sum_{j=1}^{k} \alpha_{2j} X_{t-j} + \sum_{j=1}^{k} \beta_{2j} Y_{t-j} + U_{2t} \quad (11)$$

Where: Y_t is the dependent variable and X_t is the explanatory variable and U_{1t} is a zero mean white noise error term in the first Granger causality equation, while X_t is the dependent variable and Y_t is the explanatory variable and U_{2t} is a zero mean white noise error term in the second Granger causality equation.

4. Results and Discussion of Findings

4.1. Unit Root Test Result

The pre-estimation unit root test result is presented in table 1 panel A and B using the augmented Dickey-Fuller (ADF) and Phillips-Peron techniques. The unit root test was conducted to determine the stationarity properties of the data series used in the model. It is important to carry out this test because running a regression analysis on variables which are not stationary can give spurious results. The result as presented in table 4.1panel A, showed that GDP, NER, POS, and WEB, were stationary at level while M, RTB, INF, ATM and MOB were stationary at first difference, resulting in different order of integration. The Phillips-Peron unit root test presented in table 4.1panel B further confirmed the different order of integration of the variables. While some variables were integrated at level, others were integrated at first difference.

4.2. Co-integration Test

From the unit root results, the variables were integrated of different order, i.e. I(0) and I(1). Given the different order of integration, the paper adopted the ARDL technique of estimation which is most appropriate when the order of integration is I(0) and I(1) to determine the existence of a long run relationship among the variables in the series. As seen from the result in table 2, the calculated F-statistic with the value of 4.052537 is greater than upper bound critical value of 3.39 at 5% level of significance. This implies that the null hypothesis of no co-integration is rejected while the alternative hypothesis is accepted. Thus there is the existence of a long- run relationship among the variables.

Table 1. Unit Root Test Result

Augmented Dickey-Fuller (ADF) panel A				**Phillips-Peron (PP) panel B**			
Variables	Level	1st Difference	Order of Integration	Variables	Level	1st Difference	Order of Integration
M	-0.809290	-5.221555	I(1)	M	-3.185003	---	I(0)
GDP	-4.179011	---	I(0)	GDP	-4.690150	---	I(0)
RTB	-1.745916	-4.601700	I(1)	RTB	-1.651811	-4.603123	I(1)
NER	-3.203246	--	I(0)	NER	-0.982263	-5.354634	I(1)
INF	-0.477821	-3.944536	I(1)	INF	-0.495567	-3.822786	I(1)
ATM	-0.557024	-5.404457	I(1)	ATM	-0.540725	-5.401822	I(1)
POS	-7.637431	---	I(0)	POS	-6.996740	---	I(0)
MOB	-0.057276	-5.262219	I(1)	MOB	-0.381581	-5.918973	I(1)
WEB	-3.077254	---	I(0)	WEB	-8.349167	---	I(0)

ADF Critical Values		PP Critical Values	
Level	1st Difference:	Level	1st Difference
1% = -3.679322	1% = -3.670170	1% = -3.661661	1% = -3.670170
5% = -2.967767	5% = -2.963972	5% = -2.960411	5% = -2.963972
10% = -2.622989	10% = -2.621007	10% = -2.619160	10% = -2.621007

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

Table 2. Co-integration result

ARDL Bounds Test		
Test Statistic	Value	K
F-statistic	4.052537	8
Critical Value Bounds		
Significance	I(0) Bound	I(1) Bound
10%	1.95	3.06
5%	2.22	3.39
2.5%	2.48	3.7
1%	2.79	4.1

Lower Bound @ 5% = 2.22

Upper Bound @ 5% = 3.39

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

4.3. Granger Causality Test

Having established that a long- run relationship exists among the variables, the Granger causality test was conducted in order to determine the direction of causality in the relationship between financial innovation and demand for money. The result obtained as presented in table 3, shows that there is a unidirectional causality between ATM and demand for money (M) with causality running from demand for money to ATM. The result also reveals that demand for money Granger causes POS but POS does not Granger- cause demand for money, indicating a one way or unidirectional causation. Furthermore, a unidirectional causality also exists between demand for money (M) and MOB with causality running from demand for money to MOB. The probability values of WEB and demand for money (M) indicate that no causal relationship exists between WEB and demand for money (M) as they were not statistically significant at the 5% level. Thus we accept the null hypothesis that WEB does not Granger-cause demand for money (M) and demand for money does not Granger- cause WEB.

