THE EFFECT OF DIGITAL FINANCIAL INNOVATION ON FINANCIAL DEEPENING AND ECONOMIC GROWTH IN NIGERIA

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Abstract

This study examines the effects of digital financial innovations on financial deepening and real growth in Nigeria. There have been measures aimed at enhancing financial inclusion via financial deepening. The data explored in the study spanned between the period 2009 to 2022 obtained from CBN bulletin, Annual economic report and the World Bank report. The study adopts the Auto regression models. The ARDL is considered appropriate in the study giving that the time series data utilized exhibits different cointegration order. The bounds cointegration test was also conducted for evidence of long-run equilibrium relationship among the studies variables. Post-estimation (diagnostics) was conducted to confirm the validity, reliability etc. of the models. Findings suggests that digital financial innovations affect financial deepening and real growth in Nigeria in both short and long run with varying degrees of impacts, greater positive and significant impact was found to come from ATM and POS on broad money supply, credit to Private Sector, Deposit to ratio, loan to deposit ratio and RGDP. The study therefore, proposed among others the need for both banks and the CBN to re-strategize and aggressively invest in digital finance as it enhances financial inclusion and narrow financial exclusion.

Keywords: Digital finance, financial inclusion, exclusion deepening, innovations, digital financial service providers, real growth etc.

Introduction

Financial inclusion is one of the development agenda globally and even at National levels. Among developing countries, financial exclusion still remain a major challenge and Nigeria is not exempted. The problem of financial exclusion is more acute in developing countries where more than half of the adult population are unbanked creating financial inclusion access gap (Enebeli-Uzor, 2023). Financial exclusion is a symptom of poverty and inclusive finance. Both financial innovation and financial deepening are correlates that are design to narrow financial exclusion gap. According to the Okoduwa (2020) financial inclusion defines the provision of useful, relevant, and affordable financial services to individuals and SMEs. The report of World Bank (2024) shows that financial exclusion rate in Africa stood at 50% continental and the Sub-Sahara Africa 49% respectively between 2021 and 2022. In Nigeria, financial inclusion rate is still low despite CBN targets of 95% by the end of 2024. As at March this year, the rate stood at 74%. The CBN in a bid to accelerate financial inclusion and deepening in the country rolled out a number of measures since 2012 such as launched of the National Financial Inclusion Strategy (NFIS), establishment of a distinct secretariat saddled with the responsibility of coordinating the stakeholders towards the implementation and gathering of data and the setting up of the steering and technical committee of financial inclusion agenda. The revised framework on quick response code payments, the exposure draft on operationability guidelines for open banking and contactless payments, the operationalization of the regulatory sandbox open to innovators and still to upscale financial inclusion licensed new payment service banks (PSBs) and mobile money operators (MMOs) amongst others.

Financial innovation seeks to broaden the delivery of financial services through innovative products, services, or instruments. On the other hand, financial deepening connotes the depth of the financial

services sector. Financial inclusion is the accessibility of adults to formal financial services or needs at affordable cost with little or effortless. Such services include; accounts, credit, insurance payments etc, while financial deepening seek to enhance the social welfare of the people by improving the financial sector, financial markets etc. Serkhar (2018) argued that the use of digital finance arose to bridge financial exclusion gap. Scholarly works has proven that financial innovations in financial services delivery posed significant impact on economic growth and drives financial inclusion. Studies of (Asogwa, et al., 2023, Sahay, et al. 2015, Oziliri, 2018 and Crowley, et al., 2020).

Internationally, relevant stakeholders, international standards setting bodies like the Based Committee on Bank Supervision (BCBS) and the Financial Action Task Force (FATF) are also engaging in financial inclusion agenda orchestrating strategies for the development of financially inclusive ecosystem seeing financial exclusion as a key challenge (Tilman, 2012). Nigeria is the most populous nation in Africa and the 8th in the world with an estimated population of over 200, 000. 000 and the population continues geometrically each year, hence the need to assess the extent to which digital financial innovations affect financial deepening and economic growth in the country.

The Enhancing Financial Inclusion Access (EFInA) to financial services report of 2008 showed that about 45.4% of adults Nigerian representing 52.5% where still financially excluded. This is an indication that about 21.1% of adults are unbanked (EFInA, 2024). However, between 2019 to 2023 the figure has risen tremendously to 64% from 56% in 2020, though still below CBN targets. This increase according to source is attributed to the expansion of the Nigerian Financial ecosystem through CBN deliberate initiatives targeted at deepening and widening financial inclusion and also to consolidate on the gains presented by the Covid-19 Pandemic (Adamgbo, 2024). These steps or approaches was considered desirable among other things, in order to ensure greater security and efficient payment system infrastructure.

According to CBN (2022) financial inclusion is improved through payment system infrastructure following increased enrolment in the Bank Verification Number (BVN) that grew by 91.1% from 51.8 million to 56.5 million as at the end of 2021. Again, the total number of accounts linked with BVN following the opening of new accounts rose from 81.9 in 2021 to 159.4 as at the end of 2022. Also, the revised framework for the quick response code further widened the interoperability options mode for payments which was mainly for merchants now both merchants and other customers. In the area of regulation and supervision, the CBN issues licenses to new Payment Service Providers (PSPs), Payment Service Banks (PSBs), 32, Payment Solution Service Providers (PSSBs) 12, Super Agents 10; Switch and Processing 07, Payment Service Terminals Providers (PSTPs) 14, and Mobile Money Operators (MMOs) one (1). The CBN also licensed three (3) additional cheque printers and five (5) Cheque Management Centre (CMC), with this trend, the total PSPs stood at 132 in 2022 as against 100 in 2021.

Transactions by volume and value facilitated by digital financial innovations between 2021 and 2022 has risen remarkably as well. Going by CBN Economic Report (2022), total volumes and values of e-payment, increased from 16,325.1 million to 22,073.9 million and from N1,150,32 trillion to N1,550,44 trillion respectively. Within the same period the volume and values of cheques transaction is reported to have dropped from 18.25 to 16.91 and N15.61 trillion to N15.25 trillion accordingly. Also, on the development of the financial sector; the total of financial institutions registered on the NCR portal increased from 717 to 744. The breakdown shows; commercial banks 24; MFBs 502; Merchant banks 4; Development Finance Institutions (DFIs) 5; Finance Companies (FC) 55; NBFIs 48; Non interest Financial Institutions (NIFIs) 2; and Primary Mortgage Institutions (PMIs) 4; making a sum total of 744 registered but 142 active financial Institutions (AFIs) as at December 2022 (NCR, 2022). Note, of the Financial Institutions; DMBs 20; MFBs 85; Merchant banks 2; DFIs 2; NBFIs 18; FCs 14; and PMB (1) one. These trends therefore suggest or is an indication that digital financial innovation has improved financial deepening, hence, the concern of this study to investigates the effects of financial innovations on financial deepening and economic growth in Nigeria.

Digital financial innovations such as internet and mobile banking, and P2P lending have shown to improve access to credit and financial services which in turn can spur entrepreneurship job performance and economic growth (Acharya, et al. 2016). CBN strive since 2012 for inclusive finance

to hit 20% in 2020 had since been surpassed. The CBN targets to upscale payments to 70%, savings 60%, credit, insurance and pension to 40% respectively has significantly improved, DMBs branches were to be scaled to 7.6 per 100,000 population, MFBs branches 5.0, ATM 203.6, POS devices 850, Mobile Agents 62.0. the current level of formal financial inclusion as at March, 2024 stood at 64% and now 74%. A further supporting indicator tracking the level of financial exclusion now is 13.6%, while the CBN Governor, Cardoso is still calling for a 95% financial inclusion target by the end of 2024.

Hence, it is worth wise to carry out an investigation of this sort to actually examines the effects of the improved digital financial innovations on financial deepening and economic growth in Nigeria. This had led us to ask the questions; does digital financial innovation (payments) improve (affects) financial deepening in Nigeria? Has the improved digital financial innovation enhanced economic growth in Nigeria? Has digital financial innovation and financial depth enhanced economic growth in Nigeria? This study in order to accomplish it objectives is segmented into nine (9), with the introductory section introducing the problem to be addressed, Background to the study gives insights to development, progress made in the financial sector in addressing the problem. literature review looked at underpinning theories, empirical works in the area of financial innovation, financial deepening and economic growth, the rest of the sections dwell on the methodology applied, results and revelations.