Table 3. Pairwise Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
ATM does not Granger Cause M	46	1.16742	0.3276
M does not Granger Cause ATM		3.71082	0.0388
POS does not Granger Cause M	46	0.20202	0.8184
M does not Granger Cause POS		3.54233	0.0442
MOB does not Granger Cause M	46	2.23066	0.1284
M does not Granger Cause MOB		3.92793	0.0329
WEB does not Granger Cause M	46	1.42787	0.2587
M does not Granger Cause WEB		1.54952	0.2321
GDP does not Granger Cause M	46	0.07931	0.9240
M does not Granger Cause GDP		1.02343	0.3739
RTB does not Granger Cause M	46	0.10982	0.8964
M does not Granger Cause RTB		0.56997	0.5727
NER does not Granger Cause M	46	0.41054	0.6677
M does not Granger Cause NER		2.23786	0.1276
INF does not Granger Cause M	46	0.40029	0.6880
M does not Granger Cause INF		2.62106	0.1396

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

4.4. ARDL Long Run Estimated Result Analysis

For purposes of comparison, first, we estimated the ARDL long- run model without proxies of financial innovation (value of e-Payment Transactions), as presented in table 4a, thereafter, we included the proxies of financial innovation in the ARDL long- run model and the result is presented in table 4.4b. The result of table 4.4a without financial innovation (e-Payment Transaction Channels) showed that all the explanatory variables turned out with a positive sign. This implies that they are positively related to demand for money (M). While Gross Domestic Product (GDP) and Inflation Rate (INF) were consistent with a priori expectation, Treasury bill rate (RTB) and Nominal Exchange Rate (NER) were not. An increase (appreciation) in the exchange rate means the domestic currency is strong relative to the foreign currency and therefore it can buy more of the foreign currency than its equivalent. This implies that less money will be demanded for foreign transactions since the foreign currency is relatively weak. Theoretically, the exchange rate is expected to be negatively related to the demand for money. In the same vein, a rise in the Treasury bill rate (a proxy for interest rate) will lead to a fall in the demand for money, hence Treasury bill rate is expected to be negatively related to the demand for money. A one percent increase in income (GDP) leads to an increase in demand for money by 0.039889 percent. Similarly, a one percent increase in the inflation rate (INF) leads to a 0.002765 percent increase in demand for money. A one percent increase (appreciation) in the nominal exchange rate (NER) leads to a 0.000299 percent increase in demand for money which is not consistent with a priori expectation. A one percent increase in Treasury bill rate leads to 0.001572 percent increase in demand for money. This also does not conform to a priori expectation. Even though some of the variables were consistent with a priori expectation, all the variables were not statistically significant in the long run except GDP.

Table 4a. ARDL long run estimated Result without Financial Innovation

Dependent Variable: LOGM

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(GDP)	0.039889	0.011863	3.362563	0.0028
RTB	0.001572	0.001586	0.991123	0.3324
NER	0.000299	0.000977	0.305633	0.7628
INF	0.002765	0.002411	0.422187	0.2231
C	15.46816	0.253332	61.05893	0.0000

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

Table 4b. ARDL long run estimated Result with Financial Innovation

Dependent Variable: LOGM

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(GDP)	0.081587	0.015446	5.282090	0.0000
RTB	-0.006670	0.002151	-3.100990	0.0045
NER	-0.001838	0.001592	-1.154885	0.2583
INF	0.047631	0.035523	2.755623	0.0211
LOG(ATM)	0.044790	0.034411	1.301609	0.2065
LOG(POS)	0.157884	0.039796	3.967336	0.0007
LOG(MOB)	-0.071677	0.028918	-2.478672	0.0213
LOG(WEB)	0.079616	0.035143	2.265477	0.0337
C	13.81172	0.426367	32.39400	0.0000

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

When proxies of financial innovation were included in the model as presented in table 4b, there was significant improvement in the results as income (GDP), Treasury bill rate (RTB), nominal exchange rate (NER) and inflation (INF) conformed to a priori expectation and were statistically significant with the exception of nominal exchange rate. The proxies of financial innovation, ATM, POS, and WEB were all positively related to demand for money (M) in the long run while MOB exhibited a negative long- run relationship with demand for money (M). Table 4b further revealed that while MOB, POS, and WEB were statistically significant, ATM was not. The result in table 4.4b shows that the inclusion of financial innovation proxies to the ARDL long run model, has more effects and impacts on demand for money than when they were excluded.