Literature Review

Theoretical Perspective

Access Opportunity Frontier and Access Barrier Theories

The AOFT and ABT developed by Beck and Dela Torre (2006) in Ekong & Ekong (2023) relied on the theory of supply lead and demand in explaining financial inclusion or exclusion hypotheses. According to the Access Opportunity Frontier Theory, financial services delivery, products diversification is bank infrastructure density. The theory suggests that higher cost of financial services reduces financial inclusion or encourages financial exclusion among financial users. Adding that the use and availability of financial services depends on the diversity of the products offered by financial institutions and in this sense, e-products availability and digital currency provides differentiated financial products to aid financial inclusion or reduce financial exclusion.

System Theory of Financial Inclusion (STFI)

The system theory of financial inclusion is a theoretical framework to understand financial inclusion. The theory states that financial inclusion outcomes are achieved through existing sub-systems that require financial inclusion to be attained as a necessary condition before services can be rendered, and that when financial inclusion takes place, it will have a positive effects on the existing sub-systems and the larger economic system, while also meeting the implications of the theory is that existing sub-systems relies on individual or entities to meet its needs, or financial inclusion outcomes (Oziliri, 2024).

Supply-Leading and Demand Following Hypothesis

The supply leading theory is one of the economics theories which states that the economy response to growth in the real sector facilitated by financial development. The theory predicts that financial sector development precedes economic development, stressing that the financial sector supplied the financial need for economic development. While the contrary theory “Demand following theory” developed in 1952 by R.C. Robinson states that financial deepening is dependent on growth that occurs in the economy. The supply-led theory believes that development in the financial sector will lead to economic development. On the other hand, the demand following theory believes that the economy should develop then followed by financial sector development. Notwithstanding the contradictions, both theories are crucial for policy makers to formulate policies for development of the financial sector particularly financial inclusion. Adding that the depth of the financial sector is closely linked to

economy development and it may inspire economic growth if it can transmit financial resources to the economy effectively.

Empirical Investigations

Misati, et al. (2020) examined the impact of digital financial innovation on financial deepening and economic growth in Kenya. Their work utilized the ARDL model in exploring the impact. The results revealed a positive relationship between digital financial innovation and financial depth with the strongest impact coming from internet and mobile financial services while the lowest impact comes from bank branches. The study findings further indicated that the significant impact of financial depth on economic growth was consistent with the supply-led finance theory. Anachedo& Osakwe (2023) investigated the effects of financial deepening on economic growth in Nigeria from the period, 1985 – 2021, using the time series data on GDP while financial deepening indicators include M3/GDP, CPS/GDP, MCAP/GDP and Insurance Premium to GDP sourced from CBN statistical bullion. The data were analyzed using the OLA and Granger-Causality tests. Findings of the study revealed that increase Credit to the Private Sector (CPS) coincided with rising economic growth rate. Also Market Capitalization (MCAP) was fond to have a positive link with economic progress in Nigeria, while both money supply (M3) and insurance premium showed a negative and significant impact on economic growth rate.

Ekong and Ekong (2022) examined digital currency and financial inclusion in Nigeria. The study relied on quarterly data spanning the period, $2006_1$to 2020_4, in a weighted stepwise form and regression, similar to the one used by (Demir et al., 2019, and Aitunibas &Thronton (2019) with some modifications. Their investigations revealed that the use of ATM spontaneously raised financial inclusion, a percentage rise in the use of POS and mobile payments scaled transactions and also raise financial inclusion and therefore concludes that the cumulative positive effects of digital finance on financial inclusion in Nigeria was approximately raised by seven percent.

Asogwa, etal (2023) studied the impacts of innovations in financial service delivery on the macroeconomic Real Gross Domestic Products (RGDP) and real money demand in the Nigerian economy. The study utilized the ARDL to the Fisher's Equation of Exchange, using data on the volumes of transactions via ATM, POS cheque and ETR as financial innovations indices and control over monetary policy rate (MPR) as well as Lending Rate (LR) for the period, $2009m_1$ to $2019m_{12}$. Findings revealed that financial innovations in financial service delivery posed significant impact on real growth (RGDP) and real money demand as proxies for macroeconomic performance with varying directional impacts in the short-term policy framework.

Abili (2020) examined the relationship between financial deepening and socio-economic development in Nigeria. Specifically, ex-raying the impact of broad money supply, private sector credit and financial openness on Human Development Index (HDI) using time series data from 1991 to 2018. The fully Modified Least Squires (MLS) and Granger-Causality tests were conducted. The findings showed that a long-run relationship exists between the variables studied. Broad money (M3) had a negative link with HDI score, while CPS and financial openness presents a positive and significant impact on HDI. From his findings, a unit directional causality runs from M3 and CPS to HDI, and a bidirectional causality exists between financial openness and HDI and a joint causality observed from all the independent variables to HDI.

Enebeli-Uzor&Mulkhtar (2023) studied the "efficiency of digital finance on financial inclusion. The study aim was to explain how to use digital finance to bring those who are unbanked and financially excluded to the formal financial system. The study employed the quantitative approach within the ex-pofacto research design using annual time series data between 2014 to 2020. The estimation was conducted using the ARDL estimator. Findings of the study showed that commercial bank branches and internet access are the strongest drivers of financial inclusion. That a long-run relationship exists between the explanatory variables and significantly affects financial inclusion, while holding that CPs and lending rates are critical factors contributing to financial exclusion.

Okafor, etal (2017) examined the impact of financial innovation on economic growth in Nigeria. The study was tailored to examining the effectiveness of financial innovation on economic growth. Finding revealed that the impact of financial innovations varies with the channels of use. That while the value of transactions using ATM, internet and mobile payments significantly impact growth, POS posted a negative impact. The study utilized the quarterly data from 2009 Q1 to 2014Q4 and employed the vector auto regression model and the Johansen Cointegration test, which revealed further that a long-run link exists between financial innovation technologies and economic growth.

Methodology

The study adopts the Auto regressive distributed lag (ARDL) model, which is considered appropriate over a time series methods. This method allows for application of co-integration to time series with varying integration tests to time series investigation with different orders and flexible to the sample size not large enough or small and finite. This study relied on annual time series data obtained from CBN statistical bulletin, CBN website, NBSS website and the National Bureau of Statistics (NBS). ARDL model is an Ordinary Least Square (OLS) based model which is applicable for both non-stationary time series as well as for times series with mix order of integration. ARDL is the most used econometric method preferable when dealing with time series variables with or may present different order of integration.

Model specification

Theoretically, it is proven that the primary driver of economic growth today is innovation, that is innovative capacity spurs by appropriate knowledge of technology. The advantages of innovation finance in job performance, creation and competition cannot be over stressed. Thus, Digital Financial Innovations is modeled with financial deepening and economic growth as;

1. Functionally,
   M_3/GDP = f(ATM, INTWEB, POS, MOBS) - - - - - - 1
   CPs/GDPV =f(ATM, INTWEB, POS, MOBS) - - - - - - 2
   LDR = f(ATM, INTWEB, POS, MOBS) - - - - - - 3
   DIGDP = f(ATM, INTWEB, POS, MOSP) - - - - - - 4
   RDGP = f(ATM, INTWEB, POS, MOBP) - - - - - - 5
   Econometrically
   $M_3/GDP = B_o + B_1ATM_{it} + B_2\,INTWEB_{it} + B3\ POS_{it} + B_4MOBS_{it} + \mu$
   $CPs/GDPV = B_o + B_1ATM_{it} + B_2\,INTWEB_{it} + B3\ POS_{it} + B_4MOBS_{it} + \mu$
   $LDR = B_o + B_1ATM_{it} + B_2\,INTWEB_{it} + B3\ POS_{it} + B_4MOSP_{it} + \mu$
   $DIGDP = B_o + B_1ATM_{it} + B_2\,INTWEB_{it} + B3\ POS_{it} + B_4MOBS_{it} + \mu$
   $RDGP = B_o + B_1ATM_{it} + B_2\,INTWEB_{it} + B3\ POS_{it} + B_4MOBS_{it} + \mu$
   Where; 1. Dependent Variables (Financial Deepening indicators and economic growth).
   M_3/GDP = Broad money supply (m_2/GDP in %).
   CPS/GDP = credit to private sector
   LDR/GDP = loan-to-Deposit ratio as percentage of GGP
   D/GDP = Deposit to GDP
   RGDP = real gross domestic products
2. Independent variables – Digital financial innovation parameters by volume of digital transactions annually;
   ATM = Automated Teller Machine
   INTWEB = Internet Web Transfers
   POS = Point of Sales transactions
   MOBS = Mobile payments

Data Analysis and Discussion

Stationarity Test using Augmented Dickey-Fuller: Model 1

Variables	Level	1st Difference	2nd Difference	Conclusion
M3/GDP	1.902220	5.141914***	3.279860**	I(I)
ATM	2.741452**	5.941243***	12.95509***	I(I)
INTWEB	0.471446	3.624071**	4.047627**	I(I)
POS	0.952978	10.04174***	3.438365**	I(I)
MOBS	0.9335	6.055089***	8.233015***	I(I)