4.5. ARDL Short Run Error Correction Model (ECM) Analysis

The result of the short run error correction model is presented in table 4.5. From the result, the error correction term conformed to a priori expectation with a negative sign and is statistically significant. The result further showed that the speed of adjustment to the long run equilibrium path is fast, as about 85 percent of the disequilibrium errors which occurred in the previous period were corrected in the current period. It again revealed that a positive relationship exists between Gross Domestic Product (GDP), proxy for income and demand for money. This satisfies theoretical expectation. Thus implying that a one percent increase in GDP will cause an increase in demand for money by 0.047277 percent. GDP is also statistically significant. From the result, income is a significant variable influencing demand for money in Nigeria in the short run. The coefficient of Treasury bill rate (RTB), proxy for interest rate is negative as posited by economic theory and is also statistically significant at the 5 percent level. The result indicated that a one percent increase in Treasury bill

rate will cause a decrease in demand for money by 0.001164 percent. The coefficient of nominal exchange rate (NER) is negative, consistent with a priori expectation, but not statistically significant. Thus a one percent increase (appreciation) in exchange rate, will cause a 0.001502 percentage decrease in the demand for money. However, from the result, nominal exchange rate does not have a significant effect on demand for money in Nigeria. Inflation (INF) exhibited a positive relationship with demand for money. A percentage increase in inflation will cause a 0.041004 increase in demand for money as the value of money falls during inflationary period, more units of money will be demanded for transaction purposes. For example, more money may be required to purchase a given quantity of goods in an inflationary period than in a non-inflationary period.

One-period lagged coefficients of the proxies of financial innovation such as ATM, POS and WEB turned out with a positive sign and are all statistically significant. Thus a one percent increase in ATM, POS and WEB will cause demand for money to increase by 0.066501, 0.111215, and 0.031850 percent respectively. The positive signs of these variables are not in conformity with a priori expectation but the result corroborates the findings of Mannah-Blankson and Belyne [20] and Hye and Adnan [16] who found a positive relationship between financial innovation and demand for money in Ghana and Pakistan respectively. The coefficient of Mobile Banking (MOB) is negative, consistent with theory and statistically significant. Implying that a one percent increase in MOB will cause demand for money to decrease by 0.036183 percent.

The adjusted R-squared with a value of 0.994596, revealed that in the short run, the explanatory variables explained about 99.5 percent of variation in the dependent variable while the F-statistic with a value of 714.2468 showed that the overall ARDL short run model is statistically significant. The Durbin-Watson statistic with a value of 1.646475 indicates that autocorrelation does not exist in the model therefore the results of the model are reliable and can be used in policy formulation in Nigeria.

Table 5. Parsimonious Short Run Error Correction (ECM) Result

Dependent Variable: LOG(M)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(GDP)	0.047277	0.003742	12.63464	0.0000
DRTB	-0.001164	0.000548	-2.124205	0.0446
DNER	-0.001502	0.001016	-1.479237	0.1526
DINF	0.041004	0.014223	3.273411	0.0029
LOG(ATM(-1))	0.066501	0.012896	5.156571	0.0000
LOG(POS(-1))	0.111215	0.015210	7.312062	0.0000
LOG(MOB(-1))	-0.036183	0.010884	-3.324362	0.0030
LOG(WEB(-1))	0.031850	0.014471	2.900942	0.0380
ECM(-1)	-0.850488	0.064315	-15.54856	0.0000
C	14.01273	0.156117	89.75818	0.0000
R-squared	0.995991	Mean dependent var		17.57506
Adjusted R-squared	0.994596	S.D. dependent var		0.265821
S.E. of regression	0.019540	Akaike info criterion		-4.800429
Sum squared resid	0.008782	Schwarz criterion		-4.388190
Log likelihood	85.80686	Hannan-Quinn criter.		-4.663783
F-statistic	714.2468	Durbin-Watson stat		1.646475
Prob(F-statistic)	0.000000			

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

4.6. Post Estimation Diagnostic Tests of Residuals

4.6.1. Breusch-Godfrey Serial Correlation LM Test

The results of the Breusch-Godfrey serial correlation LM test presented in table 4.6 indicated absence of serial or auto-correlation in the ARDL model since the calculated F-statistic of 8.624222 has a probability value of 0.1134 which is greater than 0.05 (5%) level of significance. This confirms the reliability of the estimates of the model.