Note that ***, **, * indicates significance at 1%, 5% and 10% respectively

Author's Computation: Extract from Eviews

Stationarity Test using Augmented Dickey-Fuller: Model 2

Variables	Level	1st Difference	2nd Difference	Conclusion
CPS/GDP	3.872998***	3.482429**	4.757314***	I(0)
ATM	2.741452**	5.941243***	12.95509***	I(I)
INTWEB	0.471446	3.624071**	4.047627**	I(I)
POS	0.952978	10.04174***	3.438365**	I(I)
MOBS	0.9335	6.055089***	8.233015***	I(I)

Note that ***, **, * indicates significance at 1%, 5% and 10% respectively
Author's Computation: Extract from Eviews

The results of the stationarity test using the Augmented Dickey-Fuller (ADF) test for each variable at different levels (level, first difference, and second difference) are presented below. The purpose of the ADF test is to determine if a time series is stationary (i.e., has a constant mean and variance over time). The notations I(0) and I(1) indicate the order of integration of the series, where I(0) means the series is stationary at the level, I(1) means the series is stationary after first differencing and I(2) means the series is stationary after second differencing. From the above, CSP/GDP is stationary at I(0) while ATM, INTWEB, POS and MOBS all became stationary at I(1). Since, this is a mixed cointegration we shall proceed to conduct bound cointegration test.

Model 2: Bounds Cointegration Test Results

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	38.51484	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Author's Computation: Extract from Eviews

The F-statistic (38.51484) is much higher than the critical values for all significance levels (10%, 5%, 2.5%, 1%). This indicates that we can reject the null hypothesis of no levels relationship. There is strong evidence of a long-run equilibrium relationship among the variables.

Dependent Variable: CPS_GDP				
SHORT RUN EQUATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ATM)	-3.132254	0.118089	-26.52451	0.0001
D(INTWEB)	-0.901661	0.169735	-5.312184	0.0130
D(MOBS)	4.918907	0.371155	13.25298	0.0009
D(POS)	-0.267947	0.233379	-1.148119	0.3342
CointEq(-1)*	0.303524	0.012227	24.82413	0.0001
LONG RUN EQUATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ATM	12.30517	10.29479	1.195281	0.3178
INTWEB	7.683459	6.516896	1.179006	0.3234
MOBS	-39.31281	33.74261	-1.165079	0.3282
POS	13.94053	11.72186	1.189276	0.3199
R-squared	0.978161	F-statistic	14.92983	
Adjusted R-squared	0.912644	Prob(F-statistic)	0.023920	

The table above shows the relationship between CPS_GDP, ATM, INTWEB,MOBS, POS in the short and longrun. The coefficient of ATM is negative and highly significant ($p < 0.05$), indicating that an increase in D(ATM) leads to a decrease in D(CPS_GDP) in the short term. This suggests that changes in ATM usage are inversely related to the CPS/GDP ratio. Similarly, the coefficient for D(INTWEB) is also negative and significant ($p < 0.05$), implying that an increase in D(INTWEB) leads to a decrease in D(CPS_GDP) in the short term. The coefficient for D(MOBS) is positive and highly significant ($p < 0.05$). This indicates that an increase in D(MOBS) is associated with an increase in D(CPS_GDP) in the short term. On the other hand, the coefficient for D(POS) is negative but not statistically significant ($p > 0.05$), suggesting that changes in POS do not have a significant impact on D(CPS_GDP) in the short term.

Model 2: Post-estimation test results

Test Type	Test Stat.	Prob
Normality Test	Jarque-Bera Stat.(2.917893)	0.232481
Breusch-Godfrey Serial Correlation LM Test:	Prob. Chi-Square Stat (0.0278)	0.6700
Ramsey RESET Test	F-Stat (6.473922)	0.1259

Author's Computation: Extract from Eviews

The results from the diagnostic tests for the ARDL model provide insights into the validity and reliability of the model used to explain the relationship between GDPCPS_GDP and its determinants. We conducted three post-estimation test as seen above. These diagnostic tests indicate that the ARDL model is statistically sound, with no significant issues related to normality, serial correlation, or specification errors. The results imply that the model is appropriate for understanding the relationships between CPS_GDP and its explanatory variables.

Stationarity Test using Augmented Dickey-Fuller: Model 3

Variables	**Level**	**1st Difference**	**2nd Difference**	**Conclusion**
DGDP	3.606371**	7.039395***	14.22748**	I(0)
ATM	2.741452**	5.941243***	12.95509***	I(I)
INTWEB	0.471446	3.624071**	4.047627**	I(I)
POS	0.952978	10.04174***	3.438365**	I(I)
MOBS	0.9335	6.055089***	8.233015***	I(I)

Note that ***, **, * indicates significance at 1%, 5% and 10% respectively

Author's Computation: Extract from Eviews

The various ADF statistic above shows that all the variables are stationary at first difference I(0) except DGDP. Since there is a mixed cointegration, it is important for proceed to test for Bound Cointegration Test.

Model 3: Bounds Cointegration Test Results

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	208.9893	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Author's Computation: Extract from Eviews

The F-Bounds test assesses whether there is a long-run equilibrium relationship (cointegration) between the dependent variable and its regressors in an ARDL model. The test involves comparing the calculated F-statistic to the critical values for I(0) and I(1) bounds. I(0) Bound: Lower bound critical value, assuming all variables are stationary at levels (integrated of order 0, I(0)). I(1) Bound, upper bound critical value, assuming all variables are stationary after differencing once (integrated of order 1, I(1)). The decision rule is that if the F-statistic is below the lower bound (I(0)), we fail to reject the null hypothesis of no cointegration (no levels relationship).If the F-statistic is above the upper bound (I(1)), we reject the null hypothesis, indicating the presence of a cointegration relationship If the F-statistic is between the lower and upper bounds, then the test is inconclusive. Since the F-statistic (208.9893) is far above the upper bound critical value at all significance levels, we reject the null hypothesis of no levels relationship. The test results indicate strong evidence of a long-run (cointegrating) relationship between the dependent variable and its regressors in the ARDL model. This means the variables move together over the long term, maintaining a stable relationship despite any short-term fluctuations. The high F-statistic suggests the presence of a significant cointegration relationship, implying that any deviation from this long-run equilibrium will be corrected over time.

Dependent Variable: DGDP				
SHORT RUN EQUATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
CointEq(-1)*	-1.004581	0.021667	-46.36383	0.0000
LONG RUN EQUATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ATM	-622.5733	44.38739	-14.02590	0.0000
INTWEB	-17.11998	36.21773	-0.472696	0.6508
MOBS	-181.9385	135.9679	-1.338099	0.2227
POS	334.4776	91.61356	3.650962	0.0082
R-squared	0.987969	F-statistic	114.9694	
Adjusted R-squared	0.979376	Prob(F-statistic)	0.000001	

Author's Computation: Extract from Eviews

The ARDL error correction regression provides insights into the short-term dynamics and the speed of adjustment to the long-term equilibrium for the dependent variable, D(DGDP). The coefficient of the lagged error correction term CointEq (−1) is -1.004581, which is highly significant with a p-value of 0.0000 indicating significance at any conventional level. The negative sign and the magnitude of the coefficient (close to -1) suggest a very rapid adjustment to the long-term equilibrium. Specifically, approximately 100.5% of the disequilibrium from the previous period is corrected in the current period, indicating that the system overshoots slightly in correcting deviations from equilibrium. This strong correction rate implies that if there is any deviation from the long-run equilibrium, the model will correct it very quickly in the subsequent period, suggesting a very stable long-term relationship. From the results above, we can conclude that there are significant long-run relationships between DGDP and several of its regressors, particularly **ATM** and **POS**. **ATM** negatively affects DGDP,

while **POS** positively affects DGDP in the long run. **INTWEB** and **MOBS** are not significant in either the short-run or long-run context, indicating these factors may not directly influence DGDP within the scope of this model.

Model 3: Post-estimation test results

Test Type	Test Stat.	Prob
Normality Test	Jarque-Bera Stat.(1.812815)	0.403973
Breusch-Godfrey Serial Correlation LM Test:	Prob. Chi-Square Stat (0.2356)	0.5332

We conducted the Jarque-Bera to assess whether the residuals of the model are normally distributed. From our results, the Jarque-Bera test statistic is 1.812815, with a p-value of 0.403973. Since the p-value is greater than the conventional significance levels (0.01, 0.05, 0.10), we fail to reject the null hypothesis that the residuals are normally distributed. The residuals of Model 3 are normally distributed, satisfying one of the key assumptions for valid inference in regression analysis. Furthermore, the Breusch-Godfrey LM test was conducted. The test statistic of 0.2356, with a p-value of 0.5332 suggest that there is no serial correlation in the residuals which means that the model's error terms are not autocorrelated. This is a positive outcome as it indicates that the model is likely well specified in terms of capturing the relationship between variables over time.