Table 6. Breusch-Godfrey Serial Correlation LM Test

F-statistic	8.624222	Prob. F (2,12)	0.113
Obs. R-squared	10.04141	Prob. Chi-Square(2)	0.3366

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

4.6.2. Breusch-Pagan-Godfrey Heteroskedasticity Test

Again, The Breusch-Pagan-Godfrey heteroskedasticity test statistic coefficient of 0.401303 with its probability value of 0.9619 showed that the residuals have constant variance and hence there is no problem of heteroskedasticity in the model. This is further confirmed by the observed Chi-squared probability value of 0.8821 which is greater than the 5 percent significance level (table 4.7).

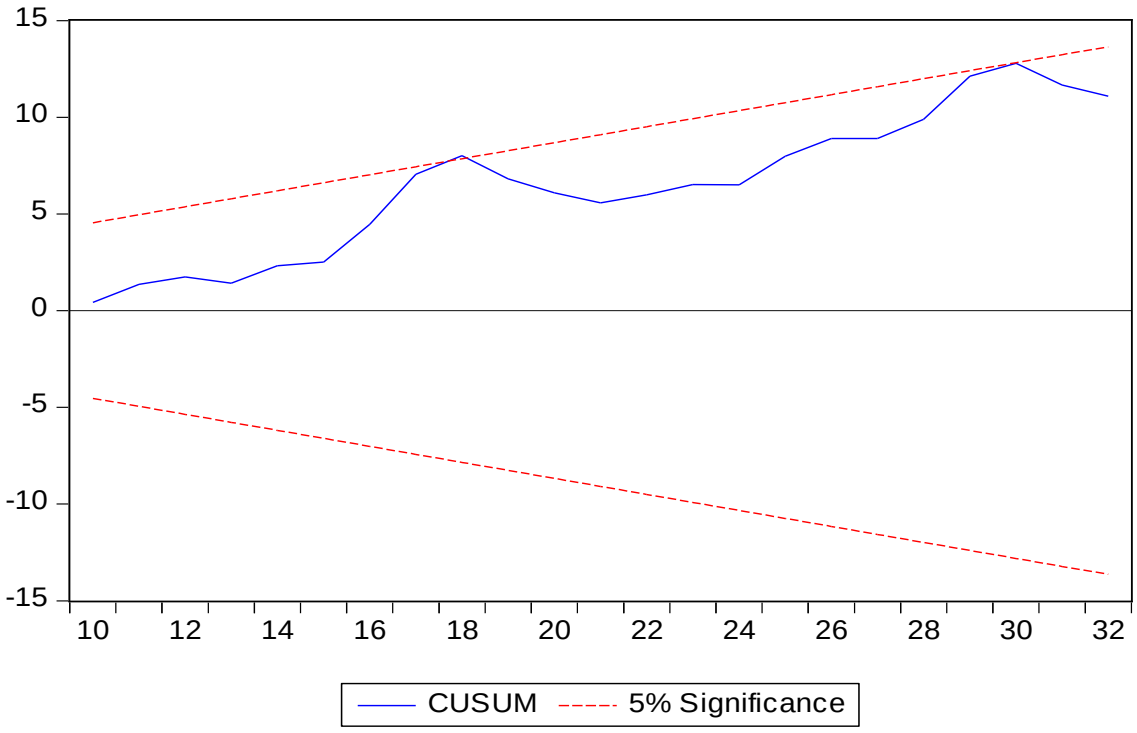
Table 7. Breusch-Pagan-Godfrey Heteroskedasticity Test

F-statistic	0.401303	Prob. F(17,14)	0.9619
Obs. R-squared	10.48445	Prob. Chi-Square(17)	0.8821

Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

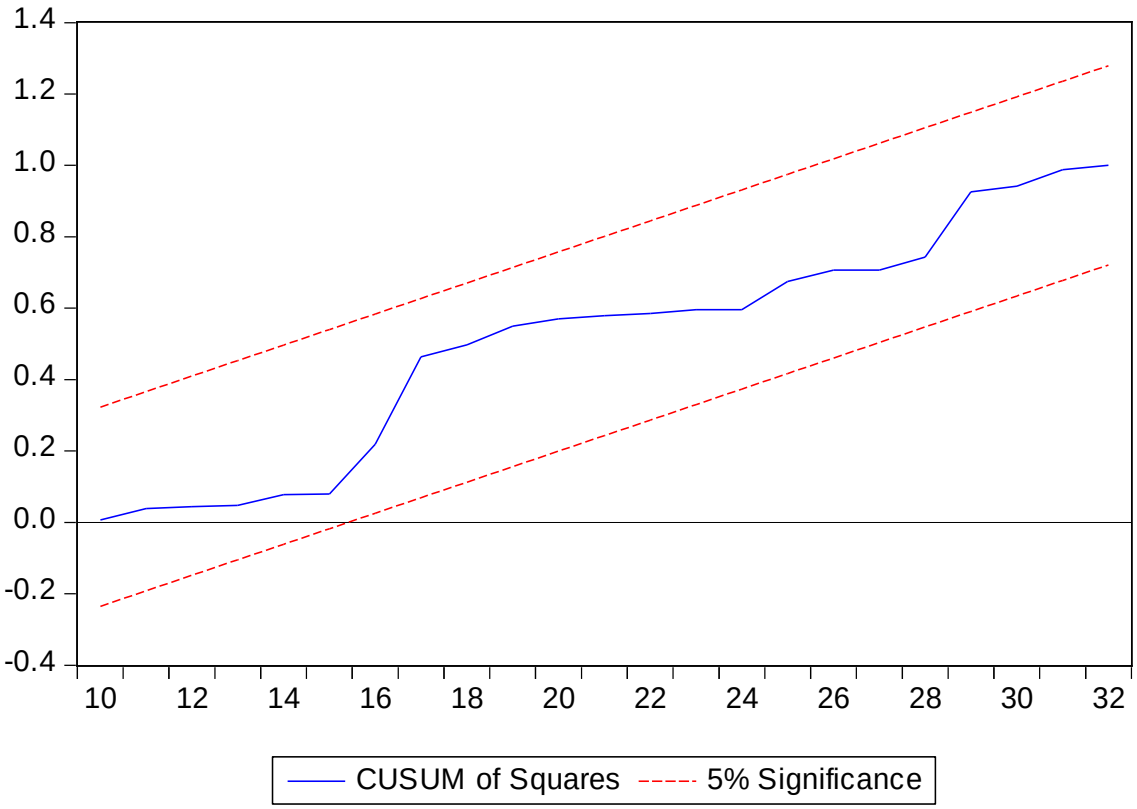
4.6.3. Stability Test Analysis

To determine the stability of the demand for money function in Nigeria, the paper applied the Cumulative Sum (CUSUM) and the Cumulative Sum of Squares (CUSUMSq) tests. The results of the stability tests are presented in figures 4.1a and 4.1b. From the results, both the CUSUM and CUSUMSq statistics fall within the critical bound of ± 5 percent level of significance. This implies that the money demand function in Nigeria is stable within the period of investigation.



Source: Author's computation using Central Bank of Nigeria (CBN) [10] data.

Figure 1a. Stability Test: Cumulative sum (CUSUM)



Source: Authors' computation using Central Bank of Nigeria (CBN) [10] data.

Figure 1b. Stability Test: Cumulative sum of Squares (CUSUM of Squares)

4.7. Discussion of Findings

From the analysis of the empirical results, a long- run relationship was established between financial innovation and demand for money. A unidirectional causal relationship was also found to be the nature of the relationship, with causality running from demand for money to the proxies of financial innovation. In other words, demand for money Granger causes financial innovation. This can be attributed largely to the fact that Nigeria is still a predominantly cash-based economy despite the introduction of a cashless policy. The desire to make cash withdrawals for cash transactions and other motives necessitated massive patronage of the various e-payment channels (ATM, POS, etc.) used as proxies of financial innovation and which accounted for their growth. There was, however, no causal relationship between demand for money and WEB (internet banking). This may be attributed to computer illiteracy or non-ICT compliance of some people in Nigeria, especially the older generation.