Stationarity Test using Augmented Dickey-Fuller: Model 4

Variables	**Level**	**1st Difference**	**2nd Difference**	**Conclusion**
LDR	2.994508	3.613184**	4.653698**	I(I)
ATM	2.741452**	5.941243***	12.95509***	I(I)
INTWEB	0.471446	3.624071**	4.047627**	I(I)
POS	0.952978	10.04174***	3.438365**	I(I)
MOBS	0.9335	6.055089***	8.233015***	I(I)

Note that ***, **, * indicates significance at 1%, 5% and 10% respectively
Author's Computation: Extract from Eviews

Stationarity Test using Augmented Dickey-Fuller: Model 5

z	**Level**	**1st Difference**	**2nd Difference**	**Conclusion**
RGDP	20.67034***	7.103015***	21.24778***	I(0)
ATM	2.741452**	5.941243***	12.95509***	I(I)
INTWEB	0.471446	3.624071**	4.047627**	I(I)
POS	0.952978	10.04174***	3.438365**	I(I)
MOBS	0.9335	6.055089***	8.233015***	I(I)

Note that ***, **, * indicates significance at 1%, 5% and 10% respectively
Author's Computation: Extract from Eviews

The results in the above table shows that RGDP is stationary at level while other variables are stationary at first difference, suggesting that all variables are cointegrated at order I(I) except RGDP. We therefore proceed to run a Bound Cointegration test to confirm there is a longrunassociationship between the variables under consideration.

Model 5: Bounds Cointegration Test Results

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	13.38500	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Eviews Results

The calculated F-statistic (13.38500) is greater than the upper bound critical values (I(1)) at all common significance levels (10%, 5%, 2.5%, and 1%).Since the F-statistic exceeds the upper bound, we reject the null hypothesis of "no cointegration." This suggests that there is a significant long-term relationship between RGDP and the independent variables (ATM, INTWEB, MOBS, and POS).

Dependent Variable: Real Gross Domestic Product(RGDP)				
SHORT RUN EQUATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(ATM)	57.25422	3.650168	15.68537	0.0001
D(MOBS)	-5.931965	3.725974	-1.592058	0.1866
D(POS)	-11.05779	3.121508	-3.542452	0.0240
CointEq(-1)*	2.923030	0.217449	13.44238	0.0002
LONG RUN EQUATION				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ATM	-20.66873	3.097352	-6.673031	0.0026
INTWEB	-2.171417	1.231851	-1.762726	0.1527
MOBS	11.52116	4.181024	2.755584	0.0511
POS	-0.547243	2.913306	-0.187842	0.8601
R-squared	0.956819	F-statistic	11.07920	
Adjusted R-squared	0.870457	Prob(F-statistic)	0.017087	

Author's Computation: Extract from Eviews

The table above show the relationship between RGD, ATM, MOBS and POS in the short run and longrun. The variables D(ATM), D(MOBS), D(POS) are the differenced forms of the variables, reflecting short-term changes. The results show that there is a positive and significant relationship between ATM and RGDP. A highly significant positive short-term effect on the dependent variable (D(RGDP)) with a p-value less than 0.05, indicating a statistically significant relationship at a 1% significance level. For each unit change in D(ATM), D(RGDP) increases by 57.25422 units, ceteris paribus. Again, the results suggest that there is a negative relationship between MOBS and RGDP as indicated by the coefficient. However, the p-value is greater than 0.05, implying that the effect of D(MOBS) on D(RGDP) is not statistically significant at 5% significance levels The results from the above table also suggest a negative and significant relationship between POS and RGDP in the short-run with a p-value of 0.0240, indicating significance at the 5% level. For each unit change in D(POS), D(RGDP) decreases by 11.05779 units.