It was also found that most of the proxies of financial innovation like ATM, POS, and WEB were positively related to the demand for money in Nigeria both in the long run and short run, and were statistically significant variables influencing demand for money. However, ATM was not statistically significant in the long run and MOB was found to be negatively related to demand for money and in line with theoretical expectation. The findings of this paper are consistent with the findings of Mannah-Blankson and Belyne [20], Hye and Adnan [16] who found that financial innovation has a positive impact on demand for money. The positive impact of financial innovation (ATM, POS and WEB) on demand for money in Nigeria may be attributed to the fact that the Nigerian economy is still largely cash based in which the e-payment channels provided avenues for cash withdrawal for cash transactions. As e-payment channels increase, they facilitate increase in demand for money, notwithstanding digital payment system introduced by the cashless policy.

The impact of financial innovation on the demand for in Nigeria was visibly seen when the long- run ARDL model was first estimated without financial innovation. None of the variables was statistically significant apart from income (GDP). But when proxies of financial innovation were included in the model, the findings were reversed. Income, Treasury bill rate, inflation, POS, MOB and WEB impacted significantly demand for money. This is consistent with the findings of Hafer and Kutan [14] in Philippines whose estimated model without financial innovation showed that no standard money demand relationship existed among M1, M3, real income and interest rate. However, when they allowed for the impact of financial innovations, the findings were reversed, indicating that financial innovations impacted real money balances.

From the result also, MOB was found to have a negative impact on demand for money and is consistent with theory. Though it used to be one of the least used payment channels between 2009 and 2012. But as innovations increased in the mobile telecommunication sector, its use as a payment channel has increased tremendously. Customers are alerted immediately a transaction takes place in their account via their mobile phones. Thus, the confidence attached to the use of MOB encourages customers to make payments, and transfers, and easily check their account details on their cell phones and hence hold less cash.

Finally, in terms of the stability of the money demand function, the empirical results indicated that the demand for money function is stable in Nigeria in the face of financial innovation from the period 2009q1-2020q4. This is shown by CUSUM and CUSUM of squares statistics that fell within the critical bounds of ± 5 percent level of significance. This is consistent with the findings of Bahmani-Oskooee [5]; Akinlo [2]; Bahmani-Oskooee and Gelan [6]; and Kiptui [19].

5. Conclusions

The paper has attempted to examine whether a long-run relationship existed between financial innovation and demand for money, the direction of the relationship, and the impact of financial innovation on demand for money as well as the stability of demand for money function in Nigeria. An exploration of the extant literature revealed mixed results. While some studies maintained that financial innovation impacted demand for money negatively, others established a positive impact. The findings of this paper established the existence of a long-run relationship between financial innovation and demand for money while the direction of causality in the relationship is unidirectional, running from demand for money to financial innovation. The results further established a positive impact of financial innovation on demand for money and a stable demand for money function in Nigeria.

The essence of financial innovation is to ensure efficient payment system, so that financial transactions are carried out faster, easier, cheaper and safer. This in turn will enhance the global competitiveness of the economy and facilitate rapid economic growth and development. In this regard, the paper proffers the following recommendations:

- The limit of daily cash withdrawals from the different e-payment channels (ATM, POS, etc.) should be reduced while cashless transactions should be encouraged and done without limit with a view to shifting the economy from a cash based economy to a cashless one; since the positive impact of financial innovation on demand for money from the empirical findings is a reflection of a cash driven economy.
- The use of mobile banking (MOB) payment channel via mobile phones should be encouraged. This payment channel allows business partners to be alerted immediately a transaction takes place in their accounts through their mobile phones. As shown by the findings of the disaggregated impact of financial innovation on the demand for money, MOB performed better and impacted negatively and significantly on the demand for money which is consistent with theory, with the propensity of making the economy cashless driven.
- More financial innovation should be encouraged in the Nigerian financial system to sustain the stability in the demand for money function.
- In the management of demand for money to achieve specific policy objectives, the government should ensure that economic fundamentals such as income (GDP), interest rate, and inflation rate are moving in the right direction; since they are significant determinants of demand for money in Nigeria.

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