CointEq(-1) represent the error correction term with a coefficient of 2.923030, t-Statistic of 13.44238 and P-value of 0.0002 This term reflects the speed of adjustment to the long-term equilibrium after a short-term shock. The **CointEq(-1)** term is significant but has a positive sign, which is unconventional for ECM models and suggests potential issues or over-correction.
Again, in the longrun equation above, AMT has a significant and negative relationship with RGDP as represented by the coefficient: -20.66873, t-Statistic: -6.673031, Prob.: 0.0026. The result suggests a strong negative long-term relationship between ATM and RGDP. As ATM increases, RGDP tends to decrease in the long term. On the other hand, INTWEB with the Coefficient of 2.171417, t-Statistic of -1.762726, and Probof 0.1527 suggest that INTWEB does not have a significant long-term impact on

RGDP.Again, MOBS with Coefficient of 11.52116, t-Statistic: 2.755584 and Prob of 0.0511 suggest a marginal significant at the 5% level ($p \approx 0.05$) This result indicates a positive long-term relationship between MOBS and RGDP. Finally, POS with Coefficient of -0.547243, t-Statistic of -0.187842, andProb of 0.8601 suggest that the POS does not have a significant long-term impact on RGDP ($p>0.05$).

Post-estimation test results

Test Type	Test Stat.	Prob
Normality Test	Jarque-Bera Stat.(0.126384)	0.938763
Breusch-Godfrey Serial Correlation LM Test:	Prob. Chi-Square Stat (0.1043)	0.6523
Heteroskedasticity Test	Chi-Square 0.2092	0.2469

Author's Computation: Extract from Eviews

We conducted various post-estimation test in other t determine the reliability and usefulness of the model. The various results above accept the various null hypotheses. These results indicate that the model is well-specified in terms of these diagnostics. The assumptions of the classical linear regression model are not violated in terms of normality, homoscedasticity, or lack of autocorrelation.

Conclusion and Recommendations

This paper examines the effect of digital financial innovations on financial deepening and real growth in Nigeria over the period, 2009 to 2022 using the annual time series data. Digital finance is the common channels of penetration in the financial ecosystem leading to financial inclusion, financial deepening enhancing financial inclusion and narrow financial exclusion gap. From our results (findings), the CBN strive for financial inclusion via financial deepening initiatives are yielding result, hence the need to sustain it and advance strategies aimed at achieving its financial inclusion targets with mix and divers degree of effects of digital financial innovations on financial deepening measure and real growth within the Nigeria context, there is strategic need for both the regulator (CBN) and the operators (banks) between the dependent variable D/GDP and all the regressors within the ARDL model context. This points to the fact that despite the short-term fluctuations, that over lone time, there is a stable relationship among the variables under consideration. This imply that deviation in the short-time will be corrected overtime. It is noticed that ATM and POS negatively affects D/GDP, while POS positively affects it at the long-run.

Although INTWEB and MOBs influence were found not to be significant both at the short and long run. This suggests that these factors do not directly affect D/GDP within the scope of the model. Model 4; where LDR is the dependent variable; from the OLS outcomes, all the regressor influence LDR positively except MOBs at the short-run. At the long-run using the bonds test, INTWEB shows a negative but significant impact on LDR, while ATM, POS and MOBs presents a positive effect with greater influence coming from ATM. models; RGDP as dependent variable; the outcomes indicates that ATM impacted RGDP positively and significantly while others show a negative influence with significant impact from POS within the short-run context. At the long-run and drawing from the bonds cointegration test, our findings suggest that there is a significant long-run equilibrium relationship between RGDP and the explanatory variables with only ATM in Nigeria to come up with more financial development initiatives that encourage financial digitalization as to reap the benefit of digital financial inclusion which will in turn reduce financial exclusion to the barest minimum.

Based on the outcomes of this study we proposed that;

- Banks invest heavily in training and retraining of its personnels in the area of appreciating and mastering of digital finance in order to well positioned banks to have edge over digital financial intruders.
- With expertise gained from (a) above, in investing in digital financial product, services, banks will not only offer unique products or services but will as well combat cyber risks associated with digitalize finance.
- The CBN should continue to sustain its financial deepening (development) initiatives by expanding the financial ecosystem. It is believed that as the market became more competitive

products and services that are more appealing in terms of convenience, affordability, cost effective the financial exclusion gap would have been narrowed via financial ecosystem expansion.

- With stung effect coming from ATM and POS at both the short and long-run on financial deepening, is a pointer to the fact that Nigerians is still driven on cash, hence the need for CBN to intensified its current policy on cash rationalization.
- While the operators is to develop digital products and programs to effectively marriage cyber security risk inherent in digital finance, the CBN need to come up with superior regulatory and supervisory mechanism to checkmate providers of financial services.

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